

ROLE OF INDIA'S TECHNOLOGICAL INNOVATIONS TO MITIGATE COVID-19 PANDEMIC

*Dr. Manish Mohan Gore**

ABSTRACT

Science unfolds the secrets of nature while technology makes the human life easy. Innovation is the third dimension after science and technology. Through innovation, new ideas are successfully exploited. In fact innovation is a new and vibrant idea which supports human lives. Technological innovations have become the boon for the humanity. Several such innovations are serving the humans to treat ailments, enhancing entrepreneurship and development of nation. During COVID-19 pandemic, technological innovations have played vital role to mitigate its impact. Such innovations have saved billions of human lives. In this study, the prominent technological innovations of India have been discussed which are worthwhile to combat COVID-19. These innovative technologies, drone, robot, Apps and multimedia digital platforms are developed by a number of scientific laboratories academic institutions of India which belong to both public and private sectors.

Keywords: App, COVID-19, digital platform, drone, entrepreneurship, innovation, multimedia, pandemic, technology.

INTRODUCTION

Homo sapiens is the most intelligent life on earth. This species scattered throughout the world and established itself. Apart from human brain, inclusion of science and technology has shaped the human progress. In fact the logic and mental exercise of humans are at the roots of science and technology. Innovation is third dimension in it. Uncovering the secrets behind natural phenomenon is known as Science (derived from the Greek word *scientia* means 'to know'). Technology concept is the brain child of humans. It provides the tools, instrumentation techniques and methods to perform scientific theories and apply in real-world adaptation. The technological attainment remarkably improves the quality of life and aids social advancement in almost everything (G. Giacomelli and R. Giacomelli, 2004). The inventions in the field of transportation have made human life more comfortable. The modern technologies have drastically changed the sectors of health & medicine research, space exploration, banking, commerce and communication. Biotechnology, Augmented and virtual reality, Internet of things (IoT), Quantum computing, machine learning, artificial intelligence and robotics are emerging as the newest technologies from the beginning of 21st century (UNESCO, 2012).

*Dr. Manish Mohan Gore is Scientist, CSIR-National Institute of Science Communication and Information Resources (NISCAIR), Dr. K.S. Krishnan Marg, New Delhi 110 012. Email: mmgore1981@gmail.com.

Innovations are reflected in the form of creative thoughts and new imaginations in the form of new method, device or product. This has the strength to reshape the society. If wind flow is science, fans are technology, and then the wind turbine is the example of innovation. Technological innovations are instrumental in sustainable development. Through science, technology and innovation, the world steadily reaches to a more modernized future (Sasvari P, 2012).

Technological innovation helps human being in many ways. It combats social problems like poverty and unemployment by introducing entrepreneurship and small-scale industry (*Kutir udyog*) in villages (Sang M Lee and Silvana T, 2018). It also mitigates health problems and medical emergency such as COVID-19 pandemic. Innovative technologies are used in the development of drugs and vaccines. The development of life-saving products like drugs and vaccines is a time taking process. It has many stages and trials to reach up to a flawless end product to be used on a large population. We reach to the drug and vaccine stage at the end. Prior to that final stage, the mitigation, containment, diagnosis and testing are some conclusive factors for the disease control. During any infectious disease or epidemic, these factors are very much crucial and technological innovations address those to contain the infection and mitigate the effect of epidemic (Janmejaya S, 2014). COVID-19 presents a good example of this. Innovative technologies developed by several nations of the world including India during this pandemic have played pivotal role to reduce the mortality as well as mitigate the pandemic impact (Brohi SN *et al.*, 2020). A number of Indian science and technology laboratories have developed many tools, technologies, App etc. during COVID-19.

TECHNOLOGICAL INNOVATIONS EASE THE HUMAN LIFE

Earlier in the twentieth century, electricity and means of transportation were big inventions that have changed the human life. Later internet and ICT revolutionized the world. Internet has become the essential thing just as oxygen for our life. Today, technology is embedded in everything we do. It impacts the way we live, work and experience the world. The journey of exploration, invention and innovation allows them to integrate its applications into human life. Technological innovations have altered the world entirely. It becomes the foundation of tools and techniques that support a more efficient engineering purpose and design (Sasvari P, 2012). In addition to research instrumentation and analytical processes, such innovations are used in industrial practices, skill development and entrepreneurship. Technology has transformed the education and knowledge-based information system and it has the huge social impacts (Banking Technology Vision, 2018).

