IITB TECHNOLOGIES

Director's message

IIT Bombay has been active in education and research in science and engineering over the last 50 years. The campus community of 480 faculty members, 6300 students and 800 research staff are focussing their efforts on ensuring that their research makes a difference. We are happy to present this booklet that outlines some of the major technologies developed at the Institute. Several of these technologies have been patented and some have been licensed. We also have many technologies that have been licensed and are being commercialised by startup companies initiated by our faculty and students and supported by our Society for Innovation and Entrepreneurship (SINE).

I hope this booklet is useful to companies who are looking to commercialise new technologies and bring them to the market place as well as to attract researchers and students to the vibrant research atmosphere at the Institute.

Devang Khakhar

Director

Deans message

We thought it would be a good idea to compile some of the technologies developed at the Institute in the form of an easily readable booklet that is understandable to the general public. A brief summary of each technology and its features are included. We have classified technologies under different themes of Healthcare, Energy & Environment, Information & Communication Technologies, Manufacturing, Special Needs, Designs, Transportation and Rural Development. A few technologies have been included under "Other Technologies".

We have provided information regarding patenting and licensing. This booklet is not an exhaustive list of technologies developed at IIT Bombay. This compilation will be updated and enhanced in the future. We will be happy to provide additional technical details to companies and researchers who may be interested in specific technologies.

We welcome your feedback. This is a part of our ongoing efforts to disseminate research results, attract bright young minds to research at IIT Bombay and ensure that our research makes a difference.

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Cover Photo: Mask aligner used for optical lithography; Location: Clean room of Microelectronics Lab

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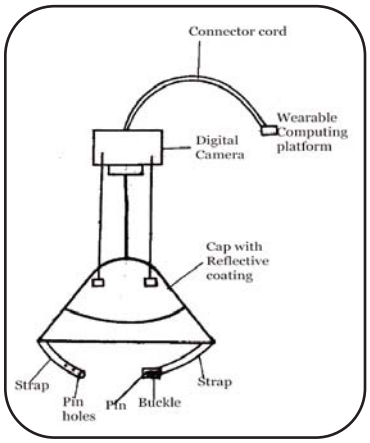
AN ENLIGHTENING DEVICE FOR VISUALLY IMPAIRED PEOPLE

A visually impaired person requires proper navigation as well as detailed description of the surroundings while traveling. Scientists through out the world wanted to develop some device to solve this problem. One such invention, describes a camera based object detection system for visually impaired persons where the user can identify the surrounding objects and independently navigate but he/she does not get a semantic or qualitative description of the surroundings. Scientists have also developed an apparatus to serve the same purpose where the visually impaired person can identify the adjacent objects but cannot get the perception of the surroundings while traversing.



Prof. S. Chaudhuri and his students of Department of Electrical Engineering have worked to develop a camera based device system for visually impaired persons which would give a semantic description of the surroundings. It is economical and light weight wearable (head mounted) device for a visually impaired person and gives him/her a semantic representation of the surroundings traversed by him/her, i.e a verbal narration of the surroundings. This helps the user to form an image of the neighboring vicinity. Furthermore, this device can be expanded to a robot navigation system where the remote operator gets a perception of the surroundings traversed by the robot.

The device is comprised of a cap adapted to be fitted on the head of the user (if head mounted, else to be appropriately worn), an image capturing means mounted on the cap, a computing platform connected to the image capturing means, a feature data store attached to the computing platform and an output module connected to the computer module (Fig. 1).

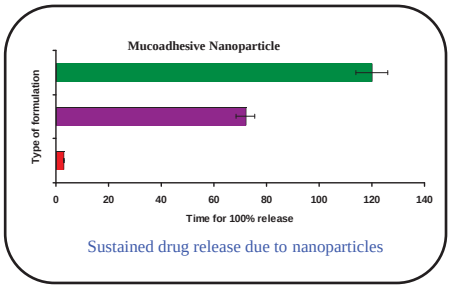
The computing platform is comprised of a laptop PC. The images of the surroundings are captured either by a non-calibrated digital camera or an omni directional camera.

Indian patent application no. 133/MUM/2006 Patent grant no. 225370
Inventors: S. Chaudhuri, Rajashekhar, A. Prabhudesai

The feature data is stored on a USB drive or hard disk. The digital camera takes the photographs of the images of the surroundings of the user reflected on the outer surface of the cap which is coated with reflective material like mercuric oxide. The omni directional camera takes the images itself and those are divided into several sectors. The laptop PC extracts the color component of the images taken by the camera, compares it with the reference feature and identifies the corresponding neighboring object. A narrative description associated with the identified feature is fed either to the speakers or to a Braille board display. As a result the user is enabled to perceive the surroundings traversed by him. When this device was tested on a visually impaired person, the estimated description of the surroundings matched with the reality thereby establishing that the newly invented device is precise and dependable.

PLATFORM TECHNOLOGIES FOR OCULAR DRUG DELIVERY

Current modalities of drug delivery in the eye are inefficient for posterior segment diseases. Only 1-2% of conventional eye drops and ointments reach the deeper tissues of the eye like vitreous, retina, choroid and retro-vitreal structures. To deliver the drug to these tissues is therefore a challenging task and nanotechnology is very promising among the various approaches in this direction.

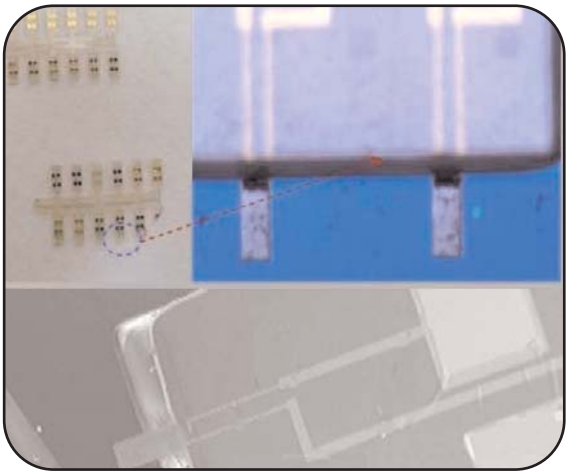


Sustained drug release due to nanoparticles

Poor penetration through tissues in the eye and washout of the drug by the tears are the two main drawbacks of existing modalities of drug delivery. Prof. Rinti Banerjee and her students at the Department of Biosciences & Bioengineering have developed several platform technologies of mucoadhesive nanoparticles and nanoparticulate inserts. These stick on to the anterior surface if the eye and resist the tear fluid washout. The nanoparticles and membranes are biodegradable and have superior penetration of drugs in the posterior segments of the eye.

These particles are less than 200 nm in diameter, and allow sustained release of the drug over prolonged periods. The formulations are stable and have high ocular penetration. The nanoparticles can be designed from different kinds of materials depending on the nature of the drug to be delivered. Further, the formulations can be used to deliver growth factors and dual drugs successfully. Such technologies will be useful for inflammatory, infectious and vasculopathic disorders of the posterior chamber of the eye.

A POINT-OF CARE SYSTEM FOR CARDIAC DIAGNOSTICS



According to some recent estimates, by 2010, over 60 % of the world's cardiac patients will be in India. However, cardiac related care is almost non-existent in the smaller hospitals and primary healthcare centres, and this project is expected to fulfil this need. The idea is to develop low-cost diagnostic aids for cardiac dysfunctions. As part of this vision, there is an ongoing effort by Prof. V. Ramgopal Rao with colleagues of Department of Electrical Engineering and colleagues of Department of Biosciences and Bioengineering, Department of Chemistry and Department of Mechanical Engineering and their students to develop an integrated system to provide point-of-care diagnostic support for cardiovascular diseases.

The system under development monitors the molecular markers to detect cardiac attacks, especially the incipient cardiac attacks that go undetected before major/fatal attacks occur. The system comprises of "infarcSens" or "iSens", which is a cantilever- and molecular FET-based affinity biosensor array for sensing myocardial infarction and subsequent cardiac status prognosis, using a suite of molecular markers. A low cost polymeric cantilever technology with embedded electrical readout schemes has been recently demonstrated in the group with electrical sensitivities in the range of a few ppm per nanometer of deflection, suitable for cardiac marker sensing. The sensing electronics is already in place while the associated data management software for tracking the markers with time, required for creating an epidemiological database, is currently under development.

CARBOGEN BREATHING APPARATUS

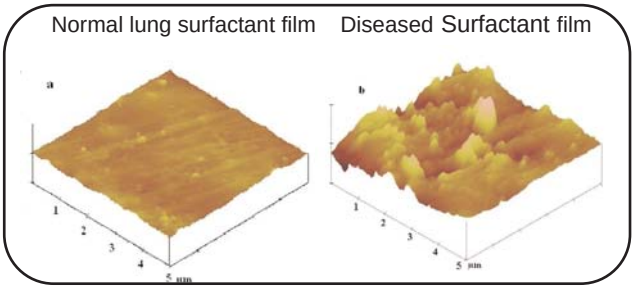
Prof. K. Munshi and his team from the Industrial Design Centre in association with a DRDO laboratory developed a system of Carbogen delivery for inhalation by persons working under high noise stress. Number of prototypes were developed and tested extensively with Indian Navy by Defence Institute for Physiology and Allied Sciences, Delhi. This system has been approved by Indian Navy for use of Jawans working in severe noise environments.

The system was developed in 3 capacities of 10 lit, 50 lit and 300 lit. The 300 lit unit has 10 stations and can accommodate 10 persons at a time for inhalation of Carbogen gas, which is a mixture containing 95% Oxygen and 5% Carbon Dioxide. Carbogen has a therapeutic role for impaired hearing and relieves the stresses due to noise pollution. If this is inhaled for 5 minutes, 2-3 times a day, the ill effects of working in severe noise environments, or noise stress can be eliminated.

It finds extensive use in Defence related environments such as firing ranges, aircraft hangers, ship engine rooms etc and in civil locations such as oxygen bars, traffic islands, fitness centres, workshops, factories etc.

Design transferred to Defence Establishment for deployment

SURFACE ACTIVE NANOVESICLES AS PLATFORM TECHNOLOGIES FOR RESPIRATORY DISEASES



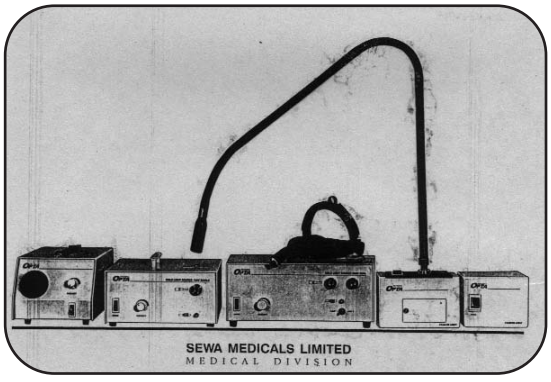
A complex lipoprotein based substance called pulmonary surfactant lines our lungs and reduces the work of breathing. Due to dysfunction, in many pediatric and adult respiratory diseases, there is a need to develop suitable artificial replacements of this material.

For example, ARDS (acute respiratory distress syndrome) is a life-threatening condition and is a severe form of lung injury. The alveolar epithelium and vascular endothelium gets damaged and results in the leakage of blood proteins (serum, albumin, fibrinogen) and inflammatory markers in the alveoli. Various blood proteins like albumin, serum and fibrinogen are potent inhibitors of lung surfactant.

ARDS can also be associated with other diseases like pneumonia, asthma, malaria, dengue and can also be induced by drugs like bleomycin. Both direct and indirect lung injuries can result in the development of ARDS. Animal derived surfactants are presently used to treat ARDS. In addition, any respiratory condition with surfactant deficiency like Neonatal Respiratory Distress Syndrome (NRDS) requires treatment with a surfactant. Further, surfactant therapy is also required for inflammatory lung diseases like asthma, chronic obstructive pulmonary disease (COPD), drug induced respiratory distress and occupational lung diseases. A large portion of the fatalities related to H1N1 was due to ARDS.

Prof. Rinti Banerjee and her students at the Department of Biosciences and Bioengineering have developed several nanoparticulate surfactant replacements that can work as artificial lung surfactants and be used as therapy in these respiratory diseases. Lipid based nanovesicles which have the desired surface activity, are biodegradable and safe for in vivo administration act as platform technologies that can be tailor made for the treatment of surfactant dysfunction seen in various respiratory diseases. The surface active vesicles can be administered as aerosols and can further be drug loaded for efficient therapy in many respiratory diseases. These nanoparticles surfactant replacements have the potential to improve treatment and recovery from ARDS.

MICRO-ENGINEERED BIOMEDICAL DEVICES FOR TRANSCATHETRAL AND ENDOSCOPIC SURGERY

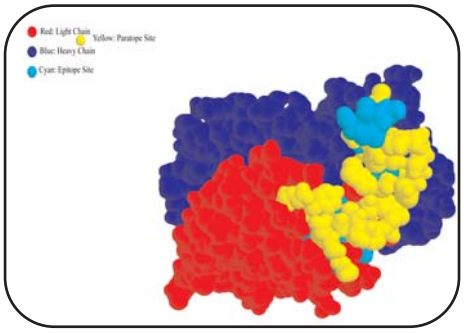


Technology support is vital to the field of minimally invasive surgery. Miniature optical devices and mechanical manipulators have to be designed and produced with precision. Prof. J. Bellare of Department of Chemical Engineering with his colleagues and students have been active in the areas of optical systems design, including fibre-optic and micro-optic technology for illumination and visualization, and more recently, the design of occlusion devices for trans-cathetral surgery. A vertically integrated fibre-optic plant has been designed at IIT Bombay, which is capable of drawing light-guide and image-guide fibres. The fibres are used in end products for light-guide applications, where bundles are made with maximum possible packing density, fused at the ends into hexagonal close-packed arrangements, and then optically polished using a gantry polisher developed in-house.

The ductus arteriosus represents a communication between the aorta and the pulmonary artery which closes at the time of birth. Some babies fail to close this connection naturally, so, there is need to close this abnormal connection artificially. A transcatheter closure is done with a micro device implanted at the patent ductus arteriosus site. IIT Bombay has developed some viable designs which function like a miniature umbrella. The device can travel across a guide-wire and can be unfurled in place.

PARADES SOFTWARE

Developed indigenously by Prof. Rajani R Joshi of Mathematics Department, ParaDes is user-friendly Linux-based software with potential applications in protein function recognition, drug design and vaccine synthesis. The software has been tested on antigen-antibody complex data available in the protein data banks (pdb) and is of high accuracy. It has been used to find the paratopes for recently predicted epitopes of envelope glycoprotein of the Japanese Encephalitis Virus, and to predict the immunogenic functions of some new proteins including HSPI, and an EF-Hand Ca^{++} binding protein.

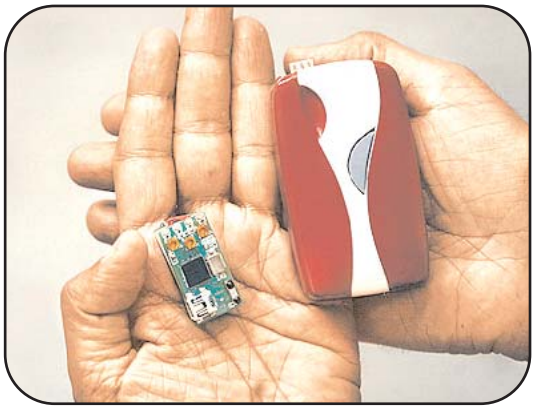


Copyright awarded SW -698/2002

The software was developed as part of a project sponsored by the Department of Biotechnology. Extension of the project towards applications in vaccine designing is under progress.

SILICON LOCKET FOR CARDIAC MONITORING

For mobile monitoring of ECG, a small toffee-sized low-cost locket has recently been developed by Prof. D. K. Sharma and his colleagues from Department of Electrical Engineering and colleagues from Department of Biosciences and Bioengineering and their students by integrating a low power microcomputer with an indigenously developed operating system, analog front-end electronics and a re-chargeable battery with an in-built charger. The system is optimized to acquire a three lead simultaneous electrocardiogram (ECG), reconfigurable up to 12-leads, and can correct for motion artefacts arising out of the physical activity of the patient. The ECG data can be either stored in the Micro Secure Digital card memory, or transmitted through a phone modem or GPRS network.



An arrhythmia event can be detected in real-time using the built-in algorithms and the system is configured to automatically inform a medical practitioner through SMS in the event of an arrhythmia. The system also allows the doctor to remotely login to the locket to view patient's ECG in real time or download the data using a graphical user interface.

The locket is equipped with USB, IrDA and RS232 ports for seamless integration with public networks, mobile phones, and personal computers. An ultra low power custom made analog integrated circuit (IC) is designed and tested which performs all the data acquisition & signal conditioning. A low cost polymeric accelerometer technology developed in the centre is integrated into the electrodes to detect and remove motion artifacts in ambulatory subjects. A pluggable ultra-small PSTN modem is constructed to transfer data to a remote computer or medical database. A 32-bit system-on-chip based base-station is also developed as an accessory for the Silicon Locket.

The base station is a handheld system with a higher processing power and a colour TFT LCD panel. The base unit primarily has advanced in-built data management and analysis software for ECG analysis. The silicon locket, developed in cooperation with the Tata Consultancy Services, is the smallest wearable ECG recorder in the world, for its features.

Technology is currently being transferred to industry.

VIRTUAL SURGERY AND PROSTHESIS DESIGN

The location of malignant bone tumours can be pinpointed by CT scans. It is however, difficult to visualize their 3D shape (necessary for accurate surgery planning and prosthesis design), especially for intricate bone formations such as the pelvis. This problem can be overcome by a combination of CAD/CAM and Rapid Prototyping (RP) technologies. The scans are 'stitched together' into a 3D model using medical modeling software. Then a haptic (or touch) based system is used for planning the resection, and performing a virtual surgery. Finally, the remaining portion of the bone is fabricated by the RP system and tested for fit with a custom-made prosthesis.

This approach has been successfully demonstrated in the case of a patient (46, female) diagnosed with pelvic bone tumour just above the hip joint, in a collaborative project taken up by Prof. B. Ravi of Department of Mechanical Engineering and his students with Tata Memorial Hospital, Mumbai.

POLYSENSORS AND BIOSENSOR

Polysensors

Prof. A.Q.Contractor and his students in the Department of Chemistry have developed a hand-held sensor assembly (including the transducer & corresponding electronic system) for monitoring the quality of drinking water. This Polysensor device is based on a conducting polymer and uses the potentiometric / conductometric technique for measurement. In this technique a receptor is immobilized in the polymer matrix. The interaction of the analyte with the receptor changes the chemical state of the polymer and this is manifested as a change in potential/conductivity of the polymer. This change can be monitored by applying a measuring signal to the sensor. By an appropriate choice of receptor, specific sensors for a variety of analyte species are being designed.

Biosensor

Biosensors can be used to measure the concentration of biomolecules in various applications. They can be used to measure blood sugar, haemoglobin, cholesterol, and urine sugar in clinical diagnosis, soil urea in agriculture and fat in food in fermentors and in the biotech industry.

The biosensor developed by Prof. A. Q. Contractor can be used to measure biomolecules based on electrical conductance. It is very sensitive and has quick response. The biosensor array has one or more conductance sensing units. This unit is composed of a pair of electrodes spaced apart and located in an inert electrically insulating matrix. An electronically conducting polymer bridge is deposited across the electrodes. The set up has one enzyme/receptor specific to the biomolecule to be measured, immobilized in the array. A conductance measuring circuit is connected to the electrode array. A reference sensor without the immobilized enzyme can also be attached helping to compare biomolecule levels in the desired sample to be tested. Biosensors of this type can be integrated into one unit to sense multiple analytes and give favourable results.

