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Smart Applications using Robotic and Iot Technologies in Fighting against Pandemic Covid19 in Medical and Societal Sectors

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Abstract*: During the past few months, the entire world is being suffering with a dangerous deadly virus named Covid19 or Coronavirus. This pandemic corona virus has washed out thousands and lakhs of people all over the world within months' time and made all the countries GDP and economic growth collapsed. Accordingly, in India and other countries an important research and innovation investments have been made by various science and technological laboratories that are collaborated with various private and government stakeholders to find new ways to eliminate or kill the pandemic corona virus in human bodies and society. All over the world, the doctors and scientists are working very hard to reduce the rate of death and control the rate of corona spread. Alternatively, the engineers, entrepreneurs, industrialists, technocrats are sorting out and finding new ways to bridge the gap between science and technology by inventing new methods and measurements in medical, societal and service sectors The purpose of the proposed study is to showcase the opportunities of using engineering technology in biomedical and societal applications taking all over the world caused by the corona attack. The introduction of Robots and IOTs made the industries and firms fully smart automated and digitalized. In other perspective, robots were also serving medical sectors since many years successfully in heart surgeries, fighting cancer cells etc. and making the footprints for further research and developments. An attempt is made to highlight the methods and applications of Robots & IOT's in large extent in medical and societal areas to safeguard from coronavirus

***Keyword*: Coronavirus, Covid19, IOTs, Robots, Virus evolution**

I. INTRODUCTION

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The current scenario point out that the role of using Robotic technology and Internet of things for the outbreak of Covid19 is very crucial and essential in hospital and societal sectors.

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This pandemic gave a huge disaster in all the countries leaving dangerous footprint for the next coming years. It is the time for engineers, scientists, and researchers to innovate new methodologies, concepts and ideas making the robots and IOT technology to stand in the front line to serve the virus affected people. As covid19 is a deadly disease like Ebola virus which affected many people lives all over the world. This created a need for developing new technology in the field of Robotics and IOT for serving people in various ways, as they are disinfectant to the coronavirus than human beings.

A. Statement of the Problem

Today the entire world is facing a major epidemic with a wide spread of coronavirus originated from Wuhan, China. The majority of countries are under the lockdown facing a severe disaster of losing economy and people on a large scale. In order to reduce the severity of virus spread, there is huge need of deploying Robots and IOT technologies as they stand in the front line saving the human labor to get infected from the coronavirus as these are highly immune to coronavirus. In this view, different types of research and innovation works are to be carried out to safeguard the people and serve the corona affected patients. The main objectives of the study are: To know the evolution of virus. To get awareness about coronavirus. Use of Robotic and IoT technologies.

II. LITERATURE REVIEW

During the Ebola outbreak that began in 2014, the White house office of science and technology policy and National Science foundation, organized workshops to identify various ways in which robots could make a difference. Guang-zhong yang, [1] dean of the institute of medical robotics at Shanghai Jiao Tong University, said during the epidemic, we really need to ensure that we have a global orchestrated sustainable approach to robotics research. Robots could occupy the place of health workers in certain circumstances, like administering tests who are infected with coronavirus and silent infection is the biggest problem. It helps that robots don't get sick and unless they run out of power, they do not sleep-Yang said. Russel Taylor, a roboticist at johns Hopkins University said sending a remotely operated robot to interact with the patient instead could dramatically reduce the risk. After all, robots are immune to biological pathogens and can be efficiently disinfected with harsh chemicals. In this scenario, engineers would not design a robot specifically for the COVID19 pandemic but the trick is to find solutions that can be broadly commercialized for the next system in the ways that they are economical to have around.

Bill Smart,[1] a roboticist at Oregon State University, explained "you're not directly interacting with the patients where it could go really wrong if the robots breaks, and you're also not denying the patient human contact. He also said robots could still help minimize the risk for front line medical staffers, use of drones by IOT to transport medicine within the hospitals or using robots to deliver meals. Robin Murphy, a roboticist at Texas A&M University, said today investing in robotics development is a lot like investing in a large snowplow. It is expensive and not put to use for much of the year, but when a big snowstorm hits, it proves it worth. It's akin to a problem faced by the scientists who works on vaccines and treatments for emerging infectious diseases. If research into the coronavirus responsible for the outbreaks of SARS and MERS hadn't dried up, options for fighting COVID19 would have been more readily available says many scientists[1]. Computer vision and technology has gotten better, IOT enablers like sensing capabilities, tracking capabilities, scanning capabilities, mobile apps capabilities has gone better, and artificial intelligence has gone even smarter and all this translates into more potential for putting robots into good usage.