The advancement of technology brings unprecedented improvement in the field of healthcare and medicine sector. A number of incurable diseases like tuberculosis are now treatable. The medical procedures and diagnosis have become more reliable and safe because of the modern precise and accurate medical tools. Advancement in technological innovation has given to human a much better existence (Fett M, 2000). We are living in a world of technology and technological innovation is reshaping our society manifold. Technological innovation affects all walks of human life from agriculture to transportation and communication. Innovation improves quality of life even if any person is facing income

lag. Global improvements in quality of life have been enhanced by the spread of technology and innovative ideas. Very cost effective health technologies that can dramatically reduce mortality are accessible across the world. The proportion of the world's infants vaccinated against pertussis, diphtheria, tetanus (DPT) climbed from one fifth to nearly four fifths between 1970 and 2006. Simultaneously the ideas that save lives such as to wash one's hands, to not defecate in the open are increasingly accepted. The fast pace developing countries like India has witnessed the improved quality of life which results from technological innovations (Charles Kenny, 2009).

Dire necessity is the precursor of any innovation. Famous scientist Stephen Hawking had once said that probably in time-period of 100 year, the earth will not be inhabitable for humans. Population explosion, resource shortage and climate adversities will bring this situation. As per the speculation of Hawking, in that circumstance, the shifting of earth's population to other conducive nearby planets could happen. Colonization in other planets will be the big leap of technological innovation and in coming future, this can be a reality. Many scientists of the world consider this as a science fact rather than science fiction.

Robots are a best example of innovation in technology. In coming future, robots will do many jobs at workplace as well as in homes efficiently, more quickly and with fewer mistakes too. Use of the robots in space research, healthcare and industry is very promising. Electric vehicles have become reality and in recent future, one will no longer need to commute oneself. Take a nap, let the car run automatically. Self-driving cars is going to become a reality. Road congestion with heavy traffic has become a big challenge. Don't worry flying cars is the next possibility (Roberts J and Milford M, 2017).

IMPORTANCE OF TECHNOLOGY DURING COVID-19

COVID-19 has posed a huge challenge before the world from February 2020. Most of the countries are in the grip of novel corona virus. First case of this viral infection was reported in Wuhan, China in December 2019. To combat the COVID-19 outbreak, the development and implementation of technology solutions aimed at are rapidly taking shape around the world. Governments, industries, research & academic institutions, incubators, start-ups are all doing their part to deploy new innovative technological solutions (Kritikos M, 2020). In order to contain the novel corona virus, governments are developing and modifying policies to promote the rapid development of technologies. The companies are supporting fund for the new innovative technologies in the fight against the COVID-19 pandemic under the Corporate Social Responsibility (CSR).

In India, the Social Impact Team at Invest India is augmenting the efforts of the MCA by collating a repository of CSR eligible innovations that can help in testing, curing and prevention of COVID-19 (CSR Funding for Technology Incubators blog).

The United States has allowed the Food and Drug Administration (FDA) to expedite the use of new medical devices during public health emergencies. During corona crisis, this effort is now empowering companies to deploy innovative medical devices to market rapidly. Abbott Laboratories has developed an innovative technology namely portable 5-minute COVID-19 test kit with the size of a toaster. The test kit is now being used across the U.S. This innovation

will help in testing the untested COVID-19 patients. These are a few snapshots to reveal the significance of technology in the pandemic.

