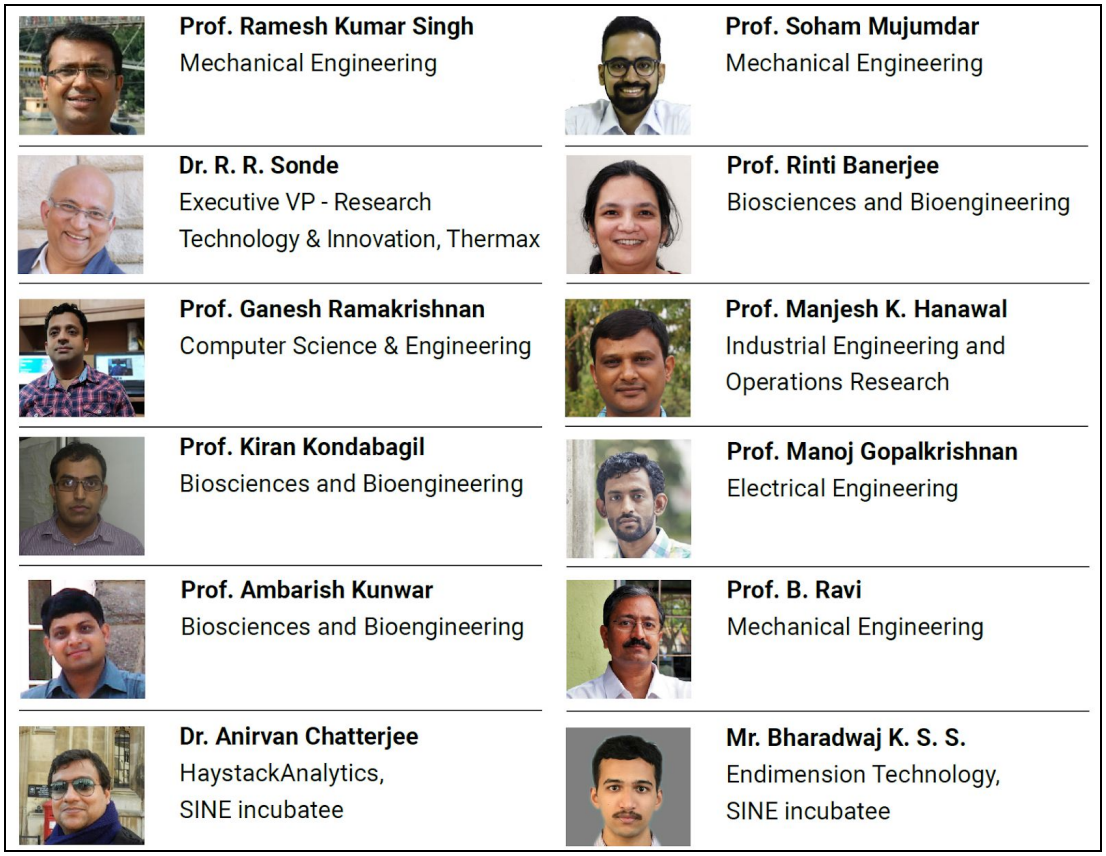
Press Release on Webinar on R&D at IIT Bombay for COVID-19 mitigation

As a response to the challenges posed by the ongoing COVID-19 pandemic, Indian Institute of Technology Bombay (IIT Bombay) has been collaborating with hospitals and industry partners to find solutions and mitigate problems. Researchers at IIT Bombay have offered their expertise towards developing medical devices, sterilisation methods, antiviral supplements, software solutions and many other scientific interventions to help deal with the direct and indirect effects of the pandemic.