Indian patent application no. 89/BOM/94 Patent grant no. 179848
Inventor: A. Q. Contractor

Based on this work, Polymeric Sensors Pvt. Ltd., a company incubated at IIT Bombay, designs, manufactures and markets biosensor and polymer sensor based testing systems for various fluids in the areas of Agriculture, Environment and Healthcare. The products are indigenous, cost effective, compact, portable lab-on-chip devices enabling digitised inputs and are computer compatible for quantitative analysis. The technology enables on the spot testing of samples and the products can be easily enhanced to test for many parameters in a single attempt for e.g. Polysense Aqua is a compact instrument, which assesses potability of available water . The current focus is marketing of products for testing water, with future plans for products that have potential in milk, soil and healthcare applications.

Technologies licensed to Polymeric Sensors Pvt. Ltd., an incubatee company at IIT Bombay

ELECTRODIAGNOSTIC EQUIPMENT

An electrical signal can be applied to a nerve and the resultant evoked electrical signals or responses from the nerve to which the initial signal was applied, or other nerves or muscles connected to it can also be measured. The nervous system can be examined in this way. Such instruments that measure electrical signals or clinical electrodiagnostic instruments are mostly of analog type which makes use of a cathode ray oscilloscope (CRO) for signal processing and display. The analog devices are incapable of numerical calculations.

Digital electrodiagnostic instruments have at least one signal pickup channel and an optional stimulatory channel. The channels are connected to a dedicated microprocessor or personal computer through a system for data collection and control. The signal pickup channel comprises of a pair of pickup electrodes connected to a biopotential amplifier, a frequency filter and an isolator. The stimulator channel comprises of a pair of stimulation electrodes connected to an electrical stimulator. Data is collected by a data acquisition system. It includes components such asa digital converter, memory and timer.

Prof. S. Devasahayam of Department of Bioscience and Bioengineering had devised an electrodiagnostic instrument for electromyography (EMG) and nerve conduction measurement. It has signal pickup channel and stimulator channels which are connected to an audio jack connectable to a multimedia card of a PC. The pickup channel has been designed to be placed removably on the part of the body when tests are made. It is connected to a biopotential amplifier, a frequency filter and isolator. Similarly stimulatory system has electrodes, an input jack and isolator. The input signal generated from pickup channels are inputted by an analog signal generator. The system has software to control the input audio signals base values and collection of signals and measurement of the data needed.

Indian patent application no. 14/MUM/2001 Patent grant no. 206022
Inventor: S. Devasahayam

NOVEL FERROFLUIDS

Ferrofluid is a colloidal mixture composed of nanoparticles suspended in a fluid such as an organic solvent or water. Different methods of preparation of ferrofluid involve steps of precipitation of the magnetic particles, their surface treatment and the use of dispersing mediums to obtain the fluid.

Prof. D. Bahadur and his student of Department of Metallurgical Engineering and Materials Science have developed a novel two stage process for the preparation of a ferrofluid that is superior in terms of achievable sizes of the superparamagnetic (SP) particle. In the first stage, precipitation happens in the presence of surface modifying agents to obtain dried SP particles that can be stored and transported in a non-hazardous manner. The particles depending on their application, are dispersed in a known volume of carrier liquid to obtain tailored ferrofluid. In the second stage of the novel method, bypassing the typical dilution process that may destabilize the fluid is done.

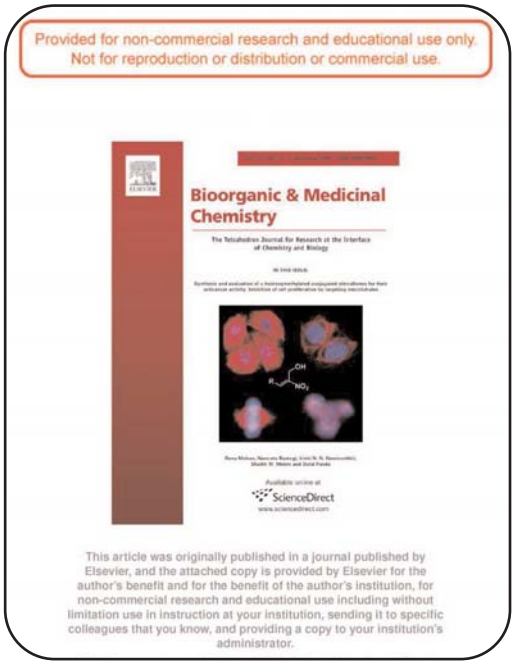
To prepare the SP particles (SPP), Fe^{2+} / Fe^{3+} based substances in an acetone and ammonia added solution, are stirred and heated. Magnetic particles collected under the influence of a magnet field are finally washed with water and acetone several times and dried. This procedure performed is half the task completed quicker. In another embodiment of the invention, the required weight of the dried SPP is added to the carrier liquid and after centrifugation, gives the required magnetization ferrofluid; removing the bad particles, which may destabilize under the influence of gravity and external magnetic, centrifugal forces.

Chemical tests showed successful creation of ferrofluids using their patented method with measured magnetization from 12 - 30 emu/cc at room temperatures. Besides electronic devices where nanotechnology is applied in a large scale, ferrofluids have found use in mechanical, military and aerospace in a variety of uses from simple friction-reduction seals to decreasing the electromagnetic signal of an aircraft and spaceship control. This can be applied in medicinal instruments today not only assisting doctors in detecting critical cancers, but can also take shape in the form of art that can promote science in schools and museums.

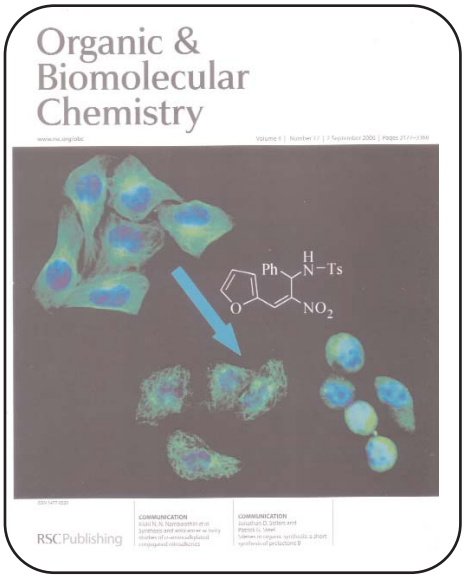
Indian patent application no. 475/MUM/2004 Patent grant no. 210641
Inventors: D. Bahadur, J.Giri

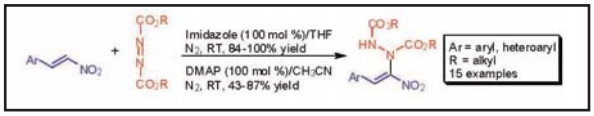
METHODS OF PREPARATION OF α-HYDRAZINO-α, ß-UNSATURATED NITRO COMPOUNDS

Morita-Baylis-Hillman (MBH) reaction is the coupling of the -position of activated alkenes (vinyl anion equivalents) with various carbon electrophiles mediated by a tertiary amine or tertiary phosphine. MBH reaction has emerged as a simple, convenient and one-pot methodology for C-C bond forming reaction in organic synthesis. However, C-N bond formation via similar strategy has been barely investigated despite the fact that C-N bond forming strategies offer convenient access into natural/unnatural amino acids and other synthetically and biologically useful building blocks.



Prof. Irishi N.N. Namboothiri and his students at Department of Chemistry have developed a method of preparation of a-Hydrazino-a, ß-Unsaturated Nitro Compounds. Although, ß-unsaturated nitro compounds (conjugated nitroalkenes) are powerful Michael acceptors and the first step in the MBH reaction is the Michael type addition of the nucleophilic amine catalyst, conjugated nitroalkenes are evident by their absence from the activated alkenes used in coupling with various electrophiles. This is presumably because the Michael type addition of amine catalyst to nitroalkenes, though takes place rapidly, suffers from the competitive retro-Michael addition. Furthermore, due to the poor nucleophilicity of the nitronate (arising from initial Michael type addition of the nucleophilic amine catalyst) and the propensity of the nitroalkenes to undergo polymerization, all previous attempts to carry out the MBH type reaction of nitroalkenes were fraught with difficulties. The compounds have been found to inhibit human cervical cancer cell proliferation by binding to microtubules/tubulins (Figure).





It has been a long standing need in the industry and in the scientific community to provide simplistic methods for C-N bond formation which have wide applications especially in the synthesis of amino acids and other biologically useful building blocks. The main objective of the present invention is to provide commercially viable single pot process for the preparation of a-hydrazino-a, ß-unsaturated nitro compounds from, ß-unsaturated nitro compounds in high yields. To obtain this, a conjugated nitroalkene was reacted with an azo compound in the presence of a cyclic or acyclic amine as catalyst and a-hydrazino-a, ß-unsaturated nitro compound produced (Scheme). During a standard reaction procedure a solution of nitroalkene and azo compound is stirred at room temperature until the reaction goes to completion. The reaction mixture is then diluted with aqueous acid and the aqueous layer is extracted with a suitable organic solvent. Finally, the combined organic layers are concentrated to yield a substantially pure a-hydrazino-a, ß-unsaturated nitro compound. This reaction is carried out in the presence or absence of a range of solvents (e.g. methanol, chloroform, benzene, acetone etc.) which do not react with either of the coupling partners. Several a-hydrazino- a, ß-unsaturated nitro compounds were prepared to establish the process.

Indian patent application no. 1410/MUM/2005 Patent grant no. 226803
Inventors: I. N. N. Namboothiri, M. Dadwal

PRODUCTION OF NANOPARTICLES USING SUBCRITICAL CARBON DIOXIDE

Prof. M. Mukhopadhyay and her student of Department of Chemical Engineering have developed a new drug delivery system with a prolonged bio-activity and enhanced drug dissolution rate. The efficiency of any drug depends upon their size, morphology and size distribution, as their solubility in the body fluid depends upon these factors. Lower the particle size of these solid drugs, higher would be their dissolution rates and their bioavailability in the body fluids.

For new drug delivery systems like dry powder inhalers, needle-free injections and controlled release devices, there is a long-felt requirement for micronized drugs with a narrow particle size distribution (PSD) for enhancement of drug dissolution rate and bio-activity and elimination of repetitive or excessive dosage. Scientists have developed crystallization processes where supercritical carbon dioxide (SC CO_2) is used to produce nano/ultra-fine particles.

However, these SC CO_2 processes have most of the following disadvantages:

(i) very high pressure requirement
(ii) high pressure CO_2 pumps
(iii) fine nozzle devices for spraying which is prone to clogging
(iv) accurate control of pressure, temperature, flow rates and concentration
(v) usage of a large amount of SC $C0_2$ for removal of solvent

To solve the above-mentioned disadvantages, a process has been developed in IIT Bombay for production of nanoparticles of solids soluble in organic solvents by using sub-critical carbon dioxide. In this process $C0_2$ at a low initial pressure in the range of 25-70 bar and a near ambient temperature is used to avoid the usage of any equipment for generation of high pressure and high temperature. Furthermore, in this process the use of depressurization of the solution is avoided and so the use of specially designed nozzles is not required.

This newly invented process involves (i) dissolution of the solid substance in an organic solvent (ii) pressurizing the solution with CO_2 to attain a pressure of 25-70 bar and then (iii) bleeding off CO_2 over the solution for drastic lowering of the solution temperature within a time span of 0.5 to 5 minutes. This causes extremely high, very rapid and uniform supersaturation in the solution leading to crystallization of the solid to nanoparticles with narrow particle size distribution.

Indian patent application no. 544/MUM/2004 Patent grant no. 213605
Inventors: S. Dalvi, M. Mukhopadhyay

A NEW METHOD FOR CHEAPER AND LONGER LASTING BIOIMPLANTS

Prof. B. P. Kashyap and his team at of Department of Metallurgical Engineering and Materials Science have invented an improved material to make bio-implants that can be used as a substitute for bone. For a material to be suitable as a bio-implant it must not be rejected by the human body, be able to integrate with the undamaged portion of the bone, should have superior mechanical properties and it should not loosen and fracture the bone.

To meet this requirement, IIT Bombay researchers have developed a novel porous bioactive titanium implant. This was achieved by mixing bioactive materials like calcium hydroxyapatite, octacalcium phosphate, tricalcium phosphate and calcium titanate with bioinert titanium, its compounds / alloys. The powdered ingredients were mixed using ball milling and high-energy milling which warrants close contact of the constituents. To ensure uniform distribution of the ingredients, titanium was added in the form of Titanium hydride for uniform distribution. The resulting material had the required mechanical strength, high resistance to corrosion and was non-toxic. In addition, an advantage of this process is that the pore size can be controlled to allow natural tissue growth. The starting materials are easily available and inexpensive, this invention making this technology very lucrative for commercial purposes.

Indian patent application no. 2490/DEL/2005 Patent grant no. 228353
Inventors: M. Karanjai, R. Sundaresan, T. R. R. Mohan, B. P. Kashyap

SEQUENTIAL SUPERCRITICAL CO_2 EXTRACTION AND FRACTIONATION OF NEEM OIL

Neem and neem products such as oil or extract are well known for their insecticidal / pesticidal / therapeutic / cosmetic properties. Processes for the production of neem oil using neem kernels and leaves developed earlier but these are not efficient / economical, as the active components in neem oil by these processes have lower stability and lower shelf life.

A better process was developed by Prof. M. Mukhopadhyay of Department of Chemical Engineering. The process comprises a sequence of static and dynamic extraction from neem kernels and fractionation of neem oil enriched with azadirachtin using supercritical CO_2. Based on this sequence, Neem oil fractions enriched with azadirachtin are collected at different intervals of time by depressurisation of the outgoing extract-laden supercritical CO_2 to atmospheric pressure for a predetermined period of time.

The depressurisation is carried out by shutting off inflow of supercritical CO_2 into the extractor and simultaneously releasing extract-laden supercritical CO_2 from the extractor and condensation of the outgoing extract-laden supercritical CO_2 in a separator. The above sequence of static extraction, dynamic extraction and depressurization is repeated a number of times. Then the residual neem kernels in the extractor is treated with an alcohol. The sequence of alcohol treatment, static extraction, dynamic extraction and depressurization is also repeated till the extraction is complete.

A remarkable feature of this process is that it results products of neem oil enriched with azadirachtin of varying concentrations, some being very high, along with other active components and also gives dry neem cakes as a by product, which can be used as a fertilizer.

Indian patent application no. 428/BOM/97 Patent grant no. 182587
Inventor: M. Mukhopadhyay

PROCESS FOR ACTIVATION OF EPOXY SURFACES

Prof. Soumyo Mukherji and his team at Department of Biosciences and Bioengineering have developed a rapid and simple process for activation of epoxy surfaces such as SU-8 (Glycidyl ether of bisphenol A), to enable surface immobilization of molecules with carboxyl and / or amino functional groups.

Microsystems for biological applications require immobilization of biological molecules within the device. Conventionally, substrate materials used for these devices have been silicon and noble metals (e.g. gold) which have been found to have shortcomings in terms of their high Young's modulus, biocompatibility and their suitability for micro fabrication. Immobilization of bio-molecules onto epoxy surfaces such as SU-8 is of interest because of their application in surface modification, bioMEMS, biomolecule immobilization related assays, biosensors, membrane bioreactors, clinical diagnostics, molecular biology, agriculture, environmental science and chemical / biochemical industry.

Bare SU-8 patterned with conventional photolithography techniques does not allow the immobilization of antibodies on its surface. Several methods are known for the modifications of polymer surfaces are not suitable for SU8 surface modification. The process of the invention developed at IIT Bombay involves grafting of NH2+ groups on the epoxy (e.g. SU-8) surface using hotwire induced pyrolytic decomposition of ammonia under vacuum, followed by antibody immobilization on the treated SU-8 surface. The process of the invention enables single or multi-step tailored immobilization of biomolecules (antigen, antibodies, proteins, DNA, RNA enzymes etc.) on the modified epoxy surface.

Indian patent application no. 1267/MUM/2004 Patent grant no. 213504
Inventors: S. Mukherji, R. Lal, R. Rao, R.O. Dusane, M. Joshi

ENGINEERED ECOSYSTEMS FOR WASTE MANAGEMENT

Organic wastes from human and animal habitations can accumulate in and endanger the environment. Engineered ecosystems research for waste conversion has led to the development of Vermiculture Technology at IIT Bombay, developed by Prof. H. S. Shankar and his students of Department of Chemical Engineering. This process overcomes the problems associated with conventional methods such as solid state composting, activated sludge, and extended aeration in which bio-energy gets dissipated. It engages an ecology consisting of soil, plants and soil micro and macro-organisms including geophagous earthworms. The process obtains synergy between photosynthesis and respiration, so that bio-energy of wastes is fully utilized.

Indian patent application no. 384/MUM/2002 Patent grant no. 203425
Indian patent application no. 383/MUM/2002 Patent grant no. 203744
US Patent granted no. 6,890,432 B2 & 7,604,742 B2
Inventors: B. R. Pattanaik, U. S. Bhawalkar , H. S. Shankar

Facilitated through initial support by the Department of Biotechnology, the process has major potential in City farming, Animal husbandry, Agriculture, Wasteland development and Agro-industrial waste processing.

Bio-reactor for Recycling of Waste Water

Engineered ecosystems may also be used for treatment of liquid wastes. Cultured Soil Filter Technology developed for this purpose consists of impervious containment (typically 1.0 - 1.5m below ground), and incorporates soil, filtration media, soil organisms like earthworms, and plants.

Technology licensed to
- Vision Earthcare Pvt. Ltd., incubated at IIT Bombay
- Lifelink Consultants and Services

Features

- A cost-effective 'green' technology, suitable for all solid and liquid organic waste
- Very low energy consumption
- Bio-mineral fertilizers and soil as by-products
- No sludge production, unlike conventional units
- Self-sustaining revenue model

Applications

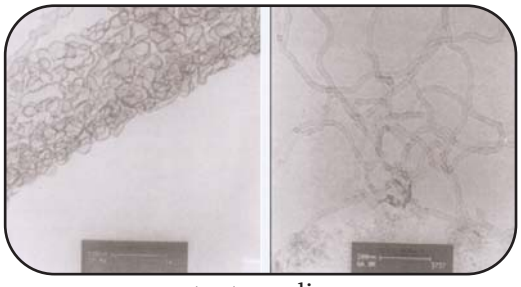
- Treatment of water for irrigation, construction, and soil application
- Industrial effluent treatment
- Processing solid wastes
- Non-chemical purification of swimming pools and drinking water

The technology has been adopted by several user organisations.

Based on the above novel technology patented both in India and USA, Vision Earthcare has been incubated in IIT Bombay for deploying this technology. This company provides products and services in the area of water & air purification and soil & sanitation.

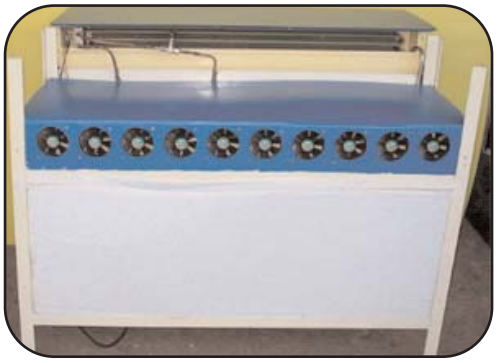
CARBON NANO-MATERIALS FROM RENEWABLE SOURCE

A process for synthesis of carbon nano-materials using Cashew nut shells has been developed by Prof. A. Ganesh and her students of the Department of Energy Sciences and Engineering. A combination of the catalyst, and the substrate gives the required structure, i.e, nanotubes, nanofibre, nanorings or rope-like nano-platelets. Some typical structures are shown. Each of these structures have different properties and have different applications.



patent pending

Plastic solar dryers



Plastic Solar Dryers are based on technology developed by Prof. M. V. Rane and his team of Department of Mechanical Engineering, wherein, light weight plastic collectors generate hot air to dry fruits, vegetables, herbs or spices. Hot air required for low temperature drying is circulated using PV operated fan for off-grid applications. Grapes, tomatoes, onion, guava, can be dried with the hot air, with out exposure to direct sunlight. Low temperature drying usually results in better quality products resulting in higher value realization.