Any epidemic can be won by three major weapons. One is drug or vaccine, second is technological interventions and third one is scientific temperament among the common people. Technology plays a crucial role to mitigate the epidemic. No country can have sufficient number of ventilators, PPE, N95 masks, ICU and hospital beds to handle any epidemic situation. Therefore vaccine, technological innovations and scientific outlook are key factors to overcome epidemic crisis. When the number of cases increases during the spread of epidemic, shortage of the ventilators, ICUs etc. start occurring. In this situation, technological innovation in the essential medical equipment become instrumental and it plays conclusive role in outbreak mitigation. Hence the importance of technological innovation cannot be ignored at the time of epidemic.

INDIA'S TECHNOLOGICAL INNOVATIONS THAT MITIGATE THE IMPACT OF COVID-19

Indian S&T laboratories such as the Indian Council of Medical research (ICMR), Council for Scientific and Industrial research (CSIR), Department of Science and Technology (DST), Department of Biotechnology (DBT), Defense Research and Development Organization (DRDO), other scientific and academic institutions as well as private sector enterprises of the country are bringing many technological innovations in response to COVID-19. Apart from this, entrepreneurs and innovators have quickly devised new apps, robots and ventilators to help overcome the pandemic across the country. A few innovations are emerging from start-ups that have been incubated by universities and IITs.

Digital Surveillance to monitor the COVID-19 Spread

Two of the CSIR labs namely the Centre for Cellular and Molecular Biology (CCMB) and the Institute of Genetics and Integrated Biology (IGIB), along with a few other institutions, are working for the digital and molecular surveillance of the spread of novel corona virus to understand the biology, epidemiology and disease impact. With digital and molecular surveillance of novel corona virus, scientists are hoping to get some clue for many of the unknowns today. The centre is established at IGIB where all the labs, research centres and hospitals will share their data through cloud sharing (CSIR News, April 2020).

App, Drone, Robot and ventilator

During COVID-19 pandemic, different mobile applications have proved extremely useful to inspire people about the hand hygiene, social distancing and following lockdown rules. In early April this year, the Indian government launched a Mobile App *Aarogya Setu* which uses GPS and Bluetooth to inform people when they are at risk of exposure to COVID-19 (Sankaranarayanan KB, 2020). This App gives input in 12 major Indian languages. Within three days of its launch, more than 5 lac people downloaded this useful App.

Dr. Tavpritesh Sethi at IIIT (Indraprastha Institute of Information Technology) Delhi and his team have developed an android-based mobile App *Wash Karo* that functions as a complete Infodemic Management Suite. This App was presented at WHO, Geneva on

8 April 2020, via video conferencing. This App aims to help aware the public about the COVID-19 pandemic. The updated content of this App is delivered in the form of byte-sized audios for those who may not be able to read (COVID-19 Newsletter, *Vigyan Prasar*, 30 April 2020).

Similarly many state governments and other government organisations have developed mobile Apps to combat COVID-19. Their objectives include patient tracking to healthcare services. A few names of these Apps are COPE Odisha, Corona Mukht Himachal, COVA Punjab, Covid Care Kerala, Haryana Sahayak, mCOVID-19, UP Self-Quarantine App, Test Yourself Goa, Kavach, Driver Seva (COVID-19 Apps from India, e-Book, CSIR-NISCAIR, 2020).

One of the DRDO laboratories, Centre for Artificial Intelligence and Robotics (CAIR), Bengaluru has created a technology based solution to track COVID patients who are under quarantine. A team of 20 scientists have developed the SAMPARC App in three weeks. SAMPARC stands for Smart Automated Management of Patients and Risks for COVID-19. The App has already been offered to various state governments to enable AI-driven measures to reduce the outbreak. SAMPARC is the software that includes an App that would be installed on the smartphones of the patients. This technological innovation is expected to drastically reduce the overhead of tracking every COVID patient under home isolation and in this way; load on the state machinery will be reduced. With SAMPARC App, the officials can easily track the violators and can also perform random checks (COVID Newsletter, *Vigyan Prasar*, 23 April 2020).