On 1 August, 2020, Industrial Research and Consultancy Centre (IRCC), Office of Dean (R&D) at IIT Bombay organised a half-day webinar where the researchers involved in the COVID-19 mitigation efforts spoke about the progress made over the last few months. The webinar was attended by over a hundred people, including students, scientists, industry personnel, medical professionals and government officials. During the session, talks were presented by faculty speakers from IIT Bombay and the industry and entrepreneurs from start-ups incubated at Society for Innovation and Entrepreneurship (SINE, Technology Business Incubator of IIT Bombay).

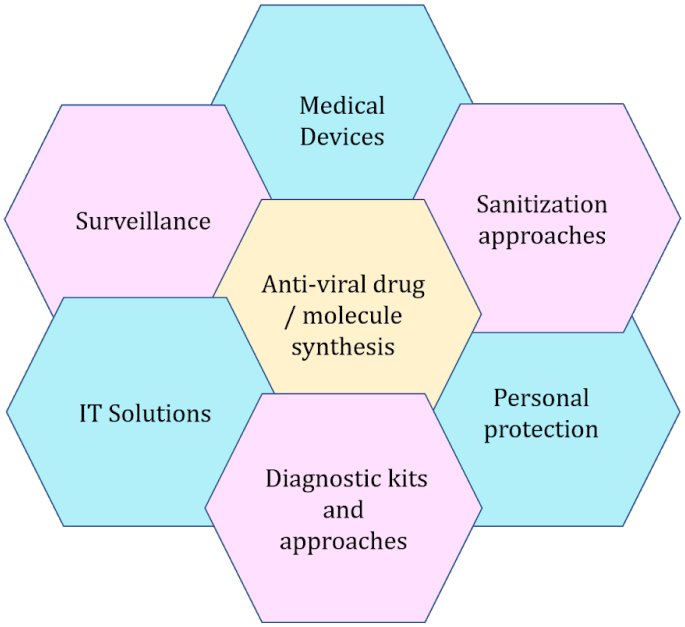


List of speakers for the COVID-19 webinar

Prof Milind D. Atrey, Dean (Research and Development), opened the session and commended the IIT Bombay professors and researchers for rising to the challenge and coming up with strategies to deal with the outcomes of COVID-19. Initially, the researchers had been given seed grants to get started, and seven patents and ten technology licenses have been granted so far.

"R&D at IIT Bombay strives to develop a vibrant industry-academia symbiosis to ensure innovations and technologies developed in the laboratories reach the society at large," said Prof Atrey. Over the last few months, about 20 industry collaborations have been forged, and there are ongoing talks with 40 industries for licensing. Prof Atrey urged more enterprises to get involved to ensure that the technology developed in the research labs reach the public.

Technologies and expertise available at IIT Bombay for COVID-19



Research areas of COVID-19 related work at IIT Bombay

"IIT Bombay is at the forefront of technology-driven solutions to overcome the COVID 19 pandemic. With decisive support from our government and industry collaborators, we have undertaken more than 30 COVID-19 related R&D projects in multiple domains with promising results. We are determined to continue development and deployment of different technologies to improve India's response to the COVID-19 outbreak," said Prof Subhasis Chaudhuri, Director IIT Bombay. He talked about the broad research areas such as palliative care and curative solutions that have been the focus of COVID-19 efforts at IIT Bombay.

Addressing the participants from the industries, Prof Chaudhuri hoped to see more interaction between the researchers and industries, stressing that IIT Bombay is always trying to find new ways to collaborate with industries.

The session was moderated by Prof A M Pradeep, Associate Dean(R&D), who introduced the speakers and conveyed the questions posed by the audience during the webinar.

Prof Ramesh Kumar Singh, Prof Soham Mujumdar, Prof Ankit Jain and their team (Department of Mechanical Engineering) have been working with Dr R. R. Sonde from Thermax Global on designing a non-invasive ventilation (NIV) system for ensuring a continuous supply of oxygen to patients infected with COVID-19. The flow rate of air supply can be adjusted, and the device takes away the need to intubate the patient. "It is a safer alternative to face masks in patients with acute respiratory failure," said Prof Singh.