III. VIRUS CONTEXT

The study of virus is known as Virology. It is a subfield of microbiology and focuses on the aspects of virus structure, classification and evolution. The word "virus" came from Latin meaning "poison or venom". Viruses were detected after bacteria. Most of viruses range from 20-400NM in size. Special fine filters which hold bacterial cells were impossible to remove infectious agents, which are known as filterable viruses. Viruses have very simple structure and can only be observed by an electron microscope, NMR spectroscopy and X-ray crystallography: the virus particle or virion which has protective outer shell protein and an inner core of DNA (Deoxyribonucleic Acid) or RNA (Ribonucleic Acid). It doesn't need any energy to grow, cunningly it uses biochemical machinery of the host cell to reproduce and the infected cell is killed. The main viral properties are: they are non-living entities, they do not have genetic capability to multiply by division, they cannot make energy or proteins independent of host cell, viral genome are RNA or DNA but not both, they are stable in hostile and dry environment, not damaged by drying, acid, detergent, and heat. It can spread easily via hands, dust fomites, etc., [2] Most of the viruses can be transmitted by respiratory transmission (influenza-A), Faucal-oral transmission (enterovirus), Blood-borne transmission (hepatitis-B), sexual transmission (HIV), animal or insect vectors (rabies). The five basic viral structures are: Icosahedral, enveloped icosahedral, helical, enveloped helical and complex structure shown in the figure (source: Mechanics of microbial disease by Schaechter)

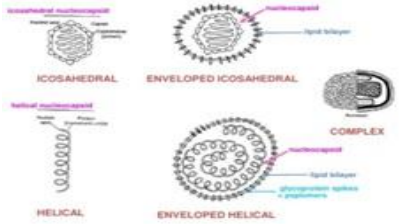

Fig.1. Types of viral structures

Viruses can be classified in many ways: 1.According to host cells they infect-animal, plant, fungal and bacteriophages.2.According to geometrical shape of their capsid, phenotypic characteristics such as morphology, structure, nuclei acid, and viral replication.3. According to Baltimore classification it can be divided into seven categories- double strand DNA viruses, single strand DNA viruses, double strand RNA viruses, positive sense ssRNA, negative sense ssRNA, RNA reverse transcribing viruses and DNA reverse transcribing viruses.4. According to Holmes classification it has three groups- Group-1: Phaginae (attacks bacteria),Group-2:Phytophaginae(attacksplants),Group-3:Zoophaginae(attacks animals)[3]. The virus infection cycle has following steps: Adsorption or Attachment, Penetration, Biosynthesis of viral nuclei acid and protein, Assembly or Maturation and Release, depicted in the figure:

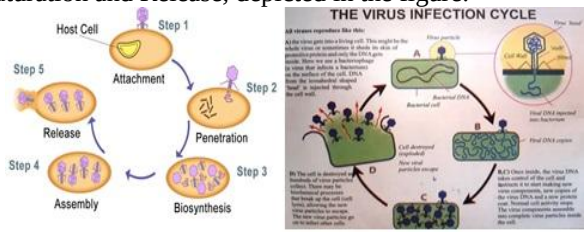

Fig.2. Viral Infection Cycle

In recent decades, several viruses have jumped from animals to human beings and spotted sizable outbreaks, adhering thousands and lakhs of people. The major deadly killer viruses are : Marburg virus (1967, Germany), Ebola virus (1976, Sudan), Rabies virus(1920, India & Africa), HIV virus(1980, Africa), Smallpox virus (1980, Europe), Hanta virus(1993, USA), Influenza (1918, Spanish flu), Dengue(1950, Philippines), Rotavirus(2008), MERS-CoV(2012,SaudiArabia),SARS-CoV(2003,China), SARS-CoV-2(2019, China)[4].

A. Coronavirus Evolution

The name "coronavirus" was derived from Latin word meaning "crown" or "wreath"[48].This name was first used in 1968 by an informal group of virology people in the journal "Nature to designate the new family of viruses." The name refers to the characteristic appearance of an infective form of the virus (virions) which have a large, bulbous surface projection making an image reminiscent of a solar carona [49]. Coronaviruses was first discovered in the year 1930 when an acute respiratory infection of domesticated chickens was shown to be caused by infectious bronchitis virus (IBV)[50]. The structure of Coronavirus is a large spherical particles with bulbous surface projections [51]. The average diameter of the virus particles are about .12 µm (120 nm) and the diameter of the envelope is about .08 µm(80 nm) and the spikes are .02 µm(20 nm) long.