The Central Road Research Institute (CRRI), a CSIR laboratory has developed an app called '*KisanSabha*' to resolve the problems related to the agricultural supply chain during the COVID-19 pandemic and lockdown situation in India. This useful mobile App acts as a one-stop technological solution for farmers, transporters and other entities engaged in the agriculture sector. For its implementation, the Indian Council of Agriculture Research has used the vast network of Krishi Vigyan Kendra (KVK) in the country (Mishra, Umashankar; 2020). In April 2020, the Union Agriculture Ministry of India had introduced a mobile App '*KisanRath*' for the farmers in India during nation-wide lockdown. The App provides assistance to Indian farmers and traders, transport produced goods during the ongoing corona virus pandemic. The *KisanRath* mobile App helps facilitate transportation by onboarding 5 lakh trucks and 20,000 tractors on the online service (Ansari, Danish;2020).

To sanitize big compounds of school, hospital, airport or government offices through a manual spraying process approach is very difficult. To resolve this difficulty, the Office of the Principal Scientific Adviser (PSA), Government of India and *Invest India* have initiated Corona Killer 'Drone CK100'. This drone has been developed by the Garuda Aerospace. It is an Automated Disinfecting Technology that aids in sanitization of public places, hospitals and tall buildings. Drone operations are faster, longer and safer than manual spraying workers who can become potential carriers of COVID-19. Drones reach heights up to 450 feet and spray disinfectants on buildings which are impossible manually. This effective technological solution prevents the spread of COVID-19 as well as communicable diseases arising due to unhygienic conditions. Using drones, authorities could spray disinfectant over a large,

crowded and vulnerable urban area. This technology protects city dwellers from COVID-19, while reducing human contact to keep frontline workers safe (COVID-19 Newsletter, *Vigyan Prasar*, 23 April 2020).

A number of doctors and healthcare workers are getting corona infection. They have great risk of infection while taking care of COVID patients. Durgapur (West Bengal)- based CSIR lab, Central Mechanical Engineering Research Institute (CMERI) has developed an innovative robotic device HCARD (Hospital Care Assistive Robotic Device) which is helpful to the frontline warriors in maintaining physical distance from corona virus infected patients. The device is equipped with various state-of-the-art technologies. It works both in automatic as well as manual modes of navigation. This robot can be controlled and monitored by a nursing booth with a control station having innovative features such as navigation, drawer activation for providing medicines and food to patients and sample collection. Through this device, healthcare workers can also do audio-visual communication with the patients. (COVID-19 Newsletter, *Vigyan Prasar*, 30 April 2020).

During COVID pandemic, a team of scientists at CAIR, DRDO has quickly customized a cost effective robot ‘*Sewak*’ within a week. It can be a safe alternative for the healthcare staff taking care of the COVID-19 patients in the quarantine centres and hospitals. *Sewak* can be tele-operated by the hospital staff from a remote location to navigate the quarantine zone and distribute food, water, medicine etc. to the affected persons. The robot gets power from rechargeable batteries and can work continuously for 5 hours on full charge. Video camera fitted in the front helps navigating to the patient’s bed. Audio facility provided in the robot facilitates two-way communication between the patient and the healthcare staff (COVID-19 Newsletter, *Vigyan Prasar*, 30 April 2020).

Asimov Robotics, a start-up based in Kerala, has also deployed robots during COVID pandemic. These robots are used at the entrances to office buildings and other public places to dispense hand sanitizer and deliver public health messages about the virus. Robots deployed in isolation wards of the hospitals are assisting to carry medicines and food items (Rekhi D, 2020). In India, during the COVID pandemic in response to the shortage of ventilators for critical care, start-ups like Aerobiosys (incubated at IIT Hyderabad), Nocca Robotics (incubated at IIT Kanpur) and AgVa Healthcare have developed the cost effective, easy-to-use and portable ventilators that can be deployed even in rural areas of the country (*Industrial Automation*, 2020).

Testing Kit, PPE and Textile with anti-Microbial Material

CSIR-Institute of Genomics and Integrative Biology (IGIB), New Delhi has developed a portable, rapid and cost-effective paper strip based test kit called FELUDA. CSIR and Tata Sons have now signed a MoU for licensing the technology for scale-up and deployment in usable kits (COVID-19 Bulletin, CSIR-NISCAIR, 12 May 2020).