Airhood designed by Prof Ramesh Singh and team

The device resembles a helmet and provides the patient with a clear view of their surroundings. It is completely sealed so that the medical personnel are not exposed to any droplets carrying the virus. The air exhaled by the patient is filtered before discharging to ensure that it's free of any pathogens. The device can also be used with any commercial ventilator, although the researchers advise that ventilators should be reserved for critical patients.

Over several iterations of the design, the team has ensured that the final prototype is ergonomic and comfortable to wear. They have verified that there is no accumulation of carbon dioxide

inside the device using computer simulations of the airflow within. The patient will be able to comfortably breathe while wearing the device and will not experience any sense of suffocation. "Since the device is not clamped on your face, it is suitable for long term use," said Prof Singh.

Dr Sonde from Thermax Global, the manufacturing partner for this project, said that the device will be available as a product within four months and would cost under INR 5000.

As the next step, by 15 August, the researchers have plans to try out the device on healthy patients to check its comfort. Then, they will be collaborating with Tata Memorial Center, Mumbai, to test the device on COVID-19 patients.

Prof Rinti Banerjee (Department of Biosciences and Bioengineering) has been leading the efforts to develop a range of products such as nutritional supplements, therapeutic agents, antiviral coatings and alcohol-free sanitisers that can fortify against COVID-19 infection. Her team has fabricated a wash-resistant, antibacterial and antiviral coating for textiles called 'DURAPROT'*TM* that has been applied over textiles such as masks and personal protective equipment(PPE). DURAPROT*TM* enabled masks have been licensed and commercialised by Meemansa and Ants Innovations as industry partners.

*Two versions of masks coated with DURAPROT*TM*, developed by Prof Rinti Banerjee and team have been commercialised by industry partners*

The coating material is safe and environmentally friendly. The coating has shown complete inactivation of the novel coronavirus. DURAPROTt*TM* enabled masks are self-disinfecting, reusable and have been validated according to ASTM and ISO standards for antiviral properties, breathability and antibacterial effects. As a social initiative, the team has also been partnering with self-help groups through state rural livelihood missions and NGOs to train them in making these advanced functionality masks. DURAPROT*TM* technology is also being used for functional

textiles, textile-based consumer products, sportswear and accessories, and is being licensed by multiple partners.

An advanced version of the DURAPROT*TM* technology namely DURAPROT PLUS*TM* has also been developed. These masks meet all ASTM, ISO and WHO standards for N95 masks and surgical masks, and are self disinfecting, affordable and re-usable.

The team has also formulated two spice-based formulations. One is a dietary nutraceutical made of FSSAI approved constituents, and another is an ayurvedic therapeutic based on PICOVRID*TM* technology, that has shown to have antiviral, immune boosting and anti-inflammatory benefits. Swabs of COVID-19 patients from Kasturba Hospital for Infectious Diseases, Mumbai, treated with PICOVRID*TM* were neutralised in an hour. Animal models that were given a dose of the compound showed reduced IL6 levels in the lungs and the cytokine storm as seen in pneumonitis complications associated with COVID-19.

PICOVRID*TM* is available as nutraceuticals and ayurvedic formulations in the formats of syrup, gel, capsules, fruit beverages, herbal water, flavored milk, herbal yogurts and herbal teas. The product has been GMP manufactured in FSSAI and AYUSH approved facilities and is ready for licensing. Clinical trials have also been planned for the technologies.