Benefits

Plastic Solar Dryers based on novel light-weight high efficiency Plastic Solar Air Heaters costing about Rs 5000 to 6000/m^2 aperture area can be coupled to efficiently heat ambient air to 50 to 900 C for use in dryers. These solar dryers can be effectively used in off-grid locations. Expected payback for drying various agro produce like onions, grapes, ginger and herbs is in the range of 1 to 1.5 years.

There are several lucrative opportunities to benefit from solar dryer technologies in our country.

Indian patent application no. 986/MUM/2004 Patent grant no. 234778
Inventors: M. V Rane

Conditioning of air using liquid desiccants

Prof. M.V. Rane and his team of Department of Mechanical Engineering have formulated a process for the energy efficient conditioning of air using liquid desiccant (CAULD). The device which comes in contact with the air can function as an exchanger that has no loss or gain of heat to the surrounding, or even a loss or gain thermodynamically. The contacting device (device which comes in contact with the air) can function as humidifiers, dehumidifiers or; direct, indirect Evaporative Coolers (EC). The system is devised such that the liquid desiccant can be regenerated by multi or single stages. This ensures that the conditioned air by the process does not contain any desiccant in it.

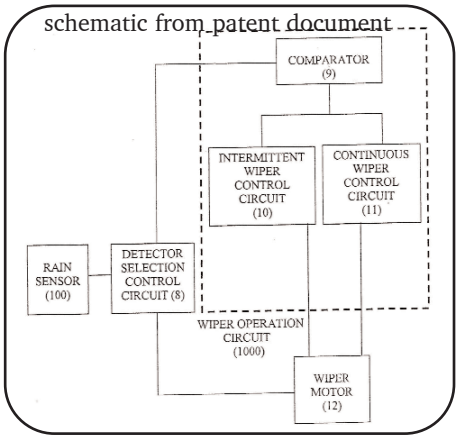
Compared to conventional VCRS, electrical power consumption is significantly reduced in the present invention. The system using CAULD is modular and can be scaled up / down to meet any air conditioning load. It operates with lower pressure drops and low desiccant flow rates compared to conventional desiccant cooling systems.

The main advantages of the CAULD is that the outgoing air stream is free of desiccant as compared to the conventional liquid dessicant based air conditioning, uses low grade heat sources and has possibility of recovering water. This is possible by the appropriate design of the dehumidifier, regenerator, liquid-liquid heat exchanger air-air heat exchangers and other components of CAULD. Significant reduction in weight and cost can be achieved with the use of alternate materials such as plastics and problems due to corrosion of the dehumidifier/regenerator as in conventional systems is eliminated. The system is compact, low weight and techno-economically viable for air-conditioning.

Indian patent application no. 272/MUM/2003 Patent grant no. 206320
Inventors: M. V Rane, S.V. Kota Reddy, R. R. Easow

AUTOMATED WIND SHIELD WIPER

For safe driving, a clean wind shield is an essential requirement. Usually the driver himself activates the wind shield wiper system of his / her vehicle during rain for clear vision. Several researchers have worked for the development of an automated wind shield wiper system and several patents have been filed on this aspect.



The basic principle of all these automated systems is detecting the water droplets on the windscreen with an appropriate sensor and then transmitting the signal to a device to activate the wiping system. But there were several disadvantages of these automated wiper e.g. inconsistent response, limited speed variation, extraneous mechanical vibration, partial clearing etc. To resolve all these shortcomings Anish Lohokare, a student of Department of Mechanical Engineering has developed a user-friendly, reliable and cost effective automatic wiper which can be regulated, based on the intensity of rainfall and also can be adapted for use in variety of vehicles. This system is available with a combination for manual option to change the transition from intermittent to continuous wiper speed as and when required. Moreover, this programmed system is available with a suitable combination of both dwell time variations between two wiping cycles of the wiper and speed control of the wiper motor or continuous operation with speed control depending on the rainfall intensity and frequency.

The entire process of operation of the automated wiper is described by a schematic diagram. As depicted in the figure, the system comprises of a rain sensor for rain water measurement which is connected to a detector selection control circuit. The rain-measuring device comprises of a calibrated collection vessel with perforations at specific heights that enable outflow of water at specific rate collected in the collection vessel at varying amount with the intensity of the rainfall. The control circuit is connected to the wiper motor directly as well as through the wiper operation circuit for the desired selective operation of the wiper. This detector control circuit is adapted to generate output signals based on the rain sensor assembly output to selectively activate or deactivate wiper motor driving wipers directly or through the wiper operation circuit. The wiper operation circuit consists of comparator, intermittent wiper control circuit and continuous wiper control circuit.

Indian patent application no. 1152/MUM/2001 Patent grant no. 198020
Inventors: A. Lohokare

4 - IN - 1 HEAT PUMP TECHNOLOGY

Novel design with air conditioning, water heating, water chilling, and cloth drying in a single unit has been developed by Prof. M. V. Rane and his student of Department of Mechanical Engineering.

Features:

- Integrated system and simple to operate
- High heat transfer coefficients: novel tubular exchangers
- Instant-on-demand supply of hot and cold water: no storage required
- Chills portable water to 18°C: and heats tap water to 45°C
- Low operating costs: 60 to 70% reduction in operating costs
- Lower initial cost: compared to the conventional air conditioner + electric water heater + water cooler
- Compact design: same footprint as that of window or split air conditioner

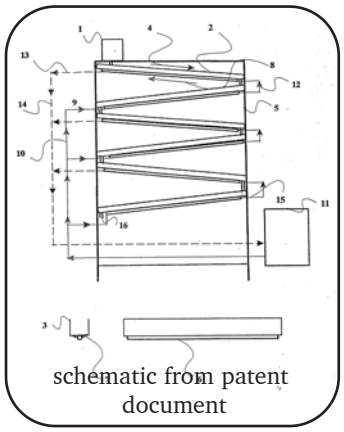
Indian patent application no. 613/MUM/2003 Patent grant no. 212316
Inventors: M. V. Rane and A. Dasgupta

Applications:

- Residential: simultaneous space cooling, water heating and cold water for drinking
- Commercial --- hotels, restaurants, hospitals
- Industrial --- dairy, pharmaceutical, textile, chemical process

Freeze concentration system

Freeze concentration as a technique is widely used in beverage industry, such as coffee, tea, wine, milk, beer, fruit juices etc., for reducing volume to be handled during storage, transportation and sale. The beverage industry's demand for high quality products at acceptable prices generally drives the development of new process technologies.


schematic from patent document

Prof. M.V. Rane and his student of Department of Mechanical Engineering have invented an energy efficient, simple and inexpensive Freeze Concentration System (FCS). The system can be used to selectively freeze solvent solutions using a heat pump. The use of a heat pump makes the process of freezing easier and the entire system now does not require a heat exchanger, recrystallizer and wash column as it was used to be in the past for the same process.

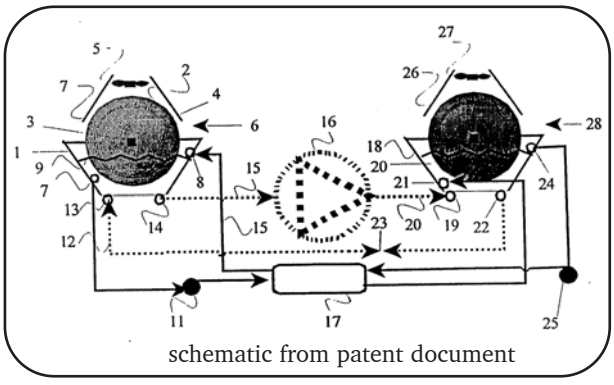
Water removal is the key to concentration of all food products. Various methods are available to remove water from liquid food products. Freeze Concentration namely precision water removal at freezing temperature ensures product quality at its technical best. The FCS has heat transfer surfaces to extract and deliver heat to freeze the solvent and melt the frozen solvent using a heat pump. An energy efficient layer freezing process is adopted. The device can have sets of heat extracting and delivering surfaces which work together to freeze and melt surfaces as to concentrate the solution in a batch or continuous process of liquid freezing process. The system has a low temperature difference between evaporator and condenser thus increasing efficiency. It has minimum number of conduits, pumps and controls, making it more efficient. In the flow through system, liquid can be introduced at the start point and concentrate can be collected at the end point of the system without need to recirculate concentrate.

Indian patent application no. 1000/MUM/2002 Patent grant no. 204956
Inventors: M. V. Rane, S. Jabade

The process of freezing and extracting a more concentrated solution was known, but with the currently devised FCS has made the process better, more efficient and more affordable to industry.

Novel hybrid cooling system

Prof. M.V. Rane and his student of Department of Mechanical Engineering have developed a novel hybrid cooling system (HCS) in which air temperature and humidity are simultaneously controlled using a novel contacting device, which meets the needs of dehumidification, decrease in temperature and significant reduction of consumed electricity. The device increases cooling and dehumidification capacity of the refrigeration compressor used as well.


schematic from patent document

The HCS devised uses liquid desiccants to dehumidify the air drawn. This system has an innovative contacting device. The HCS has a higher cooling capacity than normal vapour compressor systems. Also the liquid desiccant can be regenerated without loss to the outside environment and also does not corrode its parts. The regenerated desiccant can be used efficiently to dehumidify more air.

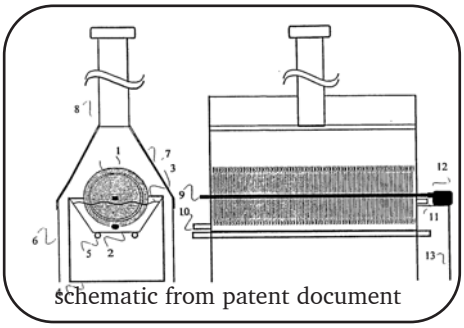
Indian patent application no. 154/MUM/2002 Patent grant no. 221716
Inventors: M. V Rane, S.V. Kota Reddy

The entire system is made of alternative materials so as to reduce cost, weight and eliminate corrosion problems normally faced by air conditioning systems. Liquid-liquid heat exchangers increase the cooling capacity and Coefficient of Performance (COP) of the hybrid system. Compared to the conventional Vapour Compression Regrigaration System (VCRS), the reheating of air is not needed in the hybrid system devised. This reduces cooling load, increases efficiency, cooling capacity and COP and lowers running costs.

Thus, newer generation air conditioners cum dehumidifiers with better features and technology are possible with HCS technology devised at IIT Bombay.

A more efficient contact device

Efficient mass exchange between liquid and gaseous phases is the key to successfully performing a range of different chemical engineering operations. Prof. M. V. Rane and his student of Department of Mechanical Engineering have developed an efficient contact device to help speed up and improve the processes for which it is used. A low cost compact contacting device developed provides greater surface area of contact between two fluids. It has multiple capabilities of large heat and mass transfer area between air, gas or liquid streams. The device was shown to have no carryover of liquid into the out going streams of gas or air. It did not have any flooding problem as well.


schematic from patent document

This novel design of the device allows it to be of use to efficiently separate gases from liquid, regenerate liquid desiccants, use in distillation columns, rectification columns, absorption refrigeration systems and other diverse applications in chemical processes industry. It can also be used in combination of appropriate devices in applications such as humidifiers, dehumidifiers and air-conditioning devices.

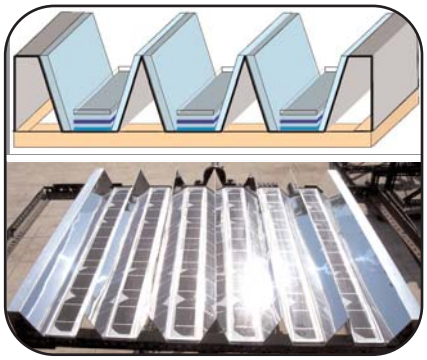
Indian patent application no. 153/MUM/2002 Patent grant no. 203949
Inventors: M. V Rane, S.V. Kota Reddy

The contact device consists of a disk mounted on a shaft, a trough to hold the liquid in which the contacting disk is partially submerged. It also has tubes in thermal contact with the liquid in the trough, a hood with a chimney to aid air or gas to move over the contacting disks. The trough has a supply and drain facility for filling and emptying. An objective of the research was to make an contacting device that incorporates surface density as high as 600 m^2 mass transfer area /m^3 which is far greater and superior to conventional Rauschert Hilflow rings that have a surface density of 210 m^2 mass transfer area /m^3 (designed for high performance packing).

The device is compact, sturdy and rigid. It has no carryover of liquid i.e, the stream of gas or air that flows out does not have any liquid which is an important feature. The contacting device has been made such that it can operate with pressure drop across it from 30 to 60 Pa. The device has a flow through system with great efficiency. The liquid in the trough can be pumped at will with no limit for the volume. The device can be adapted to be used for liquid or gas applications for heating, cooling, conditioning or changing humidity based on the application it is used for. The system has an advantage of operating with low power consumption as well.

Cost-effective V-trough flat photovoltaic (PV) modules

In order to reduce the cost of solar PV module, a reduction in material consumption per unit watt of electrical output is targeted. In these efforts, a novel concept has been developed by Prof. C.S.Solanki of the Department of Energy Sciences and Engineering. It increases light intensity on the surface of a solar cell to provide higher electrical output from the same solar cell area. Use of solar cells based on current silicon solar cell technology has been demonstrated. This results in 20 to 30% cost reduction in per unit peak watt of power.


patent pending

Features of the V-trough PV modules

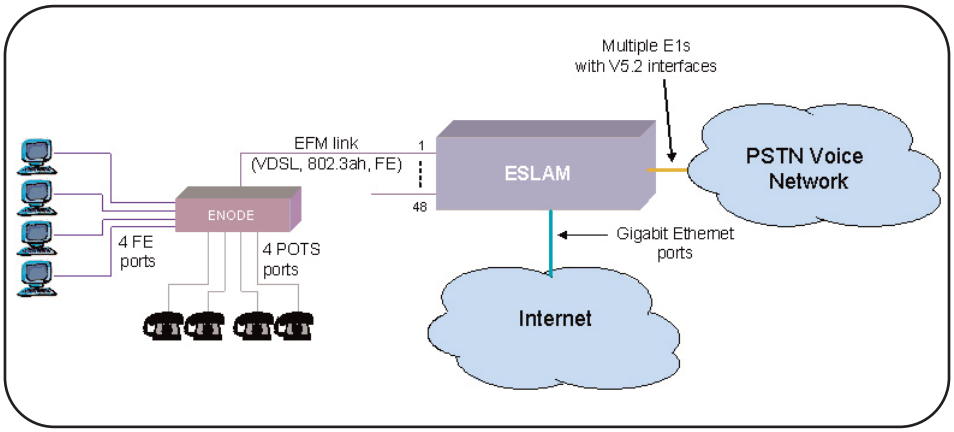
- About 60% more power obtained.
- Commercially available solar cells can be used.
- Very simple concentrator optics, called V-trough, is used for increasing the light intensity.
- Anodized aluminum used for light concentration, to provide work as a reflector and as heat dissipating material to improve output characteristics of solar cells.
- No regular sun tracking required

A prototype V-trough module of 40Wp has been manufactured and tested under various conditions.

Market acceptability: The V-trough PV modules can be manufactured for the power rating of 5Wp to 100 Wp and are suitable for any PV application, including home lighting, solar lanterns, power generation, etc.

Technologies for broadband access

Eisodus Networks, a company incubated at IIT Bombay is focusing on developing next generation technology for broadband access in the converged telecom sector. Eisodus Networks works in the area of Metro Access Networks. The company has developed an innovative architecture called EisoAccess by leveraging the potential of Ethernet to enable triple play and had seeds in the research Prof. Abhay Karandikar of the Department Electrical Engineering and his team.



The company innovated Ethernet based Broadband access technology for converged telecom sector with specific emphasis on emerging India and Asia specific markets. The team created a novel architecture that leverages the potential of Ethernet for providing Quality of Service (QoS) based triple play services. It also developed an innovative method of transporting voice over packet switched networks like Ethernet and developed unique algorithms for enhancing the performance of packet voice communication using Ethernet Adaptation Layer (EAL). Eisodus solution gives considerable superiority in Capex as well Opex costs and at the same time offers new value added services.

Technology licensed to Eisodus Networks, an incubatee company at IIT Bombay. Currently the rights of the company are with ICICI bank

Web based solutions for specific domains

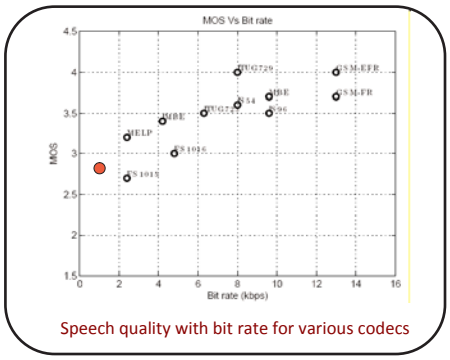
iKen Studio is a completely web-based development environment to develop and deploy applications, knowledge-based decision support systems, websites and BI (Business Intelligence) applications backed by or enhanced with artificial intelligence (AI) techniques especially integrated architectures of expert system and case-based reasoning.

This work done by Prof. R.M. Sonar of SJM School of Management is being deployed through iKen Intelligent Solutions, a software product and solution company incubated at the institute. It provides tools and solutions to develop state-of-the-art knowledge-based business applications and decision support systems based on or enhanced with integrated Artificial Intelligence techniques across verticals. The Company's product, iKen Core is an Integrated Development Shell Environment to develop, deploy and run knowledge-based web business applications, decision support systems and websites based on (or enhanced) with hybrid Artificial Intelligence mainly integrated architectures of intelligent techniques: expert system, neural network, genetic algorithm, case-based reasoning and analytical method.

The main vision of the company is to develop technologies to enable extreme personalization and highly relevant end-user experiences.

Technology licensed to iKen Intelligent Solutions, an incubatee company at IIT Bombay.

Do you have an ear for this? New method for speech compression



Speech quality with bit rate for various codecs

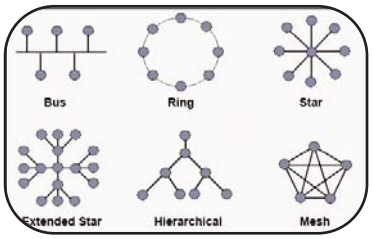
As the use of a mobile phone is getting cheaper by the day, the amount of data being transferred through wireless with every call goes on increasing. Speech coding techniques have been used by commercial mobile service providers to create a flexible voicing structure to allow natural sounding speech to be transmitted over long distances and making the sound robust to the presence of acoustic background noise. After over three decades of research, the international standards adopted by the telecom industries uses a compression technology (between 64 kbps to 2.4 kbps) to provide services while maintaining sound quality.

Prof. Preeti Rao of the Department of Electrical Engineering and her students have patented a new method that can further reduce the data bits to very low bit range (under 2 kbps) without compromising the speech quality. The current compression method uses a frame-based fixed parametric speech coder whereby either by managing the frame size, predicting the interframe correlation or encoding only selective frames together with interpolation techniques, desired compression rates are achieved. The proposed patented method uses a synergistic approach of prediction and encoding. Their invention is able to provide a good "communication quality", fixed-rate speech compression method that is capable of being ported to an appropriate hardware platform to obtain an improved speech compression system while minimising losses in sound quality.