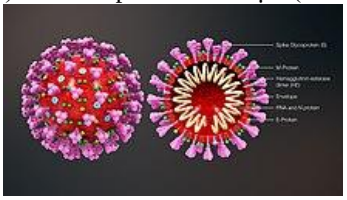

Fig.3. Structure and cross section view of coronavirus

Coronaviruses cause diseases in birds and mammals. But in humans, they cause respiratory tract infections that can range from mild to severe. Mild sickness includes cases of the common cold and fever while more severe sickness can cause severe acute respiratory syndrome (SARS) and sore throat infections. Evolutionary stages: The most recent common ancestor of all coronaviruses was existed as recently as 8000 BCE, implying long term coevolution with bat and avian species [52]. Bats and birds, which are warm-blooded flying vertebrates, are an ideal natural reservoir for the coronavirus pool.

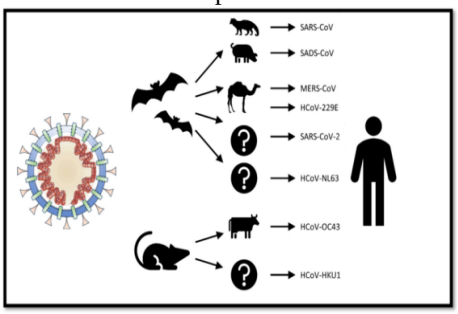

Fig.4. Origin of coronavirus

B. Human Coronavirus

The risk factor of human coronavirus may vary significantly. Some may kill more than 30% of those infected like MERS-CoV, and some were relatively harmless with common cold[53].Some viruses may cause colds with major symptoms like severe fever, sore throat from swollen adenoids [54]. Moreover, seven different species of human coronaviruses are known yet. Out of which four viruses produce symptoms which generally mild and three produce symptoms which are very severe [55].They are 1. Human coronavirus OC43, (HCoV-OC43).2.Human coronavirus HKU1, (HCoV-HKU1). 3. Human coronavirus 229E, (HCoV-229E).4. Human coronavirus NL63, (HCoV-NL63). 5. Middle east respiratory syndrome related coronavirus, (MERS-CoV).6.Severe acute respiratory syndrome coronavirus,(SARS-CoV).7. Severe acute respiratory syndrome coronavirus 2, (SARS-CoV-2). SARS-CoV-2 belongs to large family of viruses SARS-CoV, known as "Coronaviruses" and was first identified in Chinese city, Wuhan in December 2019. These viruses likely originated from bats like SARS-CoV and passes through an intermediate animal before infecting human beings. The disease caused by SARS-CoV-2 called COVID-19. [4]

IV. ROBOTICS CONTEXT

Robotics engineering is a field of engineering which deals with design, construction, application and operation of robots. The mechanism behind robots is called robotics. The robotics goal is to design intelligent machines that help and assist human beings in their day-to-day life and keep us everyone safe and secure. Actually, robotics is an integration of computer, information, electrical, electronic and mechanical engineering. The robotics was derived from the word "robot" means a slave or servant to humans was coined by Czech writer and novelist Karel capek in his paly Rossum's Universal Robots(R.U.R) published in 1920[5].Later Sir Isaac Asimov, a biochemistry professor has proposed three laws and later added zeroth law in his "Runaround "science fiction. Law 0: A robot may not injure humanity or allow humanity to come to harm. Law 1: A robot may not injure human being, unless said by high order law. Law 2: A robot must obey orders given to it by his master. Law 3: A robot must protect itself from its own existence. A robot is defined as a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of variety of tasks [Robot institute of America, 1979] .To design and operate a robot a typical knowledge base system is required: dynamic system modeling and analysis, feedback control system, sensors and signal conditioning, hardware interfacing, actuators and power electronics and computer programming. The key components of a robot manipulator are base, linkage, controller, power conversion unit, sensors, actuators and user interface. Based on the mechanical structure robots are classified as: Cartesian robot which has three linear prismatic joints, Cylindrical robot which has cylindrical coordinate system, Spherical robot which has rotary coordinate system, SCARA which has two rotary and one linear joint and Articulated robot which has three rotary 3d motion just like a human hand.