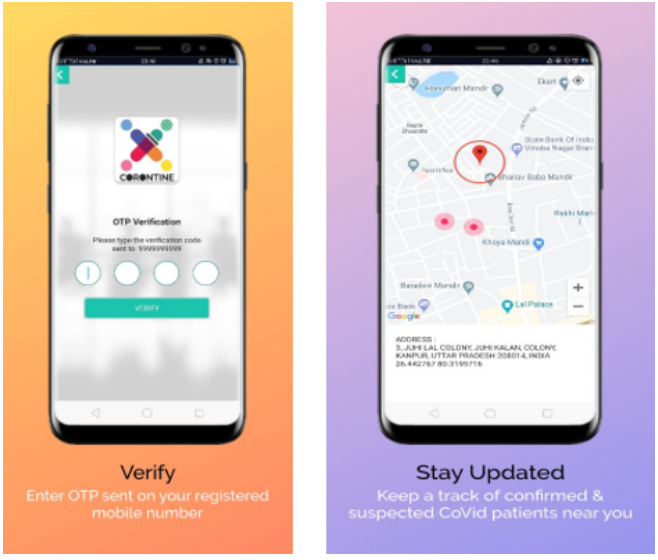
*PICOVRID*TM* and NANOSURF*TM* formulations developed by Prof Rinti Banerjee and team are available for licensing*

Prof Banerjee and her team have also developed NANOSURF*TM*, a pharmaceutical compound consisting of GRAS approved actives, which is helpful in tackling severe complications of

COVID-19 including acute respiratory distress syndrome(ARDS). The technology has been granted Indian and US patents, and works both as a pulmonary surfactant and an anti-inflammatory drug reducing the cytokine storm and alveolar protein leakage associated with ARDS complications of COVID-19. Regulatory toxicology and stability in accordance with industry standards has been established. Aerosol and oral formulations are available as liquid and lyophilised forms for licensing. Next, the researchers plan to conduct clinical trials for emergency use.

The researchers have also developed ECORSANI^{TM}, a range of alcohol-free herbal sanitisers and surface disinfectants, which can inactivate the novel coronavirus. In accordance with ASTM standards, ECORSANI^{TM} based alcohol-free sanitisers kill more than 99.9% germs within 20 seconds. The technology has been licensed to Life Essentials. Further, licensing is available for various forms of the technology as hand, surface and aerosol disinfectants, fruit and vegetable sanitisers, coatings for surfaces, additives for paints and packaging, as well as mouthwashes.

Prof Manjesh Kumar Hanawal (Industrial Engineering and Operations Research) and Prof Ganesh Ramakrishnan (Department of Computer Science & Engineering) have been working on a COVID-19 contact tracking platform called 'Corontine' for tracking asymptomatic individuals. People suspected to be infected with the novel coronavirus would have to download the application and register through their smartphone. The app sends out the GPS coordinates of the person from their phone to the authorities. It is designed to help them to ensure that infected and asymptomatic persons follow quarantine guidelines and move around only in the approved areas within a safe distance.



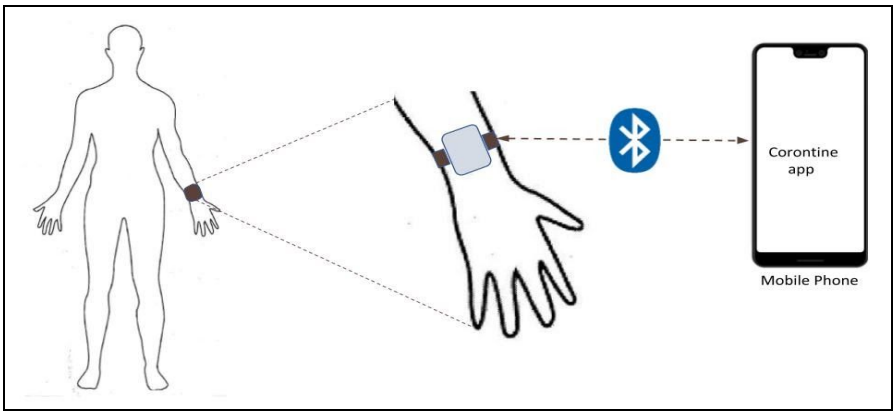
Quarantine, contact tracking app by Prof Manjesh Kumar Hanawal, Prof Ganesh Ramakrishnan and team

In this framework, only the people assigned as the authorised body for a particular local area will have access to the data from individuals in that area, thus ensuring strict privacy controls. Corontine application has been widely used in the state of Meghalaya. The Orissa Government has used some aspects of the platform to implement its COVID-19 tracking system.