The RNA extraction kit called *Chitra Magna*, has been developed by Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), an institution of the Department of Science and Technology, Government of India. This is an innovative technology for isolating RNA from swabs for COVID-19 tests (COVID-19 Newsletter, *Vigyan Prasar*, 30

April 2020).

CSIR-National Aerospace Laboratories (NAL), Bengaluru has developed a coverall protective suit for protection of healthcare workers. The polypropylene spun laminated multi-layered non-woven fabric suit has been developed in collaboration with MAF Clothing and has undergone stringent testing. MAF Clothing intends to manufacture 30,000 units per day of the cost-effective protective cover all suit. (COVID-19 Bulletin, CSIR-NISCAIR, 2 May 2020). IIT Madras incubated start-up 'Muse Wearables' has created coated-textile with anti-microbial material to be used in the manufacturing of N95 masks, surgical masks, PPE, food packaging bags, etc. The coatings are expected to be effective up to 60 wash cycles, thereby making the textiles re-usable.

Tele-medical Consultation Portal

Visiting a health centre or hospital for any kind of ailments has become a new challenge due to the high risk of possible COVID-19 infection. Doctors are also naturally cautious and sensitive about examination of patients. However, such situations provide opportunity for technology to usher in new solutions. At Indian Institute of Technology Jodhpur (IITJ), Kunal Tawatia, an undergraduate student of the CSE Department, under the mentorship of Dr Sumit Kalra has developed a tele-consultation platform. Utilising this platform, one can consult doctors for ailments (COVID-19 Newsletter, *Vigyan Prasar*, 30 April 2020).

Foot-operated Washing Station

Handles, knobs, doors, electric switches, water tap etc. are the common use surfaces in our daily life. During the COVID pandemic, these surfaces are major sources of disease spread in the community. The foot-operated hand washing stations are technological innovation where direct surface touching is not required. It is recommended to install at all public areas to enable residents to frequently wash their hands.

Foot-operated Washing Station has been implemented at the Indian Astronomical Observatory (IAO), Hanle, Ladakh (COVID-19 Bulletin, CSIR-NISCAIR, 2 May 2020). IAO has one of the world's highest located sites for the optical, infra-red and gamma-ray telescopes. Bengaluru based autonomous body of DST, the Indian Institute of Astrophysics (IIA) operates this observatory. These foot-operated hand washing stations will control the spread of the disease while reducing amount of water used. Again there is another innovation for minimal use of soap and for this chlorine has been added to the water.

Suraksha Kawach – An IoT device for Corona Patient Tracking

Defence Research and Development Organization (DRDO) has developed an IoT device 'Suraksha Kawach' for corona patient -tracking and their surveillance. It is an ankle or arm band based customised IoT solution. *Suraksha Kawach* is a tamper-proof solution for tracking the COVID-19 patients. It is a GSM and GPS- enabled rugged system for real-time tracking. It is an integrated solution with software for central monitoring and management. It is enabled with geo-fencing, tampers detection, battery status monitoring, mechanism for alerts to urban local bodies, police and distributed alert mechanism. The device can also be integrated with *Arogya Setu* or any other mobile App through server

feeds or by introducing a Bluetooth low energy chip in the current design (COVID-19 Newsletter, *Vigyan Prasar*, 30 April 2020). The unit has battery capacity to withstand quarantine period of 21 days or more, so the device need not be removed for charging purpose. This device is efficient and cost effective.

ATULYA — Microwave Steriliser

Defence Institute of Advanced Technology (DIAT), Pune, has developed a cost-effective microwave steriliser named 'ATULYA' to disintegrate novel corona virus by using differential heating in the range of 560 to 600°C temperatures. The developed products can operate in portable or fixed installations and can be used for non-metallic objects only. The sterilisation time is from 30 seconds to one minute depending upon the size and shape of the objects (PIB 2020).

Device to Track Coughing Person

Two undergraduate students of the Jadavpur University have developed a smart non-contact device with embedded image and sound sensors. It can track coughing persons and also analyse them for COVID-19. The person can be tracked even when he or she is far away from the device. It is also capable of identifying multiple coughing persons at the same time. The device can be used in quarantine centres, offices or schools for monitoring the people and children present there (*The Economic Times*, 2020).