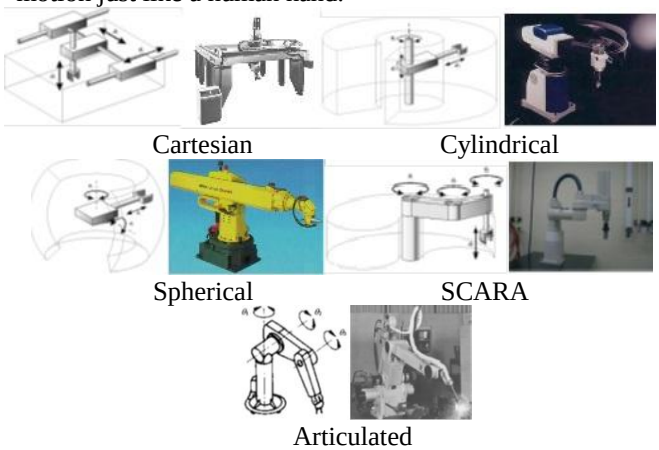

Fig. 5. Classification by mechanical structure [6]

Based on the configuration of robot manipulators, the control systems are designed: limited sequence, playback with point-to-point, playback with continuous path control and intelligent control. The different types of robots have different ways of programming methods such as: lead through (powered and manual) programming, robot programming languages, simulation and off-line programming[7]. Why do we need robots? Tim detert [8] said, we need robots for 4D environments (dangerous, difficulty, dull, dirty) and for 4A tasks(automation,augmentation, autonomous, assistance).The general features and characteristics which should acquire for a robot are: repetitive work cycles, multi shift operations, infrequent changeovers, difficult handling tasks for humans, hazardous work environment for humans and part position and orientation in the work cell.

Bases upon the design, specific task, environment and payloads the current and potential industrial applications include: agriculture, automobile, construction, domestic, entertainment, health care, kitchen automaton, laboratories, law enforcement, manufacturing, military, mining, transportations, utilities, warehouses etc. The usage of robots in various industrial and service sectors in worldwide market is shown below [8].

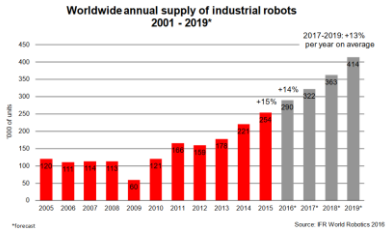

Fig.6. Bar chart of Annual supply of Robots

V. INTERNET OF THINGS CONTEXT

The IOT concept was coined by a member of the Radio Frequency Identification development (RFID) community in 1999, and it has recently become more relevant to the practical world largely because of the growth of embedded and ubiquitous communication, mobile devices, cloud computing and data analytics [9].According to CICSCO, Internet of things is the network of physical objects accessed through through internet, as defined by technology analysts and visionaries. These objects contain embedded technology to interact with internal states or external environment. In simple, it is a network or linking of physical objects. The internet means not only a network of computers, but has evolved into a network of device of all types of sizes of smart phones, vehicles, toys, cameras, home appliances, industrial systems, animals, people, buildings, all sharing and communicating information based on standard protocols in order to get smart real time online monitoring, online upgrades, smart reorganizations, positioning, tracking, process control and online administration[10]. IOT can be categorized into three stages according to the definition: 1.People-to-people(P2P).2.People-to-machines(P2M).3.Mac hine-to-machine(M2M), interacting to internet facilities. The Internet of Things is more than machine to machine communication, sensor networks, wireless sensor networks, , 2G/3G/4G,GSM,GPRS,RFID, WI-FI, GPS, microprocessor , microcontroller, etc. and these are considered as being the enabling technologies that make IOT applications possible. Enabled technologies (ET) considered in [10] can be classified into three broad categories: 1 technologies that enable things to acquire contextual information, 2.technologies that enable things to process contextual information, and 3. Technologies to improve security and privacy. The fundamental characteristics to enable the services of IOT are as follows: connectivity, dynamic changes, enormous scale, heterogeneity, interconnectivity, safety and things related services [11].

A. IOT Architecture

It has different layers of technologies which supports IOT and serves to showcase how various technologies relate to each other and to communicate the configuration, modularity and scalability. The functionality of each layer is described as: 1. Smart sensor layer-lowest layer where smart devices are integrated with sensors and these are having capacities to make measurement such as air quality, speed, humidity, temperature, pressure, flow and movement etc. Most sensors require connectivity to sensor gateways in the form of LAN such as Wi-Fi, Ethernet, personal area network, ZigBee, Bluetooth and ultra-wide band. The sensors which do not require connectivity to backend servers can be provided using WAN such as GSM, GPRS and LTE.2. Gateways and Networks-To transport the massive data, it requires robust and high performance wired or wireless network infrastructure. The various networks are WI-FI, GSM, GPRS and gateways are microcontroller and microprocessor etc.3. Management service layer-Data management is the ability to manage data information flow. 4. Application layer-It covers all smart environments, spaces in the domains such as Agriculture, Supply chain, User interaction, Emergency etc. The figure shows the detailed architecture of Internet of things. [12]