The benefits of this invention are many and the application in telecommunications is only limited by its user. This invention can be adopted by defense organisations as a standard for secure communication replacing previous systems that may be proprietary or outdated. Mobile service operators and telecommunication service providers can provide connectivity in rural India with minimum expenses as the invention can be reasonably easily implemented on the current hardware systems. With reduced bit rate, internet telephony can be used for long distance calls as the home broadband technologies in India start to match up with their western counterparts.

Indian patent application no. 273/MUM/2003 Patent grant no. 205439
Inventor: P. Rao

A novel, eco-friendly communication system



Prof. N. K. Khosla of Department of Metallurgical Engineering and Materials Science and his students, colleagues in Electrical Engineering have developed and patented a cost effective wired communication system involving Scalable Intelligent Multiple Bit Addressable bus (SIMBA). SIMBA is a type of bus system which can be used for inter-device serial communication in industrial monitoring, control and automation and other signaling applications.

Currently used field buses are available only in the high speed application domain, need repeaters for long distance communication and generally require expensive and complex devices to implement them. The cost-effectiveness of this invention makes the device ideally suited for a small to mid-sized manufacturing businesses that are looking to automate and control their process. The flexibility in the networking topology of SIMBA is a lucrative option to update systems with low budget applications.

The researchers tested the SIMBA in a pipeline corrosion monitoring process. A unique feature of the SlMBA device was that it derived its power for communication from itself by "bus shorting" the 2-wire communication channel. The self-powering capability of the device also makes this invention eco-friendly.

Though the use of wireless devices is becoming increasingly popular and convenient, majority of the households, educational institutes and office systems rely on their broadband and intra-network connectivity on serial communication devices. SIMBA can provide a communication system that can be effectively interfaced with Wide Area Networks. Because of its simplicity, the SIMBA architecture allows addition of new devices to the system with the intelligence to self-discover their bus specific parameters, such as a dynamically allocated address.

Indian patent application no. 386/MUM/2004 Patent grant no. 212327
Inventors: N K Khosla, H Ramamurthy, A John, V Shah, R Aggarwal, P Sahni

Automatic address segmentation

Large organizations such as banks, government departments, universities, and corporations need to handle massive databases of postal addresses. These databases are often poorly structured and frequently accumulate several duplicate entries for the same person. Hence, such organizations periodically engage in a data cleaning or warehousing activity where addresses are stored in a standard format, with duplicates removed. A key step in this process is address segmentation that involves extracting from address strings, individual structured fields like 'Landmarks', 'House number', and 'State'. In the less structured Indian addressing system, existing commercial approaches require extensive manual effort due to various reasons like: non-uniform building numbering schemes, reliance on ad hoc descriptive landmarks, changing city names, non-standard abbreviations of state names and style of writing addresses, spelling mistakes and omission of zip codes.

Prof. Sunita Sarawagi of the Department of Computer Science and Engineering and her team, have developed a software tool that will 'learn' a model for segmenting unseen addresses when trained with some examples of segmented addresses. The underlying model is a powerful statistical machine-learning technique that can handle new data robustly, is computationally efficient, and is easy for humans to interpret and tweak in order to rectify the address segmentation problem. Experiments using nationwide, heterogeneous collections of actual addresses showed encouraging results, with high levels of accuracy.

Software licensed to a data cleaning company in India for commercial deployment

Communication networks

Prof. Girish Saraph of Department of Electrical Engineering invented innovative routing technology for communication networks which enables delivering desired quality for various services while optimizing utilization of available network resources. The routing scheme also has applications in optimizing multi-commodity flow or logistics problems.

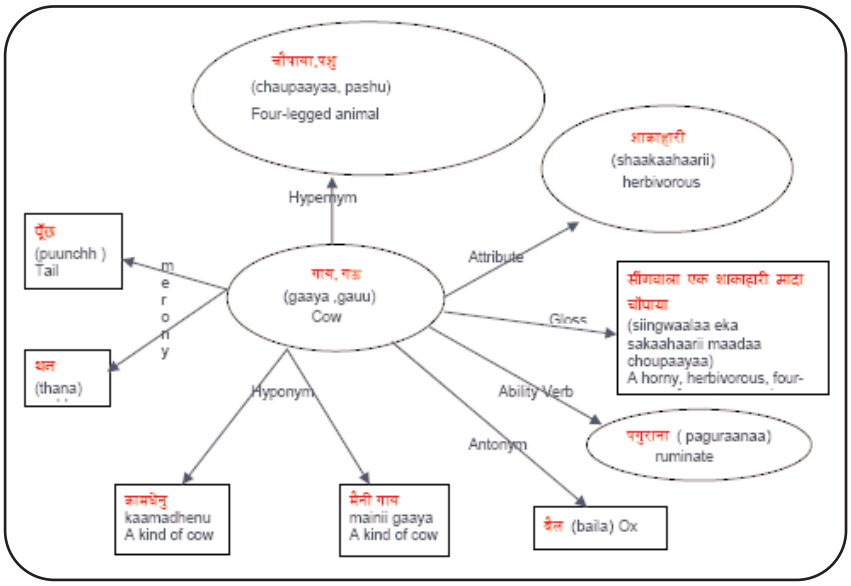
Vegayan Systems is a premiere supplier providing advanced solutions for enhancing the functionality and performance of communication networks. The company is developing breakthrough traffic engineering and network management tools and solutions for the MPLS networks. These solutions address the emerging needs in the core networks of the service provider and large enterprise customers. The company's main strengths include innovative technology with IP protection, talented and experienced team and visibility into fact-growing global markets.

US patent application no. 10/739, 655 in 2003 Patent grant no. 7,231,459B2
Inventor: G. Saraph

IP licensed to Vegayan Systems Pvt. Ltd. an incubatee company at IIT Bombay

HINDI WORDNET

Hindi wordnet and the associated software has been developed by Prof. P. Bhattacharyya and his students of Department of Computer Science and Engineering. This is the first time a rich, complex, large and widely used electronic resource along with associated tools has been created for an Indian language. Its use in translation and search in Indian languages is supreme.

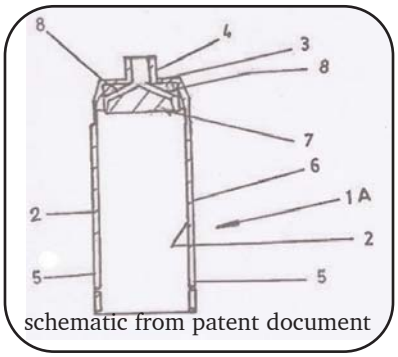


In a multilingual country like India translation between Indian languages as well as between English and Indian languages is a critical task. Similarly critical is the task of Cross Lingual Search where the query is made in an Indian language and retrieval of documents happens in English or Hindi. All these activities depend on lexical knowledge of high quality and coverage. This lexical knowledge is in the form of machine readable dictionaries, ontologies and wordnets (see figure).

Wordnets are lexical structures composed of synsets and semantic relations. Synsets are sets of synonyms. Wordnets have emerged as crucial resources for Natural Language Processing (NLP). The first wordnet was built for English at Princeton University. Then followed wordnets for European Languages Eurowordnet. Since 2000, wordnets for a number of Indian languages are getting built, led by the Hindi wordnet effort at the Institute.

- Licensed to a multinational search engine company.
- Linguistic data consortium of USA has procured Hindi wordnet and made it available through their catalogue (http://www.ldc.upenn.edu).
- Resource along with the application programming interfaces (APIs) are freely downloadable for research purposes from http://www.cfilt.iitb.ac.in/wordnet/webhwn. So far the resource has been downloaded by more than 5000 researchers all over the world.

"MAIN JUTE NAHIN BOLTAA": A NEW FLYER DESIGN



schematic from patent document

Majority of laboured workforce in our country is associated with farming and its allied activities. Though our government provides economical subsidiaries and help to the agricultural people, their safety in use of agricultural machinery and improvement of productivity of the manual labour needs more prioritisation.

Jute farming supports millions of farmers and their families and is only second in terms of its use and variety, after cotton. A natural and cheaply available fibre, jute is completely biodegradable. The high tensile strength of jute had made it the most commonly used material for bulk packing purposes as your gunny bag.

The jute fibre is spun into yarn on a spinning machine that uses bobbins to collect the yarn. These bobbins are placed within flyers and reciprocate to facilitate the winding process. Besides winding the yarn, these flyers provide the required tension to the yarn.

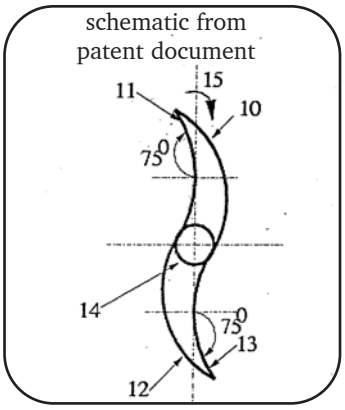
Prof. H. Hirani of Department of Mechanical Engineering invented a new design of the jute spinning machine flyer to reduce the risk for the operator. Their design suggests a new geometry for the lateral extension in a flyer; such that due the spinning movement and tension created, the yarn automatically slides towards the inner section of the flyer. The design can be operated at higher speeds providing extra strength to the yarn. It is also advantageous economically to use this geometry because the deformation of the flyer is reduced whereby increasing its usage life. Problems associated with the hairiness of the yarn are minimised and the flyer is labour-health friendly with decreased noise levels.

This invention can form a stepping stone for our economy to increase the productivity of our fast developing nation.

Indian patent application no. 661/MUM/2006 Patent grant no. 234653
Inventors: H. Hirani, S. S. Dani

A NEW METHOD FOR BETTER AND FASTER MIXING

schematic from patent document



Two or more different types of granular material are mixed using mixers, in large amounts to produce a uniform mixture in the paint, fertilizer, and pharmaceutical industries. A common problem with these mixers is that particulates or granules of dissimilar size, shape and density tend to segregate and separate out as clumps.

Prof. D. V. Khakhar and his student of Department of Chemical Engineering have devised specially designed impellers to the central shaft of the rotating drums used for such mixing. Impellers are similar to blades of a fan which protrude out from the shaft of the rotor. They actively churn the flow of the material near the drum axis and also disperse the heavy material that tends to accumulate near the central axis.

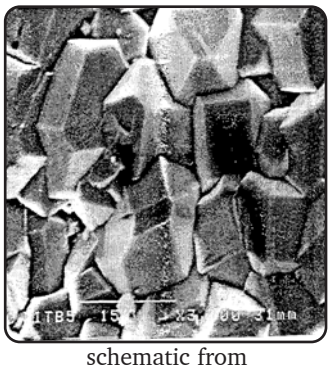
The researchers have demonstrated the efficacy of this improvisation by a novel experiment, where glass beads of two different size and colors (red and colorless) were loaded into a horizontal drums, one with impeller and one without, and rotated. The drum with impeller showed superior mixing along both the axial (along the length of the drum) and radial (across the circular cross section of the drum) directions. The impeller was designed to have 'inverse S' shape. Best results were obtained when the impeller was rotated at a considerably higher speed compared to that of the drum and in the same direction as that of the drum.

Although uniform dispersion of the beads of different colours could be clearly visualized in snapshots of the rotating drum, quantitative measurements confirmed that the mixing index was high and segregation index was low. In particular they found that for certain size of the impeller blades, the distribution of smaller particles varies rather uniformly across the cross-section and thus core formation was prevented. This invention will result in more efficient industrial mixers.

Indian patent application no. 809/MUM/2003 Patent grant no. 213856
Inventors: D.V. Khakhar, S. Hajra

HARDER CUTTING EDGE

In order to increase the hardness of articles, steel can be coated with diamond. Diamond coated steel components find applications in cutting or grinding tools, abrasive wheels, end mills or load bearing elements such as ball-bearings or types of inserts. One of the processes of coating steel components with diamond is by Chemical Vapour Deposition (CVD). This process does not make the quality of steel hardness as good because of the formation of graphite layer in steel. Other known processes using metal coats have been tried to tackle this problem with unfavourable results. The main issue to improve hardness would be to improve the adhesion of diamond on steel. Prof. D. S. Misra of Department of Physics, and his student, have devised a method to coat steel that improves the quality of diamond coat on steel components, thus enhancing adhesion and resultant hardness.



schematic from patent document

The steel surface is initially cleaned by washing the components with detergent, followed by deionized water. Next the components are washed with an aqueous alkali solution and then deionized water. Lastly, to remove oxides on the outer layer of steel, electro-cleaning or anodic cleaning is done using a sulphuric acid bath. The clean component is further electroplated with a layer of nickel, a nickel - diamond composite layer and a chromium layer followed by chemical vapour deposition coating of diamond.

The three pre-layers are thermally stable. The nickel layer enhances the second nickel-diamond coating and chromium helps in adhering of diamond very well. These layers have helped to solve the problem of poor adhesion due to formation of graphite cluster on bare steel formed during CVD. Carbon does not diffuse into the three-layer coated steel. This improved adhesion was verified using scanning electron microscopy, Raman spectroscopy and micro-hardness gauging methods, showing good adhesion and thus greater hardness.

Indian patent application no. 377/MUM/2000 Patent grant no. 200842
Inventors: D.S. Misra, A. K. Sikder

Technology licensed to individual entreprenuer

ADVANCED PLANNING AND SCHEDULING SOLUTIONS FOR PULP PAPER & PRINTING INDUSTRIES

This development work by Prof. S. Patwardhan and his colleagues from the Department of Chemical Engineering presents a novel approach for enterprise-wide planning and scheduling problem in paper, pulp and printing industries. This is essentially a large dimensional mixed integer nonlinear optimization problem. In the current approach, it has been systematically decomposed into the interconnected smaller sub-problems by using spatial and temporal considerations. Each of these sub-problems can be solved relatively easily and with less computational efforts using existing capabilities of the available solvers and personal computers.

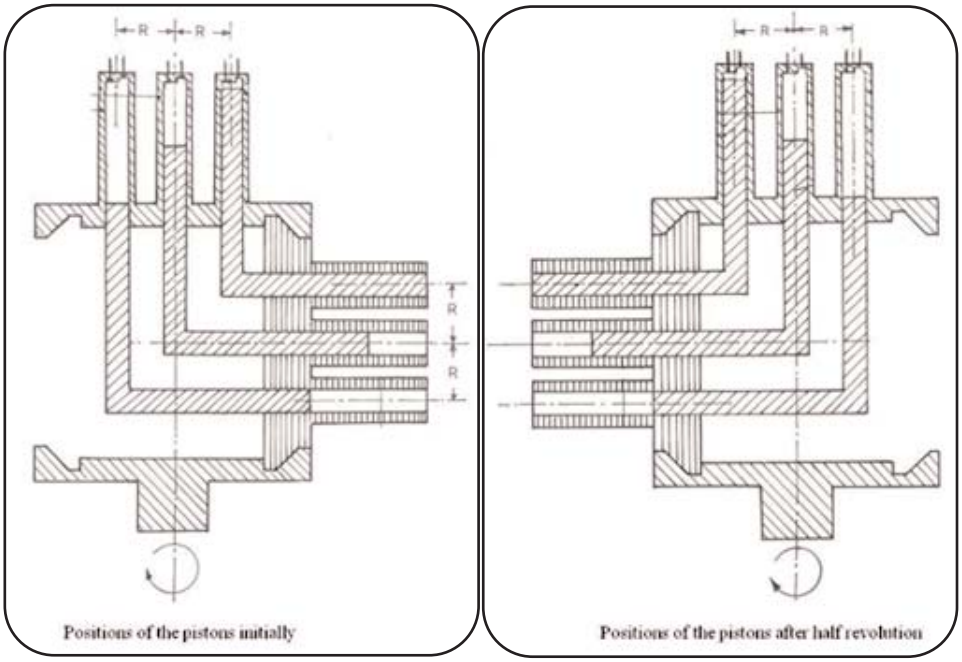
The proposed decomposition has a hierarchical structure, which strongly relies on the algorithmic approach with minimal use of heuristics and permits systematic analysis of the problem at various levels. The rolling horizon concept is used to deal with the dimensionality problem along with the changing future demands and possible disruptions. The resulting set of large scale sub-problems are solved using ILOG CPLEX 7.1 Solver.

The efficacy of the proposed solution approach is evaluated by conducting studies on a large dimensional industrial problem (3200 orders, 5 paper machines and 3 month horizon, about 300,000 variables). The proposed solution scheme provides satisfactory solutions to the large scale industrial problem for multiple scenarios in a reasonable time frame (about 2 to 3 minutes on 2.4 GHz PIV PC). Thus, the proposed solution scheme can effectively deal with large dimensional enterprise-wise order allocation, inventory allocation, run formation, trimming and pattern sequencing problems in a coordinated fashion.

Technology transferred to Honeywell Technology Solution Laboratory. (HTSL)

A COMPACT DRIVE MECHANISM OF A RECIPROCATING MACHINE

Prof. S. L. Bapat of Department of Mechanical Engineering has invented a compact drive mechanism for a reciprocating machine. Reciprocating machines are generally power consuming type or power generating type.



Drive to the above machines is given through a drive mechanism comprising crank shaft and connecting rod arrangement(s) connected to piston(s) reciprocating in cylinders).

During reciprocating motion of the piston in the cylinder, the connecting rod exerts a force component perpendicular to the piston because of which the piston rubs more against the corresponding side of the cylinder causing uneven and non-uniform wear and tear to both the piston and cylinder. This may lead to leakage of the working fluid and malfunctioning of the machine.

In order to rectify the problem reconditioning/replacement of the piston and/or cylinder liner may be required. Balancing of side force is done by attaching balancing weights to the crank to reduce the vibrations. However, in a single cylinder drive mechanism it is not possible to balance the side force completely and hence some vibrations are unavoidable. Wear and tear to the gudgeon pin and crank pin are unavoidable, calling for the periodic replacement. Breakage of the above pins may also occur at times.

The compact drive mechanism consists of two horizontal circular discs parallel to each other, both having a coinciding circumferential groove of same size and shape. One of these discs is stationary while the other (driving disc) is rotated using a prime mover. A vertical (driven) disc with external surface matching the curvature of the grooves is placed in between the two horizontal plates. It rotates in the grooves about the central axis of the mechanism and also about its own horizontal axis, which ends up in a planetary motion. This vertical disc has equally spaced circular holes, with same pitch circle diameter through it.

Similarly, the horizontal stationary disc has same number of holes to hold tubes acting as cylinders. Two circular rods are coupled to each other at right angle to obtain a L-shaped member. The horizontal limbs of such L-shaped members are inserted through holes in the vertical disc and the guide sleeve where they rotate and reciprocate and act as load bearing limbs. The vertical limbs act as pistons and reciprocate (and simultaneously rotate) in the respective cylinders mounted on horizontal stationary disc. One rotation of the vertical disc is equivalent to two strokes (one upward and one downward) of each piston. Thus, the rotary motion is converted to reciprocating one using this compact drive mechanism.

The drive mechanism enables it to have large stroke to diameter ratio. Moreover, the orientation of the drive mechanism has no effect on the performance of the application for which it is used. The line contact between the mating members ensures least frictional loss. The number of piston-cylinder combinations and angular phase difference between them can be adjusted within the geometrical constraints.

The current invention aims to provide a compact drive mechanism of a reciprocating machine which is efficient in performance and allows the piston to reciprocate in the cylinder linearly thereby eliminating side thrust.