COVID KATHA — A Multimedia Guide for Scientific Awareness

The National Council for Science & Technology Communication (NCSTC), Department of Science and Technology (DST), Government of India has launched *COVID KATHA*, a multimedia guide on A to Z scientific information on COVID-19 (NCSTC, DST, 2020). To make people scientifically aware about the COVID-19 pandemic in an interactive manner, NCSTC (DST) in association with Dr. Anamika Ray Memorial Trust (an educational and research organisation), has come up with this innovative multimedia guide on COVID-19 which makes people aware about the health and social crisis.

Covid-19 Test Bus

In an initiative to combat the surging coronavirus cases in Mumbai which is one of the worst-hit areas, an IIT Alumni Council has launched India's first 'Covid-19 Test Bus in Mumbai'. This innovative Test Bus is based on the indigenous Kodoy Technology Stack and executed by partner organizations led by IIT Alumni (Sindwani P, 2020). To accelerate the rate of testing, the bus will roam around the city collecting test samples for rapid testing.

CONCLUSION

Technological innovation has great potential to serve the human life. But in a crisis like COVID-19 pandemic, its importance is accentuated several times. In pandemic, any technology is developed with the sole purpose of maximizing the safety of human life. During the crucial situation of COVID-pandemic, all the affected nations of the world including India are developing several innovative technologies to save their citizens. Indian scientists and technologists have worked round the clock and developed a spectrum of innovative technologies to combat COVID-19. In this study, major technological innovations out of those have been discussed.

REFERENCES

1. Giacomelli ,G. and Giacomelli, R.(2005). “Science, Technology and Society”. *Non-Accelerator Astroparticle Physics*, <https://arxiv.org/abs/physics/0507092>
2. UNESCO (2012). “Science and Technologies for Knowledge Societies What Role for UNESCO in 2014-2021?” ,*Consultations of the Director-General with Member States*, UNESCO. http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/Consultation_Science_Technology_for_Knowledge_Societies_En.pdf
3. Sasvari P (2012). “The Effects of Technology and Innovation on Society”. *Bahria University Journal of Information & Communication Technology* Vol. 5(1):1-10.
4. Sang M Lee and Silvana T (2018). “Innovation for creating a smart future”. *Journal of Innovation & Knowledge* Vol 3(1):1-8. <https://www.sciencedirect.com/science/article/pii/S2444569X16300154>
5. Janmejaya S (2014). “A Historical Exploration of Pandemics of Some Selected Diseases in the World”. *International Journal of Health Sciences & Research* (www.ijhsr.org). Vol 4(2):165-169. https://www.researchgate.net/publication/282639796_A_Historical_Exploration_of_Pandemics_of_Some_Selected_Diseases_in_the_World
6. Brohi, S. N. *et al.* (2020). “Key Applications of State-of-the-Art Technologies to Mitigate and Eliminate COVID-19”.<https://www.researchgate.net/publication/340614556>
7. Fett, M. (2000). “Technology, Health and Health Care”. Commonwealth of Australia. [https://www1.health.gov.au/internet/main/publishing.nsf/Content/DA8177ED1A80D332CA257BF0001B08EE/\\$File/ocpahfsv5.pdf](https://www1.health.gov.au/internet/main/publishing.nsf/Content/DA8177ED1A80D332CA257BF0001B08EE/$File/ocpahfsv5.pdf)
8. Roberts, J. and Milford, M. (2017). “The Future of Flying Cars: Science Fact or Science fiction?”, *TechXplore*.<https://techxplore.com/news/2017-05-future-cars-science-fact-fiction.html>
9. Kritikos, M (2020). “Ten technologies to fight corona virus”. *European Parliamentary Research Service*. [https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/641543/EPRS_IDA\(2020\)641543_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/641543/EPRS_IDA(2020)641543_EN.pdf)
10. Sankaranarayanan, KB (2020). “A study on “ArogyaSetu” Application as counterfeit to COVID-19: False News circulation in Social Media”. DOI:10.13140/RG.2.2.22613.99040. https://www.researchgate.net/publication/340619297_A_study_on_Arogya_Setu_Application_as_counterfeit_to_COVID-19_False_News_circulation_in_Social_Media
11. COVID-19 Apps from India, e-Book, CSIR-NISCAIR, 2020.
12. COVID Newsletter, *VigyanPrasar*, 23 April 2020. pp23.
13. Mishra U (2020). “CSIR’s Kisan Sabha App to connect farmers to supply chain”. *The Hindu Business Line*. <https://www.thehindubusinessline.com/news/science/csirs-kisan-sabha-app-to-connect-farmers-to-supply-chain/article31487870.ece>
14. Ansari D (2020). “What is KisanRath App - How to Download and Use the App”. *Republicworld.com*. <https://www.republicworld.com/technology-news/apps/what-is-the>