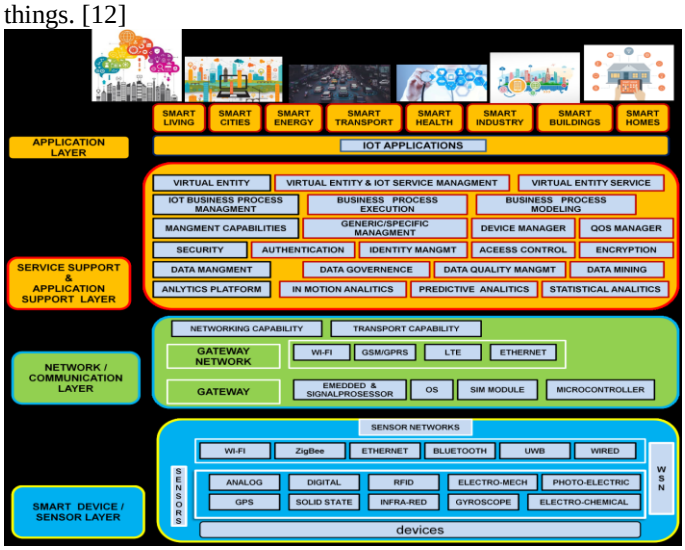

Fig.7. Internet of Things Architectural landscape

IOT has countless benefits for both businesses and consumers are such as automation and control, better human productivity, improved equipment maintenance, operations optimization and automation, comfort and convenience, time saving and money, use of telematics, efficient resource utilization, better tracking and management and access to high quality data[13].The goal of the Internet of Things is to enable things to be connected anyplace, anytime, with anyone and anything ideally using any network and any service[14]. The goals and applications of IOT are shown in the figure[14]15]:

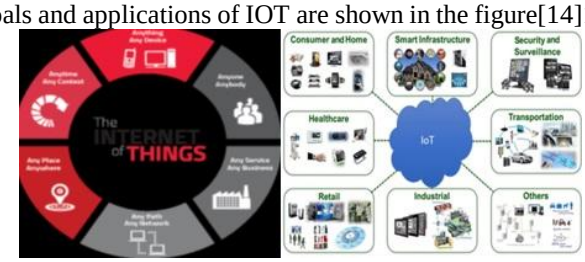

Fig. 8. Goals and Applications of IOT

VI. ROBTOIC TECHNOLGY IN COVID19

The rapid spread of human coronavirus has forced all the countries to apply each and every technology into health care and security surveillance in the society. The use of robots, drones and artificial intelligence technologies are being deployed across the globe to fight against the covid19 pandemic.

As Robotic engineering is still a developing field, many researches, surveys and experiments are being done in the field of health care sector. The robots are standing in the front line in minimizing the risk for medical staff in all applications as they are more immune to contagious spread than human beings.

According to the robot structural configuration, there are three major types: stationary (industrial), legged and mobile robots are generally used in many of the manufacturing companies. As per the hospital and service sectors, mobile robots are viable and used widely for coronavirus.

A. Methods and Applications of High-tech Robots in Covid19

UV light Disinfectant Robot: Due to the demand shortage of a thin layer of Personal Protection Equipment (PPE) such as gowns, hand gloves, face masks in the hospitals for medical staff, robots can used to kill coronavirus on their PPEs by sending UV light rays and can be further reused: Virginia Commonwealth University Health system (VCU), America has invented a robot called, called Total Room Ultraviolet Disinfection (TRU-D), stands 5'6" tall which is a mobile robot has sensors and wheels attached to the large frame and fragile uses ultraviolet germicidal irradiation (UV) light vectors to disinfect porous and non-porous surfaces without using of toxic chemicals. The high energy from UV light is absorbed in the cellular RNA and DNA of microorganisms, damaging nucleic acids and preventing them from reproducing therefore they cannot infect humans or PPEs [16].The autonomous UV mobile robots, known as Sunburst UV bots, made by local robotics technology firm PBA Group, built with a lamp module emitting powerful UV-C light helps decontaminate the environment by tearing apart strands of virus DNA. It kills about 99% of bacteria and clinically proven to eliminate coronavirus. The robots move around the places autonomously, guided by light detection, ranging sensors and also self-navigates to its charging station when power is low and can operate for 2.5 hours on a single charge. These can be widely used in commercial places like: hospitals, shopping malls, supermarkets, transport etc. [17] A Denmark based, Danish Technological institute has made Ultraviolet disinfectant (UVD) mobile robot that kills harmful microorganisms and be in a high demand since the corona outbreak. It works autonomously covering all surfaces with UV-C light kills 99.9% of viruses and bacteria within 10minutes [18]. An U.S.based GermFalcon mobile robot, from Dimer UVC innovations is also offering a similar UV disinfection solution for aircraft services that kills bacteria, viruses and superbugs on any exposed area in the aircrafts. It kills 99.99% of viruses within 3minutes on B737/A320 by UV-C light [19]. In Wuhan, Chinese based TMiRob's disinfection autonomous mobile robot, moves around the patients' area and kill the viruses during the ongoing fight against the novel coronavirus[20]