The team has also developed a volunteer-run call centre platform, called Happy-to-help, through which they help people in installing Maha Kavach, a COVID-19 contact tracing app deployed by the Maharashtra government.

Moreover, the researchers are developing CampusHelp, a Bluetooth-based application for contact tracing. It can be used in universities to alert students who are on campus when they come in contact with a person who has tested positive for COVID-19. Currently, the team is seeking funding partners to deploy the app on a larger scale.

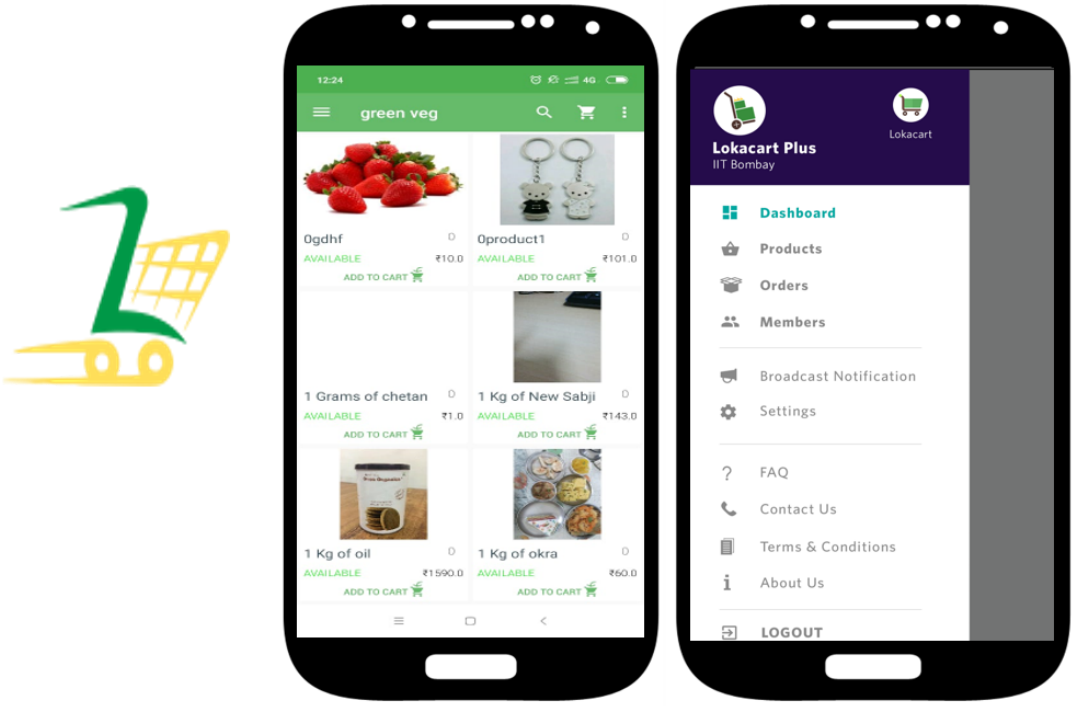
The Corontine platform can also be used in healthcare applications for monitoring vital parameters. It is being used with i_Wrist devices developed by Prof. Maryam Shojaei to measure vital parameters like temperature, pulse rate, oxygen levels and blood pressure, which are collected by the Corontine app through Bluetooth. The parameters can then be centrally monitored to keep a check on the health status of the patients. This helps health workers in observing a large number of patients and attending to those requiring critical care. The team is seeking funding and industry partnership for large scale production of i_Wrist.