kisan-rath-app-and-how-to-download-the-app.html

15. Corona Killer Drone CK100 (23 April 2020). COVID-19 Newsletter *Vigyan Prasara*, pp.1-2. <https://www.agnii.gov.in/innovation/corona-killer-drone-ck100>
16. HCARD, a robot, to assist frontline COVID-19 healthcare warriors(27 April 2020). COVID-19 Newsletter *Vigyan Prasara*, pp. 18-19. <https://vigyanprasara.gov.in/wp-content/uploads/vp-Covid-Newsletter-30apr20.pdf>
17. SEWAK - DRDO Robot for keeping hospital staff safe. COVID-19 Newsletter(30 April 2020). *Vigyan Prasara*, p.28. <https://vigyanprasara.gov.in/wp-content/uploads/vp-Covid-Newsletter-30apr20.pdf>
18. Rekhi , D. (2020). “Startup help: Making isolation wards robot ready”. *ETteck.com*. <https://tech.economictimes.indiatimes.com/news/technology/startup-help-making-isolation-wards-robot-ready/74802502>
19. Cost-effective and indigenous personal protective suit to combat COVID-19 (23 April 2020). COVID-19 Newsletter, *Vigyan Prasara*, pp.13-14. https://indianembassy-moscow.gov.in/pdf/COVID-19%20APRIL%2023_Final%20Edition1.pdf
20. Covid-19 Pandemic Gears a New Wave of Innovation Worldwide(2020). *Industrial Automation*.<https://www.industrialautomationindia.in/articleitm/9632/Covid-19-Pandemic-Gears-a-New-Wave-of-Innovation-Worldwide/articles>
21. Jadavpur University students develop device which can tell if a coughing person is a COVID-19 Carrier(2020). *The Economic Times*. <https://economictimes.indiatimes.com/news/science/jadavpur-university-students-develop-device-which-can-tell-if-a-coughing-person-is-a-covid-19-carrier/articleshow/75442327.cms>
22. COVID Katha – A Multimedia guide for Mass Awareness (2020). *National Council for Science and Technology Communication, Department of Science and Technology, Govt of India*. <https://dst.gov.in/news/covid-katha-multimedia-guide-mass-awareness>
23. Sindwani, P (2020). “IIT launches a Covid-19 Test Bus in Mumbai — capable of conducting 5 million tests per month”. *Business Insider India*. <https://www.businessinsider.in/india/news/iit-launches-a-covid-19-test-bus-in-mumbai-capable-of-conducting-5-million-tests-per-month/articleshow/75546462.cms>
24. Science, Technology, and Innovation: Enhancing the Quality of Human Life (2018). *STIC Information Technology World*.<http://sticamsud.org/2018/04/18/science-technology-and-innovation-enhancing-the-quality-of-human-life/>
25. Handforth, C (2020). “Bringing the power of global innovation to tackle COVID-19”. *United Nations Development Programme*.New York, USA.
26. Sahasranmam, S (2020). “How coronavirus sparked a wave of innovation in India”. *World Economic Forum*.<https://www.weforum.org/agenda/2020/05/coronavirus-covid19-innovation-technology-india/>