Fig. 9. TruD Sun burst UV, UVD, GermFalcon, TMiRob

2.Delivery Robots: Majority of countries like China, Europe, US, India are using mobile robots to replace and help humans fight coronavirus by delivering PPEs, food, groceries, medicines etc., in hospitals, quarantine centers, public places and nursing homes etc., Postmates, mobile delivery robots deliver food in Los Angles. Beijing-based Zhen Robotics uses yellow robots to deliver groceries. Indian based startup Asimov Robotics, lunched two robots to distribute face masks and hand sanitizer in hospitals, quarantine centers to spread awareness of coronavirus [21]

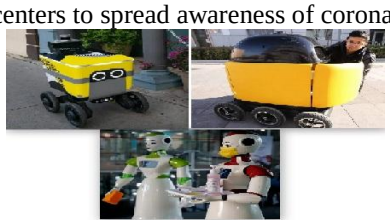

Fig.10. Postmates, Yellow robots, Asimov's

3. Sanitary Robots: There is an urgent need for cleaning and purifying the hospital areas, public areas, shopping malls, airports etc., due to the spread of pandemic coronavirus outbreak all over the world. Scientists and engineers are developing new methods of spraying disinfectant chemicals on the surfaces with the help of mobile robots. Some of the technologies are listed below: Researchers from Nanyang Technological University (NTU), Singapore have developed a wheeled robot named eXtreme Disinfection robot (XDBOT) which can navigate semi-autonomously in any type of environment using LIDAR sensors, hd cameras, a 6-axis articulated arm is controlled by human operator, a large tank with a rotating turret, an electrostatic charged nozzle and can move to 30-50metres with a rotating turret. NTU is still working with Transforma robotics, Hand plus and Maju robotics for news types of sanitary robots [22]. Hangzhou, china using disinfectant robots in large areas. Beijing-based Zhen Robotics, uses yellow robots patrol malls for people not wearing face masks and identifies the temperature reading.[21]

Fig.11. XdBot, Hangzhou, and Zhen robots

4. Surveillance Robots: During the corona outbreak, countries are using patrolling mobile robots in the public areas, common places etc., in order to prevent the risk factor. These robots alert the people and ask quires related to the lockdown and safeguard human lives. PGuard, the "robocop" [23] initiated by Tunisia's interior ministry, is a remotely operated and equipped with infrared and thermal imaging cameras, sound and light alarm system. It serves like calling out to suspected violators of the lockdown: "What are you doing? Show me you're ID. You don't know there is a lockdown?" A patrol mobile robot "LISOM" in Shenyang, china, hospital checks disinfectant people, temperatures and spaces and sends the alerts to the required personal [21].

Fig.12. PGuard, Lisom robots

5. Delivery and Patrol Drones: A drone is a robot, which is guided remotely or autonomously, often termed unmanned aerial vehicle(UAV) used to deliver food, medicine, goods, transport packages, patrolling and spying etc., in all diversified fields of healthcare, agriculture, film making,military,cargotransport,surveying, demining, target practice and so on. During the corona outbreak, many countries are widely using the services rendered by drones: Shenzhen company MicroMulticopter, deployed more than 100 drones to Chinese cities for patrolling in crowds and traffic areas and identifies who are not wearing masks, spraying disinfectant in public areas, identifying infected coronavirus people having elevated temperature by using thermal sensors.[24]Medtech companies are using robots and drones to provide services and care to quarantined or practicing social distancing. Japanese company Terra Drone ensured medical and other supplies were safely transported without exposing to humans to infection. According to the report by GPS world, using drones speeds up transport by 50% compared to road transport. In the corona outbreak, use of drones and robots would become increasingly essential support for humans in fighting the virus.[24] The figure shows the delivery of medicines by a drone.

Fig. 13. Medical kit delivery drone

VII. IOT TECHNOLGY IN COVID19

At present everyone is aware about the dangerous killer of human species spreading all over the world from the past few months originated from china. Many of the lives were destroyed without mere awareness about their control and diagnostics. As WHO announced it is a pandemic and all governments of the countries are scrambling to keep their citizens safe and secure. Presently, the Internet of things is being used for treatment, curing, diagnosing and detection of coronavirus. The IOT enabled services which are currently being used in detecting and destroying the Covid19 in all the major countries are discussed below.