Using i_Wrist device with the Corontine app

Prof Ganesh Ramakrishnan has also been involved in developing Lokacart, an e-commerce software platform aimed towards helping small-scale enterprises and farmers supplying necessities, such as fruits, vegetables and household goods, to connect with the consumers and bringing self-dependence and self-reliance in today's struggling economy and supporting the

momentum of “Vocal for Local”. They are working in collaboration with Mr Ashvin Gami, MD, ITAakash Strategic Software Pvt Ltd, an IIT Bombay alumni and with guidance from Prof. Narendra Shah (CTARA, IIT Bombay). "The application is not trying to be a middle, but rather provides an easy platform to connect consumers to the seller directly, providing the convenience of comfort as well as the trust of known buyers and sellers," explains Prof Ramakrishnan.



Lokacart, retail platform by Prof Ganesh Ramakrishnan and team

The platform automates the process of receiving orders, bill generation and delivery processing through mobile. The buyer can select the products and place an order from the store with which they have registered. The seller keeps an account of orders and stock of the products and the consumer keeps track of orders and billing and ensuring delivery.

The following two features of transparency provide Lokacart a distinct advantage among buyers and sellers: (i) complete control to the seller on what to sell, at what price to sell and to whom to sell through the admin app (as well as web interface), and (ii) complete control to the buyer on whom to buy from, through the buyer app. That's easy Ecommerce!

The story behind the Lokacart app and the testimonials of its success are available in this article. The platform is currently available in Marathi and English, and will soon be available in more Indian languages. Three versions of the platform are available on Google Play Store that caters to different stakeholders: sellers, buyers and buyers interested in bulk purchases and one version of Lokacart app is available on iOS for buyers. "So far, 194 vendors are using the platform to cater

to thousands of consumers," said Prof Ramakrishnan. IIT Bombay is happy to announce the transfer of the technology to ITAakash Strategic Software Pvt Ltd under an exclusive license agreement. ITAakash Strategic Software Pvt Ltd will be taking the product to the market at a wider scale.

Prof Kiran Kondabagil (Department of Biosciences and Bioengineering) and his team are developing a nasal gel that can be used to inactivate the novel coronavirus as it enters the nasal cavity. Prof Kondabagil explained that most COVID-19 infections happen from inhaling and ingesting the novel coronavirus. "Most of the drugs being developed to treat COVID-19 are taken after the patient is exposed to the virus. The nasal spray we are developing is a non-invasive alternative without the need to ingest any drugs," he said. The team is currently developing methods to test the capture and inactivation of the virus using the spray.

The team is also working on testing wastewater samples for the presence of the virus. This method can be used as a low-cost tool to track the samples detected with COVID-19 back to the source of infection and alert that community.

Prof Sanjeeva Srivastava (Department of Biosciences and Bioengineering) is involved in identifying the proteins linked to COVID-19 infection from nasal swab samples using mass spectrometry. It is simpler to prepare samples through their method compared to the more prevalent RT-PCR testing. The test can discern specific SARS-CoV-2 proteins in COVID-19 patients, and has been able to identify proteins related to the virus in recovered patients, which was not detected by RT-PCR. This method is currently being validated and might be used to screen asymptomatic persons.

The team is also working to identify the molecular pathways that are altered in the COVID-19 infected patients from their nasal swab samples. This can help the clinicians in planning appropriate therapy to treat the infection, and can also aid in predicting the severity as the disease progresses.

Prof Manoj Gopalkrishnan (Department of Electrical Engineering) and his team have worked on an algorithm that can provide guidance for pooling samples from patients using statistical modelling for COVID-19 detection. Currently, samples collected from a set of people are pooled together and tested for the presence of the novel coronavirus. If the test is negative, the whole group is pronounced COVID negative. If the test is positive, the individual samples are tested further to find the infected person. But, the hospital has to wait for the results from the first stage of the test to proceed further, and meanwhile, any asymptomatic people might have spread the virus.