Indian patent application no. 480/MUM/2000 Patent grant no. 200858
Inventors: S. L. Bapat

SUPERCRITICAL FLUID EXTRACTION (SCFE) TECHNOLOGY

Worldwide, Supercritical Fluid Extraction (SCFE) is gaining importance over conventional processes in chemical, pharmaceutical and food processing industry. SCFE technology could not be extensively used commercially due to very high costs and economic viability. Prof. M. Mukhopadhyay of the Department of Chemical Engineering and her students have developed world-class SCFE technology in India, to make it efficient and cost effective. This technology is superior in all respects and produces high quality extracts and is now made economically viable.

Supercritical Fluid Extraction Plant
(M/s SAMI Labs, Bangalore)

The use of conventional technologies like organic solvent extraction (using hexane hydroflourocarbons) or steam distillation may not be appropriate for user industry. Adopting SCFE is the need of the hour for gaining leadership in the growing world market of value added quality natural products.

The current global trends show a growing preference for products from natural sources with safe, eco-friendly and pollution free manufacturing processes. SCFE technology provides a ready and total solution to these challenges. Its superiority over the conventional technologies of extraction, especially for natural products in the food and pharmaceutical industry, is well recognized.

SCFE is a highly versatile technology with a varied range of applications:

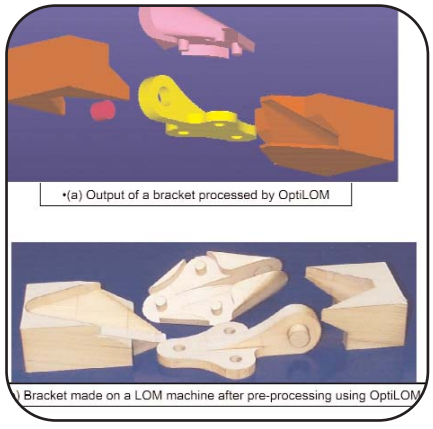
- Extraction of Natural Products such as Essential oils & Oleoresins, Flavours, Fragrances, Food Colours, Preservatives, Pesticides and Herbal Medicines etc.
- De-cholesterolisation of Food, De-Caffeination of Tea/Coffee, De-Nicotisation and Removal of Tar from Tobacco and Extraction of Hops
- Precision Cleaning of Electronic & Optical Components
- Production of Nano-Particles, Chemical Synthesis & Polymer Processing
- Processing and preservation of food products

A number of turnkey SCFE projects have been successfully completed till date.

Technology had been licensed to alumni entreprenuer for deployment

OPTILOM SOFTWARE

Laminated Object Manufacturing (LOM) is one of the early Rapid Prototyping processes to produce cheaper and stronger prototypes. It employs a paste-then-cut strategy in contrast to the conventional cut-then-paste technique. This innovative approach simplifies sheet handling and alleviates the need for an external support mechanism. However, these advantages are eclipsed by the need for grid cutting and decubing, which require extended time and skilled manpower.



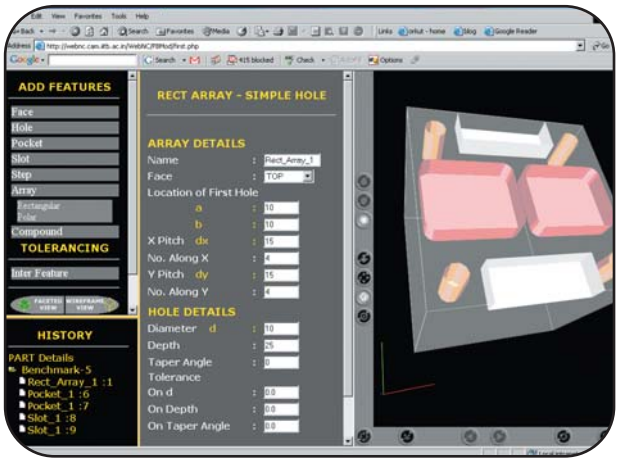
•(a) Output of a bracket processed by OptiLOM

) Bracket made on a LOM machine after pre-processing using OptiLOM

OptiLOM software developed by Prof. K. P. Karunakaran of Department of Mechanical Engineering and his students, in collaboration with Daimler Chrysler AG, Germany, removes both these limitations by pre-processing the prototype geometry before using it on the LOM machine, thereby eliminating the need for grid cutting and decubing. This method does not require any change in the hardware of the LOM machine and is hence readily adoptable and the additional geometries can be calculated using OptiLOM.

Launched during EuroMOLD 2002, Germany; sold by Materialise of Belgium as an optional module of its popular RP package Magics 8.0

WEBNC: MACHINING THROUGH THE INTERNET

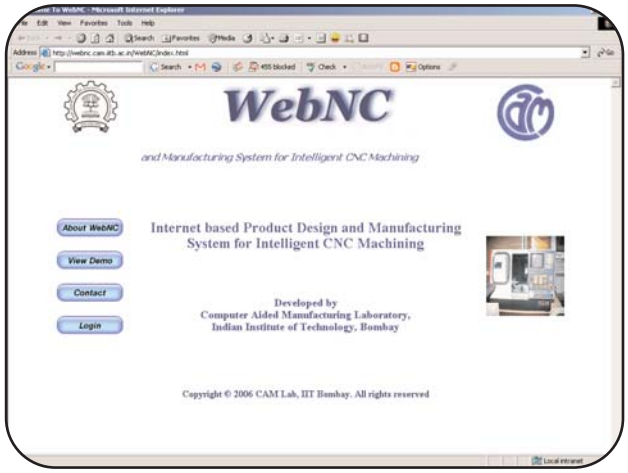


WebNC is an Internet based software for Intelligent Product Modeling and Process Planning to manufacture parts on 3 axis CNC machining centres developed by Prof. S.S. Pande and his team in the Department of Mechanical Engineering. It caters to prismatic part shapes commonly occurring in automobile, aerospace, consumer goods and electric part manufacturing industries.

Due to its Client Server architecture, WebNC will enable integration of globally distributed Product Designers, Process Planners and remote CNC machines for Collaborative Product Development and Telemanufacturing. In addition it is an excellent didactic tool for training and virtual product development.

Capabilities

- Distributed environment to provide 'Anywhere Anytime' connectivity
- Virtual design environment for Part Synthesis, Validation and Visualization
- Intelligent Process Planning for 3 axis CNC machining centres
- CNC Program Generation and Graphical Simulation
- Collaboration with remote site CNC machines for Telemanufacturing

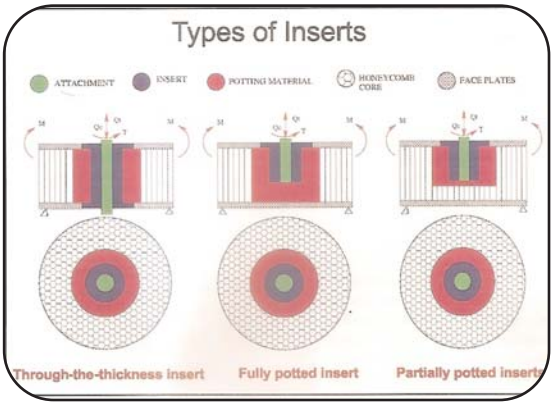


Specifications

- User friendly Feature based Part Modeling Environment
- Rich library of Features for modeling Prismatic parts
- Holes, Pockets, Slots, Steps
- Polar and Rectangular Patterns
- Freeform and Nested Features
- Design for Manufacturing (DFM) checks for Part Model Validation
- 3D CAD model visualization using Virtual Reality (VRML) tools.
- Intelligent Process Planning involving
- Automated Multi-Setup Planning
- Intelligent Operation Sequencing
- Automatic Tool and Process Parameters Selection
- Customizable tool database
- Efficient CNC Code generation
- Post Processing to FANUC OM and Neutral Data formats
- Virtual CNC Machining Simulation
- Program transfer to remote site CNC machine for Telemanufacturing

To use WebNC a PC with internet connection is sufficient, there is no need for any proprietary CAD/CAM Software at the user end.

NOVEL INSERT ASSEMBLY



Prof. N. K. Naik and his student of Department of Aerospace Engineering have designed unique insert assemblies of high specific strength to reduce stress concentration at locations where multidirectional stresses act on sandwich structures in conjugation and a novel method of reliably mapping stress distribution. These help to predict the failure initiation in sandwich structures with diverse geometrical configurations.

Light weight sandwich structures are used in structural applications such as vehicles, aerospace industry and framework. The sandwich structures have superior strength and stiffness properties along with the through-the thickness direction under bending loads. This can be achieved by combining a low density core with high stiffness and high strength face-plates. A sandwich structure is made of thick honeycomb / foam light weight core material and high strength aluminum / polymer matrix composite face-plates. The face-plates and core of the sandwich structure are bonded together with adhesive film.

The use of inserts is essential to strengthen the sandwich structures withstand localized loads. It permits the interconnection of honeycomb sandwich structures, the connection between them and other structural parts and the mounting of equipment. Inserts are also needed when external members or sub-structures are attached to the sandwich structures. Traditionally, high density metals and alloys were used, resulting in undesirable reduction in specific strength and higher weight ratio.

For the effective utilization of sandwich structures with inserts, the specific strength of the insert assembly should be as high as possible. One way to satisfy this requirement is to use polymer matrix composite materials as inserts. One of the desired properties of inserts is enhanced through-the-thickness stiffness and strength, which can be achieved using 3D orthotropic polymer matrix composites. This improves the performance of honeycomb sandwich structures. Configurations of typical 3D woven composite insert assemblies analyzed are presented in the illustration.

Design and development of an array of 3D woven composite insert assemblies with special geometrical and material characteristics for honeycomb sandwich structures were carried out at IIT Bombay. The stress distribution in the sandwich structures with new insert assemblies was mapped for stress and showed favorable results. The assemblies are of through-the-thickness, fully potted and partially potted geometrical configurations. Many woven composites were also explored in the research. The inserts designed by the team have been patented and are being considered for a variety of high-end applications.

Indian patent application no. 496/MUM/2004 Patent grant no. 211354
Inventors: N.K. Naik, N. Rao

ELECTRO SLAG REMELTING (ESR) TECHNOLOGY

ESR plant design and technology for high speed steels and other special steels developed by Prof. N. B. Ballal and his colleagues and students of Metallurgical Engineering and Materials Science.

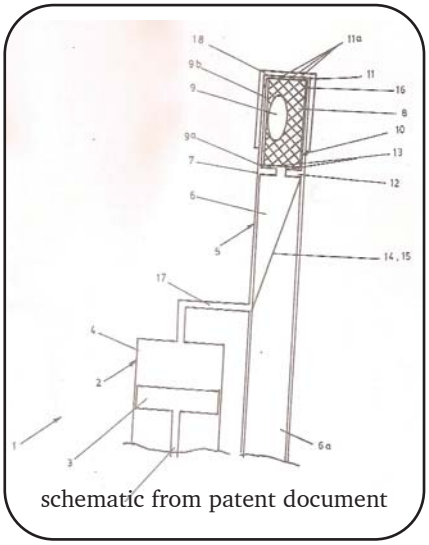
Applications

- New ultra-high strength steel developed for Rocket Motor casing
- Turn key supply of ESR facility to Vikram Sarabhai Space Centre (VSSC)
- Complete automatic control system for the ESR pilot plant developed and installed
- Inoculation of ESR steel to further improvement of properties
- Iron-aluminides for high temperature applications

Technology Transfers
- High speed steel for tool manufacture design, commissioning and know how, transferred to industries
- Technology transferred to M/s A.V Alloys, Hyderabad; National award receipient

STIRLINGLY COOL!

A unique Sterling cooler (coolers employing the Stirling cycle of operation) has been designed by Prof. S. L. Bapat of Department of Mechanical Engineering. In a Stirling cycle, a working fluid such as helium or hydrogen is first compressed and this hot gas is allowed to cool down to the desired temperature while passing through a regenerator (porous matrix) and then allowed to expand to cool down further. The resultant cooling or refrigeration effect is extracted and used for cooling applications. During return of the cold gas for the next cycle of compression, it is allowed to pick up heat from the regenerator. Stirling coolers used for cryogenic applications are also known as Stirling cryocoolers.



schematic from patent document

The unique designed Stirling cooler developed consists of a compressor which has a piston disposed in a compressor cylinder. It has an expander comprising a piston rotatably and reciprocally disposed in an expander cylinder. A regenerator is placed within a cavity formed in an extension at the top of the expander piston. A circumferential groove is formed on the extension adjoining the bottom wall of the cavity and the top end of the expander piston and gas passages formed in the top wall and bottom wall of the cavity. A pair of helical grooves is provided along the length of the expander piston with their ends meeting each other. The pitch of the helix formed by the helical grooves is twice the expander piston stroke.

The compressor cylinder is connected to the expander cylinder through a connecting tube and helical grooves provided along the length of the expander piston and the circumferential groove. At least one seal is provided between the sidewall of the cavity and expander cylinder to prevent gas leakage and a conductor material cap is provided over the top of the expander cylinder, which corresponds to the expansion space formed within the expander cylinder between the top end of the extension and the closed end of the cap.

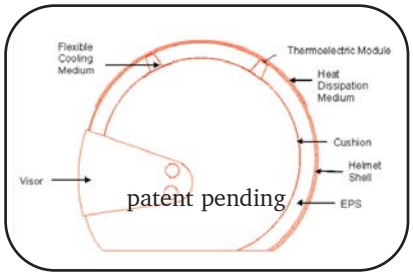
The unique design of the cooler makes it very compact and effective in cooling. The coolers have long life, attained through the use of non-contact running surfaces. Gas bearings allow the two moving parts to "ride on a cushion of gas" keeping the running surfaces from making contact while the machine is operating. Unlike vapor compression systems outfitted with capillary tubes that have optimized performance at only one temperature condition, Stirling coolers maintain their high performance over a wide range of temperature conditions.

Cooler uses the environmentally safe inert gas, helium, as the working fluid. Light weight makes portable cooling a reality. Stirling coolers perform well in harsh temperature environments and high ambient temperatures and are limited only by the materials of the cooler. These are some of the advantages of the designed cooler.

Indian patent application no. 299/MUM/2006 Patent grant no. 225128
Inventors: S. L. Bapat

THERMOELECTRICALLY COOLED TWO WHEELER HELMET

- Complies quality standards in terms of dimensions, weight and safety parameters
- Comprises thermoelectric modules with a heat dissipation medium and a flexible cooling medium
- Cools 8 to 10 degrees below ambient temperature
- No maintenance, Marginal weight, Aesthetically retrofit on a regular helmet
- Can cool as well as heat the interior of helmet



This technology was developed by Prof. M. V. Rane of the Department of Mechanical Engineering.

Developed in association with and licensed to Mr. George Koshy, Latent Tech Pvt. Ltd

A PROCESS FOR CYCLIC SUPER CRITICAL FLUID (SCF) CO_2 EXTRACTION OF FRAGRANCES

A process for cyclic super critical fluid (SCF) CO_2 extraction of fragrances from jasmine flowers was developed by Prof. M. Mukhopadhyay at the Department of Chemical Engineering. The process results a higher and better recovery of fragrances in a single step, as compared to conventional processes.

The process comprises a cycle of static extraction from flowers using supercritical fluid CO_2 and dynamic collection of the fragrances by depressurization. Supercritical fluid CO_2 is charged into an extractor loaded with jasmine flowers from the bottom and stripping fragrances from the flowers by holding the supercritical fluid CO_2 in the extractor for a predetermined period of time in a static condition.

The dynamic fragrance collection is carried out by releasing the fragrance-laden CO_2 from the top of the extractor at a controlled rate and simultaneously charging fresh supercritical fluid CO_2 into the extractor for a predetermined period under specific pressure and temperature. Fragrances from the extractor are then recovered in a separator by depressurising the fragrance laden CO_2 thereof from the top of the extractor to separate the fragrances.

Indian patent application no. 72/BOM/96 Patent grant no. 183454
Inventors: M. Mukhopadhyay

The process is repeated to continue the cycle of stripping of fragrances from the flowers in static condition and collection of fragrances in dynamic condition. In addition the flowers may be treated with a water soluble organic cosolvent prior to extraction with supercritical fluid CO_2 for a still better and higher recovery.

EXTRACTION TECHNOLOGIES FOR BETTER QUALITY PRODUCTS

Process to Sterilize Food

Prof. M. Mukhopadyay and her student of Department of Chemical Engineering has devised a novel process for the sterilizing and enhancement of the shelf-life of biological material using sequential pressurization-depressurization treatment with supercritical fluids. Biological materials require sterilization or preservation to overcome the problem caused by presence of naturally occurring microbes and enzymes that eventually cause degradation and limit the safety and shelf-life of the biological material. The existing sterilization techniques such as pasteurization, use of ultra high temperature, ultra high pressure has impact on shelf-life. However, they are not desirable as they result in loss of natural flavour, aroma, colour, freshness and texture felt in the mouth.

Indian patent application no. 543/MUM/2004 Patent grant no. 211305
Inventors: M. Mukhopadhyay, A. Chakraborty

The process devised combines one or more sequences of pressurization-depressurisation using supercritical fluids. The process involves subjecting the biological material to sequences of pressurisation-depressurisation at a specified pressure and treatment time, based on the nature of the biological material, to achieve sterilization with desirable characteristics; the process parameters are adjusted based on the material. This method of extraction allows shelf-life enhancement for at least 90 days using no chemical preservatives.

Novel Process to Extract Nutraceutical Concentrates

A process for the extraction of nutraceutical concentrate enriched with active ingredients by using supercritical fluid has also been developed. Nutraceuticals are natural, bioactive compounds that have health promoting and disease preventing properties. Traditionally solvent extraction has been used to extract the nutrients. This may be phased out in the near future to meet international standards. The nutraceuticals produced using supercritical fluid extraction is of superior quality with no microbes or solvent residue. Super critical CO_2 is the most preferred fluid solvent; as it is easily available, low cost, near-ambient critical temperature, non-flammable and inherently non-toxic.

Indian patent application no. 545/MUM/2004 Patent grant no. 213518
Inventors: M. Mukhopadhyay, H. Karamta

During extraction the plant source is first washed with an organic solvent in which the active ingredient should be insoluble. Selective leaching is done to remove undesired components. Supercritical fluid fractionation of the treated plant source using a single separator with varying time at ambient pressure is conducted. The process allows easy and superior nutraceutical concentrate extraction.

A communicator for children with cerebral palsy

Survival and communication are complementary to each other. Cerebral Palsy being a major neuromuscular disorder, children suffering from this require a special type of communicator for their existence. Based on a concept developed by a teacher and therapist at the Happy Hours Centre, Khar, Mumbai, Prof. G. G. Ray of Industrial Design Centre with his colleague at Department of Electrical Engineering worked towards developing a special type of communicating tool based on a personal computer which can be foot operated. Initially the product will act as training equipment but once the child becomes master in using the system, it can act as a communicator.

The input to the computer can be given through a specially developed Foot Operated Switches (FOS) in conjunction with specially developed software to cater the need of such children who can neither speak nor have control over their body movements except a marginally better control over the leg and toe tip muscles. A special sequence of function based keywords like 'Do', 'Go', 'Drink', etc. were developed so that minimum efforts were required to express their needs. Those keywords were structured for different levels of hierarchy and were presented with images of the respective situations. Along with the FOS and software, a special type of furniture was also developed for positioning the monitor and FOS for their safe operation while the child was on wheel chair.

Development of vestibulator for vestibulator therapy of cerebral palsy children

Vestibular therapy is an important method for neuro-muscular development of cerebral Palsy children. A new concept vestibulator was developed by Dr. S.A. Hosseini and Prof. G.G. Ray, Industrial Design Centre under a doctoral research project to develop the neuro-muscular coordination and balance mechanism of the Cerebral Palsy children, in association with the Children Orthopedic Hospital, Hazi Ali, Mumbai.