1. Smart Image processing IOsIP): It is a form of signal processing where the input and output of image processing be a set of characteristics or parameters related to the image [25]. It is a technique to enhance the raw images received from sensors, cameras placed on space robots, satellites, aircrafts, video cameras, cell phones and pictures of day-to-day life of various applications. Image Processing systems are becoming popular due to easy availability of graphics software, powerful personnel computers, large size memory devices, etc. There are two methods available in image processing sequence: analog and digital image processing. The Various techniques used are: image representation, image pre-processing, image enhancement, image restoration, image analysis, image reconstructions and image data compression. The major applications in this field are: document processing, graphic arts, printing industry, remote sensing, non-destructive analysis, forensic studies, material science, film industry, military and medical imaging etc. [26].

2. Smart CCTV (IOsTV): Closed-circuit television, also known as video surveillance, use of video cameras to transmit the signals to the specific place, on limited set of monitors.[27]CCTV systems provide surveillance capabilities used in the protection of assets, systems and people. The systems have many components with a variety of functions, features, and specifications. Key components include cameras, lenses, data distribution, housings and mounts, monitors, switchers, multiplexers and video recorders. The components of CCTV are shown below:

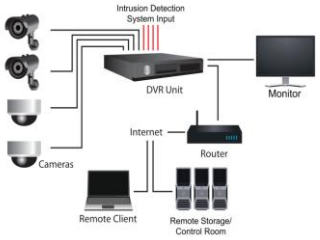

Fig.14. CCTV Component diagram structure

3. Smart Mobile Applications (IOsMA): A mobile application, simply referred as a mobile app is a software application or computer program designed to run on mobile devices like cell phones, tablets and watches. In 2010, American dialect society [28] termed software application as “app” shortly and was listed as a “word of the year”. In 2014, government regulatory agencies began trying to regulate and curate applications particularly medical applications. [29] Mobile applications are classified by many methods: Native app, Web-based apps and Hybrid Apps. Most of the devices are sold with many pre-installed apps, such as web browser, email, calendar etc. and the apps which are not pre-installed are available usually through platforms called app stores. The three biggest app stores used in mobile and laptops are Google paly for android, App store for IOS and Microsoft store for windows10 and many more other apps are listed: amazon appstore, blackberry world,ovi for nokia, Samsung apps, electronic app wrapper, f-droid and opera mobile store.

4. Smart Telemedicine (IOsT): Modern information and communication technologies such as computers, cellphones gives how individuals communicate each other, seeking and exchange information and enriching their lives. These technologies have high potential globally to address health problems all over the world. Telemedicine is a term coined in the year 1970, literally means “healing at a distance” [30] signifies the use of IOT & ICTs to improve patient outcomes by increasing access to medical care and information. It is defined as the delivery of health care services, where distance is a critical factor, by all health care professionals using IOT for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for continuing education of health care providers, all in the interests of advancing the health of individuals and communities. [31] Telemedicine applications are of two types: according to the timing of information transmitted and according to the interaction between the individuals involved. [32] The majority of telemedicine services focus on diagnosis and clinical management in the array of services like tele radiology, tele pathology, tele dermatology, and tele psychiatry. The information transmitted from telemedicine through IOT can be done in wide variety of media like audio, video, text and images.[33]

5. Smart Human Tracking (IOsHT): Smart monitoring systems have evolved to respond for particular needs in healthcare sector. A tracking system is used for observing the objects and people while in motion and supplying a timely ordered sequence of location data for further processing. Recent advancements in mobile technology allow Global positioning System (GPS), Radio frequency identification (RFID), Real-time location systems (RLTS) and Global mobile system (GSM) provides a real-time location based services for vehicles, assets and humans in various applications. Global positioning system is a satellite navigation system used to determine the ground position of any object. A GPS navigation device [34] is carried by a moving animal or person or vehicle that uses GPS to track the device's movements and determine its location. Mobile applications have three types of GPS trackers: data loggers, data pushers and data pullers. RFID uses electromagnetic fields to automatically identify and track tags attached to the objects or humans. A tag consists of tiny radio transponder, a radio receiver and transmitter. It is one method of automatic identification and data capture (AIDC)[35]. RFID can be used in a wide variety of industrial and domestic applications such as[36][37] access management, tracking of goods, animals and humans, tracking and billing processes, machine readable travel documents, airport baggage tracking, retail management, advertising and promotion tracking, transportation and logistics , human implantation, animal identification, institutions like hospitals, healthcare, libraries, schools and universities, museums and sports.