In the method developed by Prof Gopalkrishnan and team, samples from the same individual are tested in multiple pools at once. Based on all the results, the algorithm zeroes in on the individual who has tested positive across multiple tests as carrying the infection. This method makes the testing timeline shorter and provides a quicker screening platform.

The researchers have tested over 2000 samples using this method, and there are more clinical trials going on at Malabar Cancer Centre, Thalassery, Institute For Stem Cell Science and Regenerative Medicine(InStem), Bengaluru, and Tata Memorial Center, Mumbai. They have built a web app as well as an android app. They envision this method could be used in places where thousands of people have to be screened very quickly such as universities, workplaces and movie theatres, as well as in testing labs.

Prof Ambarish Kunwar (Department of Biosciences and Bioengineering) and his fellow researchers have built a portable sterilisation device and a germicidal cabinet that uses ultraviolet(UV) light to eliminate pathogens including the novel coronavirus. Within 3 minutes of exposure, these devices can almost completely eliminate the virus present on small objects such as mobile phones.

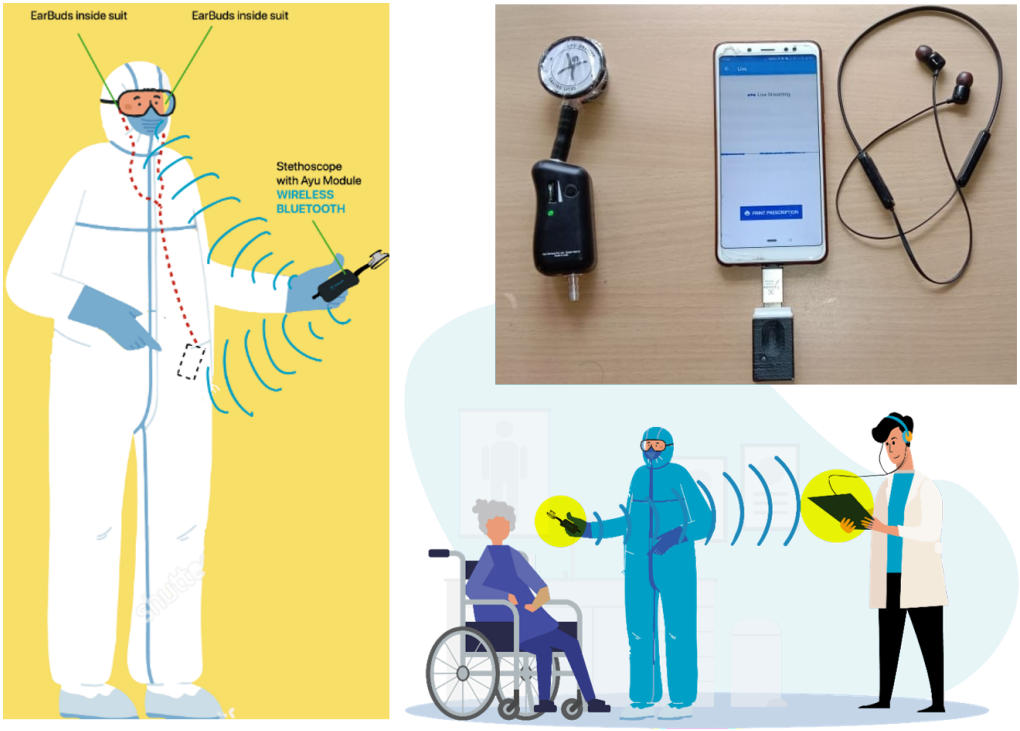
UV germicidal cabinet designed by Prof Ambarish Kunwar and team

The team has also designed a wheeled sterilisation unit that can sanitise a larger area within a radius of 1 meter when exposed to UV light for around 15 minutes. All three devices are currently being used in IIT Bombay Hospital. They are in talks with industry partners to produce the device on a larger scale. So far, a non-exclusive license has been given to one company.