The device has been found highly effective by reducing the existing therapeutic effect of six months to one and half months.

Lightweight rehabilitation aids for polio-affected children

The main disadvantage associated with steel (metallic) rehabilitation aids is the weight that has to be borne by the user, especially so when the user is a child.

A lightweight prosthesis, employing novel material, was been developed by the jointly between Prof. S. C. Lakkad of the Department of Aerospace Engineering and SDM Hospital, Jaipur.

Clinical trials on over 1000 patients have confirmed the superiority and acceptability of the product in cases of lower limb paralysis.

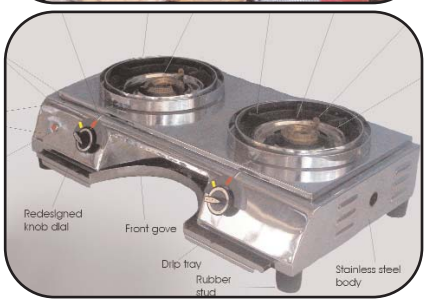
Ascender: the climbing wheelchair

There has been a continuous need to upgrade and improve wheelchairs for more effective and independent use, especially by handicapped persons. Prof. V. P. Bapat and his students of Industrial Design Centre has developed an innovative design of wheelchair for increased comfort and ease of operation by disabled persons.

The 'Ascender' provides higher level of operational freedom and self-reliance to the user. The new design makes transfer of persons to and from the wheelchair easier than is possible with conventional designs. Ascender also allows the user to negotiate kerbs and steps with greater ease. This not only makes public spaces more accessible to the user but also accords greater operational independence. Unlike traditional wheelchairs, Ascender's mechanism eliminates intensive use of hands.

The new design allows easy transportation and assembly of the parts. Utilizing newer materials and joining methods, Ascender embodies a strong visual appeal.

An LPG kitchen stove for persons without sight



Like sighted people, a blind person also goes to the kitchen and uses this specially designed LPG stove for preparing food for the family. The existing design lacks ergonomics and user safety aspect.

This problem was addressed through a project taken up by Prof. G. G. Ray and his colleagues of Industrial Design Centre. Based on a wide survey, in-depth work-content analysis, and observing blind people in the training and rehabilitation centers, several conceptual designs for LPG stoves were developed. Out of these, six design concepts have been registered and one of the concepts was developed further for prototyping.

Salient features:

- Low cost two-burner stainless steel gas stove with separate auto igniters.
- Auto flame failure detectors for each burner with different tone.
- Flame guard ring for each burner with five-prong pan support.
- Drip disc around each burner and drip tray underneath the stove.
- Easily operational burner control knob with three control positions.
- Two step body for easy location of burner and control area.
- Reference ridge on the body for easy location of burners and easy repositioning of pan support and flame guard
- Central groove on the front surface for keeping vessels
- User can replace the battery
- Aesthetically pleasing and safe product form and easily serviceable
- Can be efficiently used both by the visually handicapped and sighted persons.

The project was sponsored by the Department of Science and Technology, Govt. of India.

Product Cost: Approximately Rs. 3,500/- to 4,000/- per stove.

30 stove units have been developed in association with M/s. PK Limited, Hyderabad, and distributed to different blind persons through organizations like National Association for the Blinds, Rotary Clubs etc. for trial. Design improvements done and efforts towards commercialization is planned.

Low cost motorized arm

The incidence of limb loss due to road accidents, and unsafe handling of machinery is fairly high in India. Loss of the hand may be below the wrist, the forearm, or in the upper arm; a loss at the shoulder results in the greatest loss of function of the hand. An 'artificial hand' can help restore a measure of normalcy to the injured. One of the options for obtaining a man-made replacement for a lost hand is an internally-powered motorized hand that can perform finger-like pincer movements. The control of such a hand is usually achieved by bioelectric signals picked up from muscles in the residual limb. The costs of such imported motorized hands, however, are prohibitive - it can be more than Rs. 3.00 lakhs.

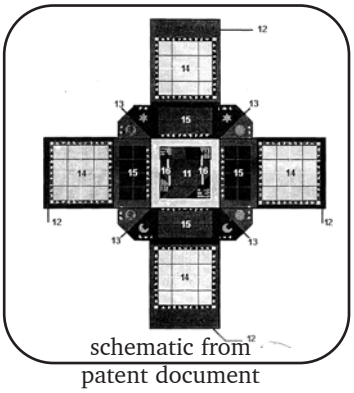
With funding from the Ministry of Social Justice and Empowerment (1999), a team of researchers lead by Prof. S. Devasahayam of Department of Biosciences and Bioengineering and Christian Medical College (CMC), Vellore, have developed the first successful, indigenous, motorized artificial hand that would cost less than Rs 10,000.

The motorized hand has several user-friendly features including myoelectric and whistle controllers. A single motor helps the co-ordinated movement of the fingers and thumb, while another motor turns the hand at the forearm. The motors are operated by switches placed in the socket of the artificial hand. The bulging of the muscles and the slight movement in the residual limb of the amputee are used to control these switches. Apart from its lower cost, the advantage that the indigenously developed product has over imported ones is that it works better in humid climates.

Following preliminary tests at the All India Institute for Physical Medicine and Rehabilitation, Mumbai, an initial set of artificial hands fabricated by WORTH (Workshop for Rehabilitation and Training of the Handicapped) Trust, Tamilnadu, was subjected to extended clinical trials at CMC-Vellore. Improvements including miniaturization of the electronics, and placement of control switches inside the socket were made based on further studies and user feedback. Sizes appropriate for both young children and adults are available.

A NOVEL DEVICE TO AID LEARNING OF FRACTIONS AND MATHEMATICAL OPERATIONS

Prof. U. A. Athavankar and his student of Industrial Design Centre have invented an educational and entertainment device to learn concepts of fractions and its addition, subtraction and equivalence for children through game and play. Teaching mathematics with the help of graphical tools is common to hold the learner's attention. The available games focus more on the demonstrative side directly in limited ways. This device helps learning fractions of multiple levels of challenge with interactive fun. It allows strategy based on encouraging creativity, requires 2-4 players and is self-packaged thus making it easy to carry from place to place.


schematic from patent document

The game is in the form of a checkered board with demarcated placement of playing tile pieces of various shapes. The tile pieces must be combined with one another to make shapes. A designed die is thrown during a turn to determine which fraction tile is to be used, to complete the shape. The person who completes the final shape with minimum use of fraction pieces and with minimum throws of dies wins. Every time the die is thrown players pick up a new tile piece from the pack. The challenge level, learning processes, and sequence can be varied by using varying dies in different numbers giving diverse options.

Indian patent application no. 1167/MUM/2003 Patent grant no. 210463
Inventors: U. A. Athavankar, A. Agrahari

The device designed at IIT Bombay allows flexible approach to understand concepts related to fraction mathematics, through the internalisation of the idea while playing a game.

WALKING ROBOT

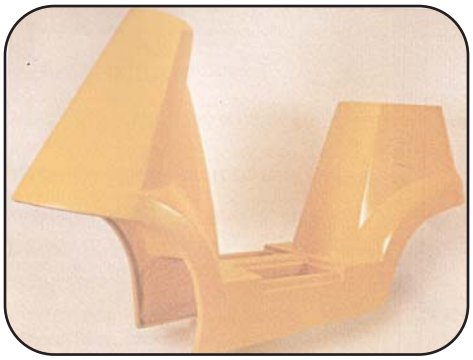
IIT Bombay has successfully developed robotic system NATARAJ - the six-legged walking robot. Apart from serving usual functions, it has been designed to negotiate uneven terrains and for monitoring and maintenance activities in hazardous radioactive environment. It can climb steps and ramps and step across small obstacles and can manoeuvre in narrow spaces. It can lift 500 kg with all legs on ground. Its innovative design of leg mechanism has one PCB along 6 PWM amplifiers for each leg. The robot can work on batteries for 20 minutes.

This system was developed by Prof. C. Amarnath and his team from Department of Mechanical Engineering.

INNOVATIVE PRODUCT DESIGNS

Based on innovative designs developed by Prof. K. Munshi and his students of Industrial Design Centre, CTech Labs Pvt. Ltd. a product design, industrial design, product engineering and innovation led development incubatee company, creates and delivers eco- friendly (green design). CTech actively promotes the concept - GO GREEN.

C-Tech creates marketable products from technologies available at various IITs, research institutions, individual inventors and patent holders. The company constantly scans potential clients to find the technology-business need match and demonstrate the prototypes, and convert them in the complete products by designing, customising and documenting them. C-Tech also develops variety of affordable, energy efficient, eco-friendly products for niche markets with an excellent business potential, better acceptability and marketability for the manufacturing & marketing organizations.



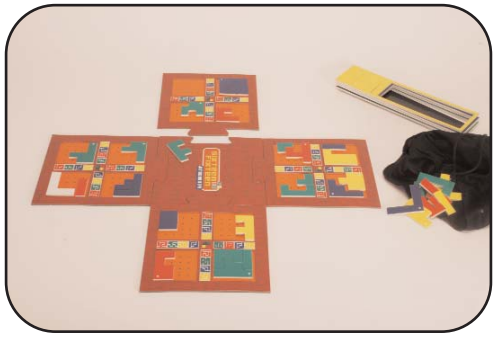
Perspective Design - electric scooter

DESIGNING OF BOARD GAMES

Games for the children aged 6+ years and 8+ years developed by Prof. U. A. Athavankar and his students of Industrial Design Centre.

Unique features:

- Designed with principles of education and creativity
- Designed based on use of spatial intelligence and mental imagery
- Instill a sense of problem solving approach, such as foresight and planning
- Short games for entertainment
- Long games to teach children how to come up with strategies
- Games teach children to socialise as well as how to choose companions to defeat the opponents



Games designs licensed to Funskool (India) Ltd., products in market

Following Design registration have been grant for the Game Set (Class 21-01):

Design	Registration No.
Bi-Pass	222968
Over the Top	222973
Brick Burst	222969
Delta Attack	222972
Pugploy	222974

A NEW LETTERBOX FOR INDIA POST

The old rusty red letterbox, popularly known as "Lal Dabba" just got a new look. This novel mailbox was developed by Prof. B. K. Chakravarthy and his student of Industrial Design Centre. New technology based products need investments in tooling and development and the attempt of the project was to provide well designed products in the public domain.

The letterbox developed has an elegant stainless steel body mounted on a base making it easy to collect letters because of the overhang of the body. This design also keeps the letters from being soiled during rains. It has an attractive red composite plastic top with a beak like aperture for posting letters bringing in an inviting look for the letterbox and making it identifiable.

The new model including the lock is rust free, does not require painting and has a maintenance free life of 20 years. The top box caps the stainless steel body from all sides, preventing seepage of rainwater into the letterbox; while the slopes at the top drains out the water fully. Wide openings to accommodate large envelopes, an easy time slider, a flat top surface which can be used for writing, plus a common key to open all letterboxes in one region, are some of the additional features of this easy to install letterbox which creates a new identity for India Post.

The brief given by India Post was to design a maintenance free letterbox, since the existing letterboxes which are made of mild steel were damaged easily and rusted rapidly. As a result the postal department spent a lot of effort and money in respect of painting, repairing and maintaining them.

The stainless steel body is manufactured using high-end CNC machines where production quality is consistent. The letterbox is packaged in a knock-down condition with the top and base fitted inside the main body for transportation thus reducing transportation cost.

Design registered in September 2005; No. 201789

As a strategic marketing initiative the new letterbox has large space for advertisements on its sides and the cost of advertisements can pay for the cost of the box for the initial period of 2 years, and later on become a revenue generating activity. This new letterbox was launched on 18th October 2005 in New Delhi. Currently orders are placed for their manufacture for deployment across the country.

TOOLS AND TECHNOLOGIES FOR THE CANE AND BAMBOO CRAFT

Numbering over five lakhs, bamboo artisans in India face various problems relating to purchase of raw material, their processing, production of commercially viable items, and their subsequent sale. Prof. A.G. Rao and his team of the Industrial Design Centre have developed a number of technologies to bolster the unorganised craft sector by helping artisans produce value-added, contemporary bamboo products to compete with other materials in the urban and international markets. These include:

- A tool-kit with nearly 100 product-specific hand tools to process bamboo
- Small hand-operated machines for bamboo-processing, suitable for remote areas with unreliable power supply
- Jigs, fixtures and moulds to aid control of sizes and give better finishes
- Variety of treatments such as smoking, alum, etc. to prevent fungal and insect attacks
- Various surface finishes using natural dyes
- New weaves and product designs for ergonomically, functionally and aesthetically improved products

These technologies have been disseminated to artisans by organising workshops at regular interwals.

ATM ENCLOSURE DESIGN

ASAN, a low cost Automated Teller Machine (ATM) was launched in December 2003. Prof. U. A. Athavankar and his colleagues of the Industrial Design Centre designed the product, based on a survey of current and potential users interviewed for their views on existing ATMs. ASAN has several advantageous features over the currently deployed ATMs to suit the Indian customer and settings.

The attractive new design incorporating elements from traditional Indian architecture departs from the current neutral appearance of ATMs. Banks may further customize it based on their needs. The small size makes it suitable for deployment in places with space constraints. ASAN's ergonomic design suits the typical Indian body dimensions with respect to the height of the keypad and the inclination of the screen. Additionally, the machine has a provision for keeping one's personal belongings, and protruding wings for ensuring privacy during transactions. A multi-coloured card reader status indicator guides users unfamiliar with new technology.

Consultancy Development Centre National Award for Excellence in Consultancy Services - 2004

The machine has intelligent power-saving hardware and software. An integrated pedestal accommodates a Uninterrupted Power Supply, providing maximum availability during outages. The robust engineering design ensures trouble-free operation in hot, humid and dusty environments. Additionally, a unique airflow system allows deployment at non-air conditioned sites. Such features make it suitable for interior locations. Other features include, 40-column graphics thermal receipt printer, secure encrypting PIN pad and a flat panel screen.

Design licensed to NCR for installation in various banks

KEY-LEKH: COMPUTER KEY BOARD FOR INDIAN LANGUAGES

The majority of the Indian population is more comfortable with communication in regional languages. Even when English is used, it is often liberally sprinkled with words from an Indian language for greater effect. This is quite common in direct and telephonic conversations, and even in written communication, but not on a computer. This is because, typing Indian languages on the computer keyboard is complex, and current schemes for feeding text in Indian languages are not adequately usable. Many solutions for 'Text Input in Indian Languages' are based on the currently used QWERTY keyboard designed for the Roman script.

Indic scripts have a different structure from the Roman ones and none of the above commercially available keyboards are usable by a majority of Indian people.

As a solution to this problem, Prof. Anirudha Joshi and his team at the Industrial Design Centre through a Media Lab Asia Project have worked on designing alternative mechanisms for text input in Devnagari. Amongst several alternatives, a keyboard called Key-Lekh was developed with a goal to enable persons familiar with Devnagari to use it without instructions. For example, on a ticket vending machine at a railway station, literate passengers should be able to 'walk up and use' this keyboard to type their name, destination and other details to buy train tickets. The underlying concept of the design of Key-Lekh is based on the 'Varnamala'-the well-structured Indian alphabetic system. Studies on a prototype have proven that the Key-Lekh is an efficient 'walk-up-and- use' keyboard, and can also work as a desktop keyboard. The prototype was subjected to extensive tests by users in various age-groups through road shows and competitions held, on the campus. The feedback suggested that Key-Lekh is the easiest-to learn keyboard yet developed for Indian scripts. Key-Lekh's design is being further improved to make it more robust and useful as a commercial product.

Indian patent application no. 720/MUM/2003 Patent grant no. 213525
Inventors: A. Joshi and A. Rathod

K-YAN: THE COMPACT MEDIA CENTRE

New generation communication technologies allow creation of novel media products that can serve the community. Such products must be robust, and possess simple and universal interfaces. As part of a project from IL&FS (Infrastructure Leasing & Financial Services Ltd.) Educational & Technology Services, Prof Kirti Trivedi of Industrial Design Centre has developed K-Yan, a compact media product for community use. It combines the functions of: a multimedia and internet enabled PC, large format television, DVD/VCD/CD player, CD writer, video-conference device, LCD data projector, and an audio system that facilitates shared viewing and participation by users.

Launched in March 2004 at the major event IT.Com held in Bangalore, K-Yan has been demonstrated to several Chief Ministers and senior state and central government officials. K-Yan is easy to use, has multilingual facilities, and eliminates the need for investing in other media hardware. A single unit can cater to the teaching needs of an entire class, and substantially reduce the cost of computerizing schools. The integration of various functions not only allows students to learn how to use a computer, but also other subjects. The product will also be useful in other group learning or information dissemination programs like healthcare, family planning, agricultural practices, and civic awareness drives.

K-Yan is equipped with extra solar energy-based portable power supply to enable use in areas with no electricity. Mounted on a van, it can also function as a mobile communication centre from remote locations. With an internet connection and a web-camera, it would allow low cost web-conferencing from any location, making it useful in disaster management or project progress monitoring. The web-conferencing feature will also be useful in e-governance, as it will facilitate direct communication between various agencies and the administration.

K-Yan has evoked enthusiastic response and is on the way to becoming a major commercial success.

Transferred to IL&FS; has been deployed in more than 250 schools, educational institutions, NGOs and rural communities

LOW COST ENGINE MANAGEMENT SYSTEMS FOR PETROL-POWERED SMALL VEHICLES

Automobile engine management systems (EMS) refer to the collective unit comprising of sensors, actuators, signal conditioners, power-amplifiers and a micro-controller (usually termed as the electronic control unit or "ECU") that perform the functions of real-time engine control and diagnostics. Engine management systems are designed to enhance fuel economy, reduce tailpipe emissions and improve overall drivability over the range of operating conditions of interest. Engine management systems supporting fuel-injection operation have become standard in all four-wheelers and are gaining increasing presence in two/three wheelers. Fuel injection systems offer the benefits of reduced tailpipe emissions, improved drivability, improved startability and the promise of improved fuel economy as compared to carbureted solutions.

Prof. S. Suryanarayanan and his team from Department of Mechanical Engineering have developed an indigenous, fully-functional, low-cost EMS prototype supporting port fuel-injection.

Test results indicate that a vehicle fitted with the IITB EMS solution produces an order-of-magnitude less hydrocarbon emissions and similar engine-out carbon monoxide, nitrogen-oxide emissions when compared to a production-quality carburetion. Further, the test results indicate the potential for bettering the fuel economy performance of a production-quality carburetion solution by about 5-10% if the IITB EMS solution is developed further into a production-ready design.

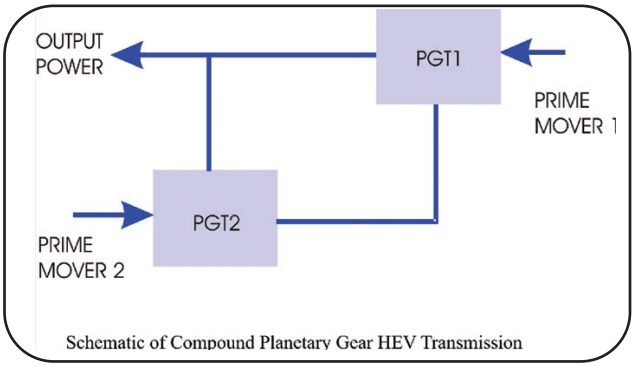
The IITB EMS development effort has led to the proposal of a minimal sensing architecture for EMS supporting fuel-injection operation in petrol-powered, single-cylinder small vehicles - over 15 million of which are sold every year around the world. This research has resulted in arriving at a sensing architecture consisting of a total of three inexpensive sensors which allow the IITB EMS to meet emissions, fuel economy and drivability performance specifications of today. Further, the team has shown that this is the least expensive sensing configuration possible for small vehicle EMS solutions. In addition, the IITB effort has led to the proposal and development of novel control algorithms that exploit the small size of components of the engine system.