6. Smart AI Thermal Scanners (IOsTS): These are body temperature detection devices used for detecting elevated temperatures in human body located at different places. These thermographic cameras use infrared radiation from the image created just like normal camera which use visible light. Thermal scanners are integrated with Artificial Intelligence analytics connected to automated web and mobile application alerting. These scanners can be equipped with robots and drones which can works on ground and aerial surveys. These can be applied in many fields like: thermal mapping, medical imaging, non-destructive testing, night vison and tracking etc. As the covid19 pandemic goes rampant across the globe many engineers, researchers, startup companies are seriously involving in launching various AI based thermal tracking devices in hospitals, shopping malls, schools, universities, offices etc.

A. Methods and Applications of IOTs in Covid19

The various real-time applications using IOT technologies across the globe are listed below:

1. A government of India initiative, "Arogya Sethu" app is designed to assist citizens from contact with any infected covid19 person. The app uses GPS and Bluetooth on a smartphone to get the live updates. MapMyIndia, has created "covid19 dashboard" app, it provides state-wise data, treatment centres, isolation centres, hunger relief centres, relief camps on the map [38].

2. A.P launches 'YSR Telemedicine', facility which helps health department to track the symptoms of covid19 people.Dial14410, is the helpline where a doctor will respond through audio or video conference and prescribes the medicines and tests through sms [39].

3. Cambridge and Manchester University [40] launches Firetinas, the first A.I. Thermal scanner against covid19.It uses distance radiation algorithm, so that far way temperature can be read easily. Gurgaon based start-up Staqu has launched new thermal camera by its video analytics platform, JARVIS. It alerts when body temperature raises 37°C and can range up to 100meters to identify people [41]. A company "care.ai", working on A.I. overhead scanners screens bystanders to scans facial attributes like sweating, discoloration and thermal data[42].IIT Roorkee professor, Dr.Kamal Jain created a new surveillance system and an app to alert government if anyone violates quarantine and also can do geofencing around him[43].

4. Germany based start-up Thryve, launched smartwatch app to monitor corona spread. Here, the corona data donation app gathers vital information from smartwatches or fitness trackers to analyze the symptoms [44]. University of Illinois, Professor Brian Cunningham developed a smartphone app for coronavirus testing within 30minutes without the need for a diagnostic lab which can reduce time and saves money.It can used in airports, meetings, functions etc[45].IITMadras, incubated start-up Antariksh Watse Ventures developed an IoT-enabled Smart Bin system(AirBin) to prevent the spread of covid19 through waste generated from hospitals, clinics, public bins, quarantine zones etc.It alerts when the clinical waste overflows to the concerned personal[46].

5.Hyderabad based,T-Hub startups, like Terisoft, blocksapps.ai, blue semi, maruth drones, started many IoT enabled smart devices, apps, thermal screeners, surveillance camera drones etc. to fight against coronavirus pandemic [47].

VIII. CHALLENGES TO ROBOT AND IOT SERVICES DURING COVID19

Due to the severe pandemic covid19 attack we have to encounter two major challenges: The first one, challenges faced by the front line citizens, hospital staff, sanitary workers, and police personal.

The second one, challenges faced by the technology to improve better in the future. Some of the issues raised are: market adoption towards using of robots and IoT devices worldwide, level of using the technology, awareness of using the smart services by common citizen, reliability and durability of startup based IoT devices, long standing applicability of robots, maintenance and serviceability, adaptability in day-to-day life, inviting the new changes at living and working places, change of living lifestyles, acquiring more science and technical information, and combatting the future epidemic in prior.

IX. RESULTS AND DISCUSSIONS

The results of these IOT and Robotic applications have proven that there is a huge need and demand in emergency epidemics than human labor, which can assist along with the integration of technical personal. Due to the smart technologies like sensors, transducers, actuators, and microprocessors used in robots, drones, scanners etc., they proved in various medical, societal, shopping malls, public places, schools and colleges working effectively as they are highly immune to bacteria, coronaviruses and super bugs.

Finally, we have proven the robots and IoT technologies stood in the front line after the medical doctors, paramedical staff, sanitary workers and police staff which can work, assist and help in unhygienic, high security and remote areas. In the future with the impact of pandemic disasters the robots and Iots with the use of Artificial intelligence plays a major role in medical and societal sectors.

X. CONCLUSION

Because of severe attack of pandemic coronavirus across the globe, everyone has to get secured and to get awareness about the using of high end robotic technology and IoT enabled services at hospitals, shopping malls, public areas, quarantine centres, schools, colleges and many more once the lockdown or quarantine period lifts up. One has to get prepared or get sound awareness of using Science and Engineering services in the society.

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