The researchers have also received funding from Wadhwani Research Centre for Bioengineering at IIT Bombay for the development of a robotic sterilisation unit that can be utilised for sterilising hospitals and public transport systems such as buses.

Further, the team has developed a prototype of a portable and rechargeable car sanitiser. "This can be stored in the trunk of your car, and can also be used in ambulances," said Prof Kunwar. His team has also developed a Safe Biohazard Transporter which can be used for inactivation, transport and safe disposal of biohazards such as used masks. The transporter is currently being used by Proteomic Laboratory of Prof Sanjeeva Srivastava to carry inactivated COVID-19 samples from hospital to the research lab. In parallel, the team is providing its expertise to industries on developing various UV sterilisation devices and their testing.

Prof B Ravi (Department of Mechanical Engineering) has been coordinating efforts from Biomedical Engineering & Technology Innovation Centre (BETIC) in developing novel medical devices. They have designed a smart stethoscope equipped with Bluetooth that can transmit sounds from a patient's chest to the clinician's earpiece inside PPE, thereby preventing the need for physical contact. Several clinicians are currently using the smart stethoscope manufactured by Ayu Devices, a startup who have licensed the technology from IIT Bombay.



Contactless auscultation by smart stethoscope developed at BETIC

The Ayu Devices team also developed a smart COVID OPD booth with a glass barrier for clinicians to examine patients and take swab samples without touching. Fifteen booths have been installed in various hospitals across Mumbai, including Cama & Albless, Cooper, HHSB Thackerey, Nair, Rajawadi, Sion, and St. George.

"The facilities and ISO 13485 certified process of BETIC enable validating the clinical needs, translating research prototypes into commercially viable products, obtaining the necessary regulatory clearances, and technology licensing to industry partners. The process has been adapted by several other engineering and medical institutes," says Prof Ravi.

Two startups spawned at BETIC cell of COE Pune include MediAsha, who have developed disposable face masks, shields and hoods, and Atmen Technovention, who have developed an endo-tracheal tube blockage detector. Another startup OKO Icare from VNIT Nagpur cell developed contactless hand sanitiser that can also be equipped with a thermal scanner. The IIT Bombay team is currently engaged in developing an ICU ventilator, which has reached testing phase.

Smart COVID-19 booth developed by Ayu Devices

Two start-ups incubated by Society for Innovation and Entrepreneurship (SINE), HaystackAnalytics led by Dr Anirvan Chatterjee and Endimension Technology led by Mr Bharadwaj KSS, have also been involved in providing technology solutions to the COVID-19 pandemic.

The team at HaystackAnalytics is building a real-time testing system to analyse the genetic data of patient samples to check for the presence of the novel coronavirus. They have validated their results using global genomic datasets. In this platform, around 96 samples can be tested in every

4 hours, with an estimated cost of INR 2500 per sample. The system can be deployed at workplaces to ensure that there is no transmission of the COVID-19 infection.

Mr Bharadwaj's team at Endimension Technology is developing artificial intelligence methods to detect abnormalities associated with COVID-19 infection from chest scans. In hospitals with a large number of COVID positive cases, the software can help sort the patients according to the severity of the risk, ensuring that they receive appropriate treatment.

"Since most hospitals are equipped to take chest X-rays which cost less than INR 150, this method provides a low-cost diagnostic solution," said Mr Bharadwaj. The system can also be used to monitor how the patient is responding to treatment. The AI platform is ready to deploy, and the team is awaiting partnerships with clinicians to validate their results.

In closing, Prof A. K. Suresh, former Deputy Director (AIA) and former Convener of COVID-19 Task Force at IIT Bombay, summarised the salient points of each research work mentioned in the webinar. He congratulated the researchers for making rapid progress in their work over the last four months. He also applauded the government agencies for fast-tracking grants and the industries for quickly forging collaboration on the various projects.

More details and updates on all the R&D activities around COVID-19 taken up by IIT Bombay can be found here.