Technology licensed to SEDEMAC Mechatronics Pvt Ltd., an incubatee company at IIT Bombay

Based on this work on engine management systems SEDEMAC Mechatronics Pvt Ltd has been incubated at IIT Bombay to realize a commercially-viable production ready prototype of EMS solutions for two, three and four wheelers: This start-up is dedicated to establish itself as "a globally competent design house, specializing in automotive embedded system products". Particularly, it is focused on building an innovative, fuel-efficient, low-emission automotive engine management system as a product.

NOVEL HYBRID ELECTRIC VEHICLE TRANSMISSION

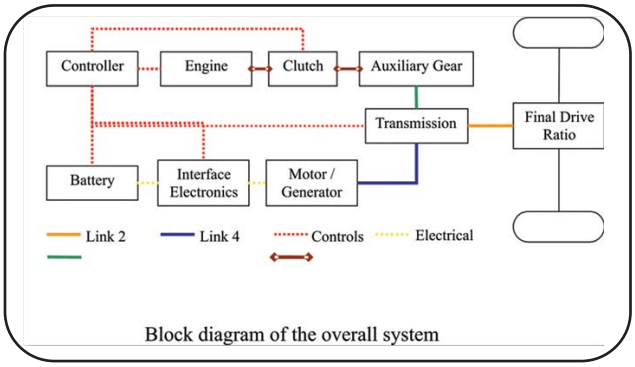
The sharply rising crude oil prices have put a technical challenge to the automotive sector to reduce fuel consumption. Automotive business is looking towards electric vehicles to reduce the dependence on oil. However, battery technology development has been found deficient to support electric vehicles. Fuel Cell powered vehicles are being sought as permanent solution but infrastructural demands of transporting hydrogen currently cloud their progress. Hybrids - assimilation of electric vehicles and current IC Engine based vehicles - have been shown to reduce fuel consumption by Toyota, Honda and Ford.



Schematic of Compound Planetary Gear HEV Transmission

The fundamental difference between a hybrid vehicle and an IC Engine based (conventional) vehicle lies in their powertrain. A hybrid uses at least two prime-movers whereas a conventional vehicle uses only one. This implies that the transmission gearbox be able to accept two inputs rather than one i.e. it needs to be a two degrees-of-freedom mechanism. Additionally, the gearbox needs to be compact. A planetary gear train (PGT) is the most basic two degrees-of-freedom mechanism. But a single PGT gearbox (as in Toyota Prius) means that the wheels never receive the full torque of the prime-mover, whenever the vehicle is being run by a single prime-mover. A compound PGT - with two such basic PGTs interconnected - then becomes a natural solution.

The current patent pending invention of Prof. B. Seth and his student of Department of Mechanical Engineering, relates to one such compound PGT meeting all the desirable features listed above, and harmoniously adds up the power of both the prime-movers i.e. the recirculating power - that plagues all of two mechanisms having a power loop - never goes to disastrous levels. The engine is connected to the transmission via an auxiliary gear-set that lends it the scalability for various types of engines (gasoline, diesel) or for various categories of vehicles (hatchbacks, SUVs etc.). Additionally, this auxiliary gear-set ensures that speed longitude (on torque-speed map) in which the engine operates is narrow and is at the lower end of speeds (1200-3000 RPM), a characteristic extremely important for current (as well as those in future) Lean-Burn SI Engines and also Common-Rail Diesels. Apart from the desirables listed above, the invented compound PGT allows a fool-proof vehicle operation with varying ratios also.



Block diagram of the overall system

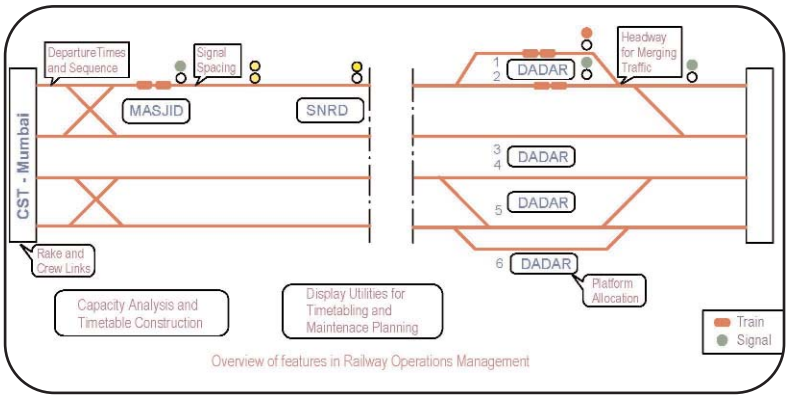
Schematic of Compound Planetary Gear HEV Transmission

The augmenting control architecture is simple and real-time since it decides based on measurables such as battery SOC, vehicle speed and change in throttle movement. The decision for gear number in next instance is based on state of these variables in this instance, thereby devoid of any a priori information of drive cycle and hence implementable. The control architecture exhibits negligible increase in fuel consumed for 25 rounds of NEDC (compared to one round of NEDC). Further, the controller alters the engine torque contribution based on a "SOC-correction factor" which ensures that the battery is sufficiently charged always.

The invented transmission is a generic two degrees-of-freedom transmission and not specific to IC Engine and motor hybrids, hence versatile to be adapted on to a two-motor architecture fuel-cell vehicles.

SOFTWARE FOR RAILWAY OPERATIONS MANAGEMENT

The suburban railway system on which Mumbai is heavily dependent, has been rightly called the life-line of the city. Railway operations present a huge range of problems to work on. For the past several years, Prof. N. Rangaraj, IEOR with his colleagues from Department of Computer Science & Engineering and Department of Chemical Engineering have been working on various aspects of suburban railway operations management.



Overview of features in Railway Operations Management

Line Capacity Simulator for the Indian Railways Institute of Signal Engineering and Telecommunications has been developed to represent the operational features of trains in selected sections. The simulator can help estimate the capacity of long-distance track segments on the railway network under complex traffic conditions. It is also useful in changing time-tables, analyzing the effect of adding scheduled trains in a section, evaluating investment at a local level (such as additional loop lines and platforms), and studying the effects of signal failures and train delays. Essentially the programme uses priority-based scheduling of trains along with the operating constraints of track occupancies and platform availability.

The simulator also allows realistic analyses by reproduction of the operational logic of railway movement, and related engineering details. It also records train speeds that depend on track signal conditions, which in turn depend on the status of several trains ahead of the signal. The simulator can display train movements on a distance vs. time graph with details of individual trains.

Rake Management System (RMS) is a set of utilities and tools designed for analysis and decision-making on the overall use of rakes vis-a-vis their deployment, operation, and maintenance cycles for suburban train services.

THE SKYBUS PROJECT

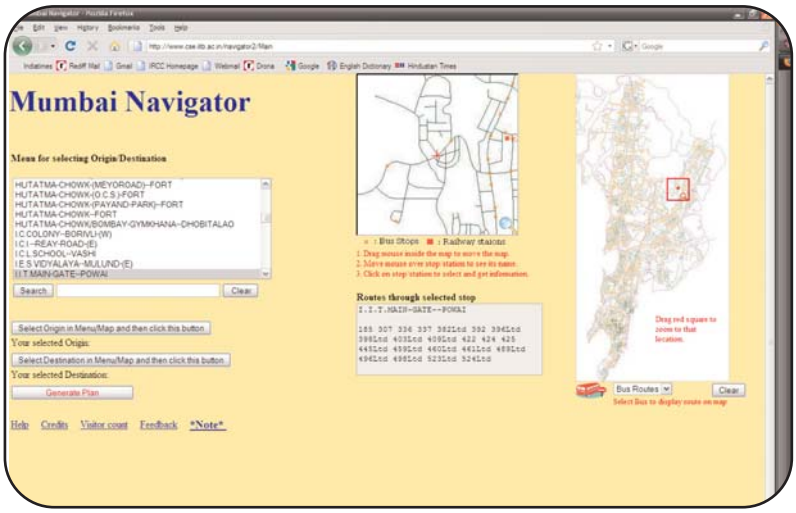
The "Skybus" devised by Konkan Railway Corporation Ltd., has been seen as an innovative, eco-friendly and cost-effective solution to the transportation problems of metro cities. This is an outcome of the research and development by Prof. S C Lakkad, Department of Aerospace Engineering. It consists of an elevated rail system laid on a set of pillars and tracks. A regular bogey moves on the rail track and the coaches are suspended from the bogey.

IIT Bombay has been involved in the design and development of composite Skybus coaches under a TIFAC Project. Fabricated by Kineco Ltd., Goa, the prototype of the coach is designed with:

- a stainless steel skeleton with FRP side, roof and side panelling for corrosion resistance coupled with light weight.
- a four metre wide door for quick discharge of passengers.

MUMBAI NAVIGATOR

Mumbai Navigator is a programme which helps plan travel within the city of Mumbai using public buses and local trains. Developed by Prof. A. Ranade and his students of Department of Computer Science and Engineering the salient features include the following:



- The programme takes as input, the starting point of the journey and the desired destination, and generates a plan describing which buses/trains to take and where to change.
- The expected travel time including the time spent in waiting for buses/trains to arrive is also provided.
- The generated plans are adaptive, i.e. they may prescribe a different set of actions depending upon which bus arrives first while waiting at the stop.
- Plans generated by the program have been shown to be minimum travel time solution

A survey shows that the program is being used by residents of Mumbai as well as visitors.

Available at **www.cse.iitb.ac.in/navigator**

Bio-char unit for low cost production of charcoal

Prof. A. Ganesh and her students of Department of Energy Sciences and Engineering have developed a simple to operate, non-polluting Bio-char Unit (BCU). Although developed for bamboo waste, the unit can be used for other non-powdery biomass. The uniqueness of BCU lies in using the otherwise polluting gases as a thermal energy source. The device is aimed at ensuring village energy security.

Special features

- Easy to operate-a single person can operate the unit.
- Uniform quality and yield of charcoal (25%)
- Eco-friendly

Applications

- Use of thermal energy from burning of gases by retrofitting
- Production of charcoal in households and supply to manufacturing industries

Several units deployed at various rural locations through National Mission on Bamboo Applications, TIFAC

Extraction units for preparing herbal oil

A low cost extraction process for manufacture of herbal oil from Nirgundi leaf extracts for joint/muscle pain and inflammation relief was developed through the efforts of Prof. N. G. Shah of Centre for Technology Alternatives for Rural Areas (CTARA) and his colleagues from Department of Chemical Engineering and their students. Herbal oil is prepared under vacuum in water-jacketed extractor. This unit uses LPG fuel. This technology has an advantage of reducing extraction time to about 8 hours where as conventional method takes about 120 hours. Pay back time on investment is expected to be less than a year.

Commercial scale extractor was designed, fabricated and commissioned at Yusuf Meherally Centre, Tara village, Raigad district, Maharashtra.

Riding type power tiller

Researchers at the Centre for Technology Alternatives for Rural Areas (CTARA) at IIT Bombay have developed a riding-type power tiller (10HP) suited for use by small land holders.

Features

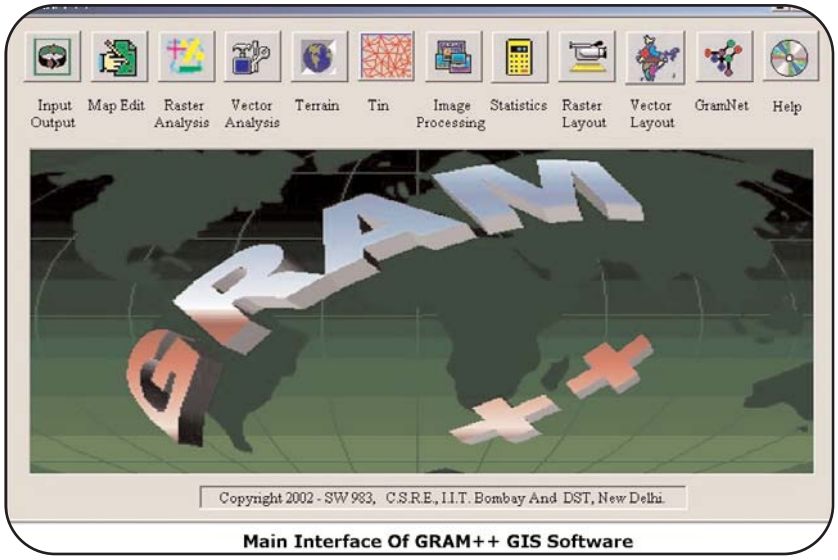
- A low-cost traction and haulage vehicle with easy, comfortable steering and small turning radius
- Two chain and sprocket drives for agriculture and transportation uses
- Light weight diesel engine
- Easy maintenance and repair

Applications

- Ploughing and harrowing operations
- Intercultural operation in field
- Running irrigation pump, thresher etc.
- Transportation of goods up to 1 ton

GRAM++: A GEOGRAPHIC INFORMATION SYSTEM

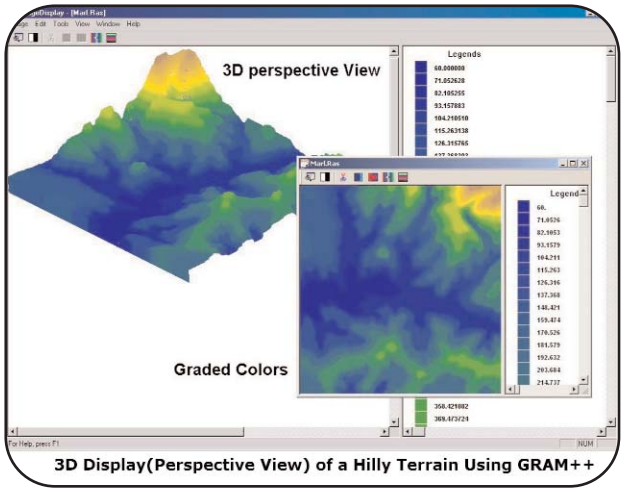
GRAM++ is a geographic information system (GIS) software developed Prof. P. Venkatachalam and her colleague from Centre of Studies in Resources Engineering (CSRE), with support from United Nations Development Programme (UNDP) and Department of Science and Technology (DST), Government of India.



Main Interface Of GRAM++ GIS Software

GRAM++ has rich functionality to support: Spatial database preparation by import of data from popular GIS formats, Mar editing and onscreen digitization of scanned document, Analysis using tools such as Vector analysis, TIN, Network analysis enabling map display, query, statistical chart generation, distance calculation, thematic map generation, terrain modeling and contour generation, shortest path and spatial allocation problem.

GRAM++ has also equally rich raster functionality. Raster analysis allows map algebra, map overlay, buffering, regroup, watershed analysis; zonal / focal / local analysis terrain modeling allows building DEM from contours or spot heights, visibility, profile plotting, slope / aspect / relief. Image processing supports a range of popular features such image enhancement and filtering, principal component transform, band arithmetic, neural network for analysing remotely sensed images that can lead to build up of GIS databases.



3D Display(Perspective View) of a Hilly Terrain Using GRAM++

GRAM++ also supports a basic statistics utility to derive several statistical parameters such as mean, median, mode, skewness, curtosis etc. It has powerful map composition tools for composing cartographic quality maps for both raster and vector types.

This software is designed to work on a commonly available computer system to make it accessible to a larger number of users.

Bhugol GIS Pvt. Ltd. an incubatee company based on the above work is providing Geographic Information System (GIS) software products - GRAM++, software development tools, GIS Tutor, Digital Atlas. It also offers training and capacity building to meet all GIS and IP needs.

Copyright registration granted: Gram++ SW-2629/2006 and SW-983/2002

Licensed to Bhugol GIS Pvt. Ltd. an incubatee company at IIT Bombay

aAQUA: a knowledge source for farmers

aAQUA:almost All QUestions Answered

- Online platform which serves as knowledge source for farmers
- Builds a bridge between farmer and technology
- Multi-Lingual / Multi-media Support
- Multi-Lingual Storage and Retrieval

Deployed and ongoing activities

- Forum for farmer to pose questions
- Panel of experts to view the problem and work out feasible solutions
- Sending back solutions to affected farmer
- Creating cumulative archived database of questions and answers
- Providing crop related recommendations
- Providing weather information related service
- Providing expert answers through communication
- Translation of forum threads

The technology has been developed by Prof. Krithi Ramamritham and his students and staff of the Department of Computer Science and Engineering with funding from Development Gateway Foundation, Media Lab Asia, Pan Asia and Ministry of Communication & Information Technology. The development partners are Krishi Vigyan Kendra, Baramati and Maharashtraand Vigyan Ashram, Pabal, Maharashtra.

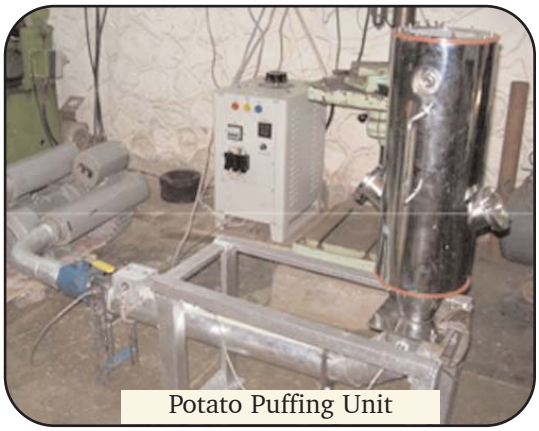
Agrocom Software Technologies Pvt. Ltd., an incubatee company deploying the above technologies, is dedicated to establish itself as a 'Globally Competent Farmer Media Content Company' specializing in agri-publishing and environmental measurement products. Agrocom seeks to leverage its technical strength and create a niche space as a proprietary content provider to the rapidly expanding vernacular publishing market in India.

Particularly, Agrocom operates the world's first mobile portal dedicated to farmers. Agrocom's sms service provides timely information to Indian farmers. Agrocom's www.aaqua.org mobile portal enables email and discussion forum services to a large number of farmers who currently do not have access to the internet.

Licensed to Agrocom Software Technologies Pvt. Ltd. an incubatee company at IIT Bombay

Technologies for enhanced rural industrialisation

Prof. N. G. Shah of Centre for Technology Alternatives for Rural Applications (CTARA) with his students and colleagues and Khadi and Village Industries Commission (KVIC) are working together on a variety of issues of mutual interest so as to generate technologies for the rural sector. Several technologies particularly in the thrust areas of agro and food processing, rural engineering and organic/natural products have been developed.



Potato Puffing Unit

- Development of simple pedal powered devices
  - water pump, battery charging unit, potter's wheel, paddy thresher and flour/masala grinding units
- Process for making and storing chemical-free cane jaggery
- Simple, easy to operate and cost effective solar air heater unit for maintaining honey storage space
- Development of Potato Puffing Unit employing fluidised bed technique for oil-free RTE (Ready to eat) snacks

PERFORMANCE EVALUATION OF OIL WELL CONFIGURATIONS

Oil is found deep below the earth's surface where it is entrapped in porous structures called reservoirs. A miscible or immiscible liquid is introduced through the wells of the walls of the reservoir which displaces the stored oil and thus oil is recovered. The configurations of these wells are either horizontal or vertical or a combination of both and their placements is a measure of oil recovery performance. To determine the strategy of oil recovery, a core sample is obtained from the reservoir and is placed inside a core holder maintained at high temperature and pressure. The core is then saturated with oil and water to levels close to those in the reservoir. Pressure measurements at various locations along the core are required to track the movement of the fluid front and fine-tune the oil recovery predictions of commercial numerical simulators.

Scientists have been trying to develop an appropriate core holder for the evaluation of oil well configurations and there are several patents on this. But all these core holders are cylindrical and are restricted for measurement of relative permeability only. Such measurement needs facility for saturating the core with the displacing fluid, which is readily done by injecting fluid from one end and collecting it from the other end of the cylinder. Also these do not have provisions for evaluation of fluid flow in the core (rock) along multiple directions.

To solve these problems, Prof. S. K. Mitra of Department of Mechanical Engineering, his colleague from Department of Chemical Engineering and their students devised a novel three-dimensional core holder with configurations for placement of horizontal and vertical wells in the core, which should also enable saturation of the core sample and allow multi-point pressure measurement for determining the oil recovery strategy.

The present invention permits fluid flow in a core with different well-configurations to enable their performance evaluation and enables measurement of pressures at various locations on all faces of the core, to provide information to fine-tune theoretical predictions. It also provides a core holder that can be used for loose material like sand and packed material like rock with the flexibility of putting injector and producer wells at different locations in the core to enables oil recovery studies for different well lengths. Furthermore, this invention provides a core holder that can be positioned at any angle with the vertical axis to conduct studies on dip effect and to enable study on multi-lateral wells.

The core holder comprises of a cover and a body that houses the core. The body comprises of side-faces and one bottom-face. The cover and the side-faces of the core holder have bored through holes. These holes permit pressure measurements. To evaluate the performance of oil well-configurations, the porous medium is placed in the core holder and is uniformly saturated by inserting the fluid into the manifold.

Indian patent application no. 1463/MUM/2005 Patent grant no. 225118
Inventors: S. K. Mitra, Madhu Vinjamur, Raghuvir Singh (ONGC), C R Maurya (ONGC).

Work under joint collaboration and technology licensed to ONGC

FPGA based RTL simulation acceleration

Programmable FPGA devices can be used to speed up the simulation of digital systems using hardware description languages. In order to do so, the design description needs to be analyzed and transformed so that it can be fitted into an array of FPGA devices. The technology needed to do this includes RTL analysis, partitioning, clock and memory transformations etc. This was developed in a series of M.Tech. projects under the guidance of Prof. M. P. Desai of Department of Electrical Engineering. This technology is being taken forward by Powai Labs, an IITB incubated company.

Powai Labs is focused on innovation in the electronics design automation (EDA) space. The company is currently offering a product "IMAGE" which is a high quality, affordable, robust price-performance Simulation Accelerator and Emulator and is also available in a range of models for Industry, Research Labs and Higher Technical Education & Research. Its clients are spread across Europe, USA and Far East, apart from domestic space.

Technology licensed to Powai Labs, an IIT Bombay incubated company

A novel method for making a fluid separation material

This invention relates to a method of making a fluid separation material such as membrane of nanopore structure. An object of this invention is to provide a method of making a fluid separation material such as membrane which has wide permeability and selectivity range and is simple and easy to carry out.

Prof. J. Bellare of Department of Chemical Engineering and his colleagues from Department of Chemistry have developed a novel method for making a fluid separation material and came up with a membrane of nanopore structure comprising a conducting porous polymer film to obtain a porosity of 0.01 to 50% in the nanopore sizes of 0.05 to 17 nanometers.

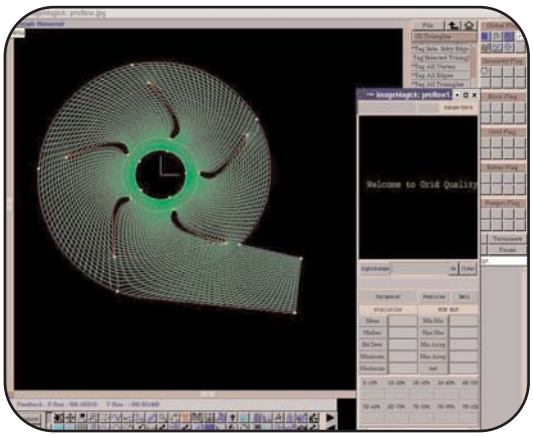
The inventors provided several embodiments of this new method. One of the methods comprises chemically synthesizing a free standing conducting polymer membrane of 50 to 10000 microns thickness and nanoengineering the pore structure to obtain a porosity of 0.01 to 50% and pores in the nanosizes of 0.05 to 17 nanometers. Another method comprises casting a conducting polymer membrane of 0.01 to 100 microns thickness on a porous substrate of 10 to 70% porosity with the respective polymer solution and nanoengineering the pore structure.

The porous substrate may be of inherent conductivity made from conducting material or of induced conductivity made from a non-conducting material or ceramics and coated with a conducting material.

The permeability of the membrane obtained by the method of the invention has been found to be 25.3 to 0.000005 and the selectivity has been found to be 100-59000. The method of the invention is simple and easy to carryout and can be used for the separation of liquids or gases.

Indian patent application no. 12/MUM/2001 Patent grant no. 197754
Inventors: J. Bellare, A. Q. Contractor, S. N. Dutta

Tools for computational fluid dynamics



Computational Fluid Dynamics (CFD) is the result of the confluence of fluid dynamics and a range of allied subjects: numerical methods, grid generation, computational geometry, computer-aided geometric design, computer graphics and parallel computing. Its application ranges over: combustion / heat transfer studies, pollution management and control, underground water management, or aerodynamic design of aerospace vehicles.

The IITZeus team headed by Prof. G. R. Shevare of Department of Aerospace Engineering developed two major software products- CFDTutor and CFDExpert. The former to train beginners and the latter is a full-fledged 3D CFD software capable of modeling, simulation and visualization, and provides end-to-end capabilities from design to analysis.

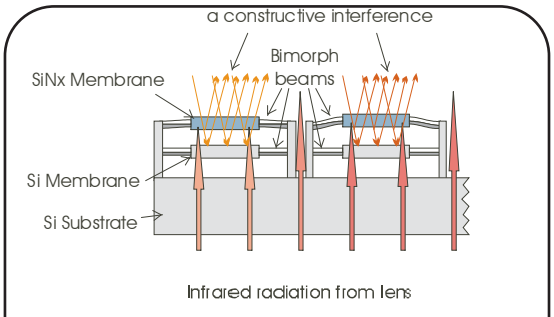
Zeus Numerix Pvt Ltd, a technology driven engineering solutions company, based on this development work develops engineering designs, tools, solutions and simulations that enable industry through virtual prototyping to quickly and efficiently develop unique products. Zeus Numerix has developed numerous products in the field of CFD, Electromagnetics, Structural Analysis and Corrosion. The company's CFD simulation software products and market innovative solutions have a wide range of industry applications including automobile, mechanical, aerospace and chemical industries. All products are architected so as to make customisation and enhancement very easy.

IP licensed to Zeus Numerix Pvt Ltd. a company incubated at IIT Bombay

Coloured imaging system

Prof. P. Apte of Department of Electrical Engineering and his colleague of Department of Mechanical Engineering and their students from have been able to develop an opto-thermo-mechanical integrated uncooled imaging system that captures the thermal images for direct coloured display of thermal images. Thermal imaging is used in applications such as night vision, environmental monitoring, astronomy, biomedical diagnostics, and thermal probing of microelectronic devices.

The invention collects infrared radiation which passes through an infrared lens system and forms an image onto the device. The system works in the following way. IR radiation passes through a special substrate in the lower diaphragm and gets absorbed in the upper diaphragm of the array. The heat absorbed gets conducted to the substrate through displaceable bimorph members linked to the diaphragm. Heated bimorph members cause deflection that raises the upper diaphragm. White light incident on the upper diaphragm causes constructive interference of a specific colour in visible light range. The end result of this process is that a direct colour image can be generated.



Working of the Colour Infrared Imaging System

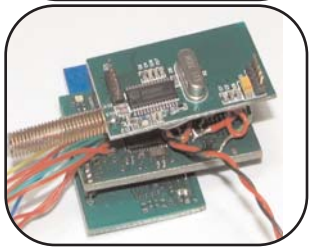
Some features:

- IR sensing and coloured image display capability
- Room temperature operation
- No cryogenic cooling equipment required
- Inherent room temperature compensation
- No further image processing of captured IR images needed

A direct coloured display of images is formed by the system without any processing device or electronics, intervening electronics or electrical connections and reduced thermal cross-talk between neighbouring pixels. No internal heat is generated due to the absence of electrical current. The device is simple and robust and has minimal number of parts.

Indian patent application no. 541/MUM/2005 Patent grant no. 236126
Inventors: P. Apte, B. Seth, O. Karhade, S. Chiluveru

A CANTILEVER BASED ELECTRONIC NOSE FOR EXPLOSIVE DETECTION



Prof. V. Ramgopal Rao of Department of Electrical Engineering with colleagues from Department of Biosciences & Bioengineering and Department of Chemistry and their students are carrying out work in the area of explosive detection down to the parts-per-billion level of sensitivity for RDX and TNT has been demonstrated using an extremely sensitive and low cost piezo-resistive polymer cantilever structures. These detectors are meant for vapour phase detection of explosive molecules and come with an integrated wireless transmission capability.

The surface stress which causes the deflection of the cantilever is generated from a selective chemical reaction on the surface of the cantilever. The cantilever surface can be regenerated after detection for subsequent measurements.

The technologies are particularly suitable for wireless sensing networks and are extremely low cost. Further efforts are currently underway to improve on the selectivity aspect in order to make them useful for deployment in public places.

AN EFFICIENT METHOD FOR CLEANING CLOTHES

The main objective of the invention is to provide an environment and user friendly and efficient method for cleaning of cotton or synthetic clothes. Our clothes get dirty with stains very frequently. These stains are mostly organic in nature and are due to sweating or materials like dyes, ink, turmeric, tea or coffee. Usually detergents or bleaching compounds are used to remove these stains. These cleaning agents convert the stains into water soluble material which have to be properly rinsed out. The clothes require physical handling which is time consuming and cumbersome. Moreover, these cleaning agents are not user or environment friendly.

Prof. M. Sharon of Department of Chemistry has developed an environment and user friendly and efficient method of cleaning clothes which eliminates use of polluting and allergic non-soap detergents and bleaching compounds and are very effective in the removal of fast stains.

In the present invention, the cleaning method comprises of mixing soap and ceramic oxide of nano-size particle followed by irradiation of the clothes with UV light. Ceramic oxides are biocompatible and include titanium dioxide (TiO_2) zinc oxide (ZnO), iron oxide (Fe_2O_3) or tungsten oxide (WO3) preferably TiO2 or ZnO. Nano size particles of ceramic oxides form an electrically charged particles at the interface between the stained clothes and detergent solution.

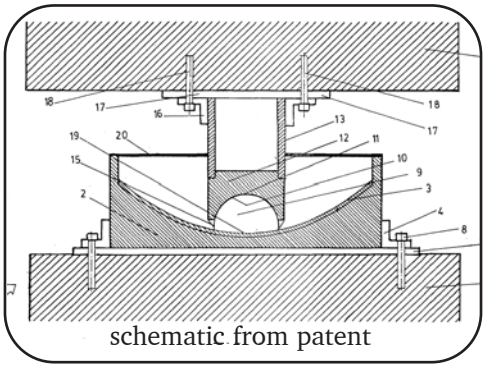
On irradiating the stained cloths with UV light, photogenerated electrons and holes are formed at the interface, which convert the stains into gases (CO_2) and water soluble mineral acid salts (hydrochloric acid salts) which may be easily rinsed out. The gases escape into the atmosphere and need no separation. . The UV light may be from sunlight or UV light source and duration of irradiation depends on the nature and surface area of the stain. Typically for a 15 Watt UV light, an irradiation period of 20 to 30 minutes is required. If the cleaning is carried out in a washing machine, the UV light source is fitted in the washing machine and operated by the control panel thereof. Stains are removed by converting them into gases and water soluble mineral acid salts. For this reason all types of stains are effectively eliminated.

Shirts which got yellow sweat stained at the collars were soaked in a soap solution with water containing 10g of a washing soap and 0.1g of titanium dioxide of nano-size particles, exposed to sunlight for 30 minutes and rinsed with water. The shirts were completely free from the sweat stains. In several other examples, ink or turmeric or coffee stained towels were treated similarly and become completely free from the stains. This present invention provides an environment and user friendly and efficient method for cleaning clothes.

Indian patent application no. 24/MUM/2001 Patent grant no. 206020
Inventor: M. Sharon

Constant and variable vibration-protective pendulum isolators

Structures such as buildings, bridges, industrial structures, equipment, machinery or other subsystems such as piping are often subjected to severe vibration motions due to earthquakes, heavy wind or machinery. It is necessary to reduce the vibrations that are experienced by the structures for safety, serviceability, or for operation considerations. One strategy for enhancing safety of such structures is to use vibration isolators.


schematic from patent

Prof. Ravi Sinha and his student of Department of Civil Engineering have patented two types of pendulum isolators (constant and variable period isolators). A constant long period vibration-protective pendulum isolator for structures has constant fundamental periods of 0.3 to 10 seconds, dissipates energy through friction and transmits reduced energy into the structure. This system can also be used as a constant long period tuned mass damper. The designed isolator is illustrated below:

Indian patent application no. 15/MUM/2001 Patent grant no. 197756
Indian patent application no. 867/MUM/2001 Patent grant no. 197850
Inventors: R.Sinha, M. Pranesh

The second type is a variable period protective pendulum isolator for structures having fundamental time periods from 0.2 s to 6.0 seconds, which dissipates energy through friction at sliding surface and transmits reduced energy into the structure. The variable period vibration protective pendulum isolator has its time periods varying in a pre-determined way as the sliding takes place, which limits the restoring force so that the force transmitted to the structure is bounded irrespective of magnitude of sliding displacement of the isolator or the size of the earthquake.

The growing need to counter strong vibrations of large structures as a protective measure makes these technologies useful and important. Such applications are typically observed in important life-safety buildings such as hospitals and communications facilities, and in facilities such as bridges and pipelines. The application of these protective measures also exists for safety of important objects such as displays in museums.

New composite layer to help make ICs faster

When Integrated circuits are fabricated, a copper layer that forms the contacts is deposited on a low dielectric (the measure of electrical insulation) material layer coated on a semiconductor material substrate. In order to reduce RC time constant (the time to charge a capacitor) associated with the integrated circuits and to improve the frequency or speed of operation of integrated circuits traditional methods used result in a high dielectric constant.

Prof. R. O. Dusane and his students of Department of Metallurgical Engineering and Materials Science have formulated a method of depositing an amorphous SiC:H barrier layer on a low dielectric material layer. The method is simple and convenient to carry out, is cost effective and gives rise

Indian patent application no. 4/MUM/2006 Patent grant no. 223221
Inventors: R.O. Dusane, A.A. Kumbhar, S.K. Singh

to a composite layer which lowers leakage of current. The layer is also of reduced thickness leading to lower costs of manufacture. The amorphous SiC:H is deposited to form the barrier layer on deposited material of low dielectric constant that is coated on the silicon layer. The barrier layer is deposited by exposing the material layer to hot wire chemical vapour deposition (HWCVD) using a mixture of silane and acetylene gases at a temperature of 200 to 300^{o} C and pressure of 100 to 200 mTorr. HWCVD is done by heating a tungsten wire at 1700 to 1900^{o} C.

The invention of depositing a barrier layer on the dielectric material layer by HWCVD eliminates the use of RF generators and impedance matching circuits thereby rendering the process simple and convenient to carry and also making it more cost effective. Further the process has been shown not to damage the dielectric layer. A barrier layer of 10 nanometers is adequate to prevent the copper diffusion into the dielectric material layer. The composite layer of barrier material and low dielectric constant material has reduced leakage of current. Thus Integrated circuits fabricated using the composite layer thus designed will have reduced RC time constant and improved frequency.

Method to treat low dielectric k deposited material of ICs

The speed with which integrated circuits work depends on the RC time constant (time taken to charge capacitors). It is essential to use material that has a low dielectric constant so that RC time constant is also low. Today, Hydrogen silsesquioxane (HSQ) with a dielectric constant of approximately 2.95 has been developed to be layered on the silicon base of ICs. HSQ is a porous material and is thus susceptible to moisture attack.

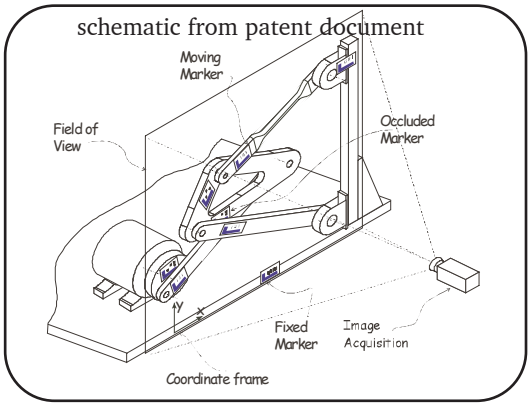
A method to treat low k dielectric material layer coated on a silicon substrate which is simple, cost effective and convenient has been developed by Prof. R. O. Dusane and his students of Department of Metallurgical Engineering and Materials Science. The method does not damage the dielectric layer, renders the dielectric layer very effective against adverse effects of oxygen plasma treatment, and improves the hydrophobicity of the dielectric layer reducing moisture adsorption. Thus the leakage of current is lowered improving performance of the treated IC. The process developed also helps to deposit low dielectric material (layer) on silicon base substrate and retain low dielectric properties of the deposited layer.

HWGAH treatment eliminates use of RF generators and impedance matching circuits, simplifying IC manufacturing. The method does not damage the dielectric layer, prevents penetration of oxygen during plasma treatment and other adverse effects. It also improves the repelling of water by the dielectric layer, reducing its adsorption and subsequently caused leakage of current. Since the dielectric property of the layer is retained the performance of the IC manufactured by this technology will be of higher quality.

Indian patent application no. 5/MUM/2006 Patent grant no. 232216
Inventors: R. O. Dusane, A. A. Kumbhar, S. K. Singh

Track it

Prof. B. Seth and his students of Department of Mechanical Engineering have developed a method for tracking planar movement of multiple objects from sequence of digital images using markers. This invention is useful for videographic study of motion in machines. Tracking of objects from a sequence of images requires automatic identification of the objects of interest and accurate location and orientation information of the tracked objects in each frame. The approaches used to accomplish this include recognition based on the radiation characteristics and reflective properties of the object itself or of a tag or marker attached to the object. Use of markers, when permissible, assist in tracking by facilitating automatic recognition of the objects. Traditionally symmetric markers are used.



There are several drawbacks in the traditional marker system. In multiple marker system there is the problem of marker correspondence (i.e., identifying the corresponding markers in successive image frames). This problem can become unmanageable when markers get occluded or go out of the field of view. Also a traditional marker yields accurate position information; however, for obtaining accurate orientation multiple markers are needed on the same body.

Indian patent application no. 1278/MUM/2003 Patent grant no. 206126
Inventors: B. Seth, A. C.Acharya, R. Raj, K. Moharir

Advantages of the system

- Marker detection is robust
- There is no added difficulty when more markers are used
- A single mark yields both position and orientation information
- Correspondence problem of a marker is eliminated by a unique tag
- Re-tracking of an occluded markers starts immediately after the marker comes in the camera view again

In this tracking system, a number of parts move in parallel planes and it may be desirable to accurately track the motion of some parts. Markers are afixed on the different bodies of interest. During motion the markers can get occluded.

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