Applications for Different Phases of Covid-19: A Review

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Abstract

Internet of Things (IoT) has recently captured influential research foundation by way of a novel research area in an extensive range of educational also business disciplines, particularly in Medical-care. IoT innovation is improving contemporary Medical-care services by integrating technical, commercial, and communal prospects. Medical care systems are progressing from traditional to more custom-made medical systems, which have made examination, surgery and monitoring uncomplicated for patients. The ongoing worldwide threat of the pandemic originated by the new serious infectious lungs disease coronavirus 2 presents the extreme worldwide communal health catastrophe from the time when the pandemic influenza plague of 1918. The total cases of COVID-19 had touched more than 93 million worldwide. Subsequently pandemic ongoing, there has been a speedy struggle in various research groups to utilize an extensive category of technologies to fight this global danger, and IoT is one of the innovators in this extent. In the situation of COVID-19, IoT supported gadgets are used to lesser the probable transmission of COVID-19 to other people by timely identification, observing victims, and performing well defined practices once patient healing. This article reviews the functionality of IoT-based equipment used in fighting against the COVID-19 in three core stages, which comprises of initial diagnosis, quarantine time, and after recovery.

Keywords:
Covid-19, Medical IoT, Internet of Things, Pandemic

1. Introduction

From this section, input the body of your manuscript according to the constitution that you had. For detailed information for authors, please refer to [1]. An expansion in the utilization of versatile innovation and shrewd gadgets in the medical services area brings about a critical effect on the world. Possible advancement of new savvy and ground-breaking gadgets for checking of people's wellbeing, wellbeing specialists are exploiting these advances, consequently a considerable improvement in medical services in clinical settings besides out of them. IoT permits incorporating actual gadgets equipped for associating with the Internet and gives constant wellbeing status of the patients to specialists.

Constant illnesses, for example, diabetes, heart, circulatory strain are surprising on the planet financial and social level issues. It can likewise give a stage that authorizes general wellbeing organizations to get to the information for checking COVID-19 pandemic. Fresh cases in the USA are expanding speedily than in different nations. China has taken measures to control Covid-19, thus pace of expansion in novel cases in China is the most negligible.

1.1 Overview of Covid -19

Coronavirus 2019 initially perceived in 2019 December in Wuhan China is most novel respiratory infection epidemic right now tormenting worldwide wellbeing. The entire world is influenced by novel Covid (SARS-CoV-2) epidemic that was accounted for as of Wuhan, China, on 31 December 2019 presently called Corona Virus Disease 2019 (COVID-19). It is quickest dispersal irresistible infection which is bringing about another danger to general wellbeing universally. It demonstrated brought about by a different Covid, life-threatening intense respiratory disorder Covid 2 (SARS-CoV-2) is fundamentally identified with infection which surroundings SARS. Li et al. characterized an alleged COVID-19 instance as per pneumonia that coordinated related four models: (1) fever with or without chronicled disease: (2) radiographic indication of pneumonia: (3) typical or tiny white cell monitor or small lymphocyte tally: also [4] not any decrease in side effects future antimicrobial cure aimed at 3 days [1]. By way of appellation recommends main source of fatality as of COVID-19 is hypoxic respiratory displeasure [2–4]. Coronavirus presented huge difficulties for clinical also nonmilitary personnel networks practically equivalent to what was knowledgeable about two going before examples of SARS-CoV infection flare

up voguish 2002 similarly 2003, 2012 in Middle East Respiratory Syndrome (MERS) [1, 5, 6]. Expressively Li et al. predicted 425 patients by avowed COVID-19 in Wuhan also assessed that vital multiplication numeral (R0) aimed at SARS-CoV-2 at that fact to be 2.2 [1]. By and large, can spread the contamination to a normal of 2.2 others. The infection will probably keep on spreading except if this number falls underneath 1.0 [5]. Also, ideal and successful regulation actions have been a foundation of dealing with COVID-19 episode also decreasing virus-related communication.

1.2 Internet of Things for Healthcare

Growing interest of wearable sensors has by way of late arose by means of integral assets aimed at medical services applications also various devices are at present accessible economically aimed at various purposes as well as individual medical services, crusade mindfulness besides goodness. Analysts similarly have planned novel clinical usages of such improvements aimed at frameworks of distant wellbeing perceiving which include functionalities for extensive haul status footage and clinical admittance to bodily data of the patient [7]. Maximum distant wellbeing checking planned systems has engineering of a three level body sensor network level which include a wearable sensors functions as units aimed at info obtaining for example circulatory strain heart status also internal heat level subsequent level include correspondence also organizing plus administration which collects info from sensors then sent it [8, 9]. The third level includes making as well as examining places.

2. Important Role of IoT in Covid-19

Since 2020, world has been fighting with pandemic caused by high respiratory disorder known as Covid-19 by attempting to control the unusual spread of disease and build up an antibody [10]. As most prominent endeavors to discover a cure or control the spread of COVID-19 have not demonstrated sufficient outcomes up until this point, there is a great request for overall checking of patients using suggestive also asymptomatic COVID-19 disease. Figure 1 depicts the importance of IoT in Covid-19. IoT innovation has caught noticeable

attention in the field of medical services where it accepts a critical part in assorted phases of different illnesses [11]. In the present pandemic, as the chance of COVID-19 is great, here is a significant necessity aimed at patients to be connected with also checked via their medics' proactively voguish assorted periods of COVID-19. Voguish this examination, we inspect the IoT part innovation provide answer toward COVID-19 among three fundamental stages checking initial determination, isolate time and later recuperation. Throughout the principal phase of COVID-19, which gives initial diagnosis [12], here is an indispensable requirement for earlier finding.
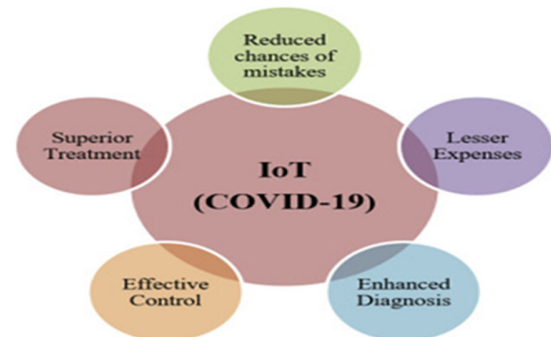

Fig. 1. Importance of IoT in Covid-19 [11]

Because the pace of infectiousness of COVID-19 is extremely high; where an asymptomatic patient is capable to spreading infection to other people. The preferably patient is examined, well the spread of infection may be controlled then patient can have suitable cure. Certainly, IoT gadgets accelerate recognition cycle through getting data by patients. This can be applied by getting internal heat levels utilizing different gadgets. The later stage, named quarantine time [13], is a critical time period of this sickness after the patient has been diagnosed to have COVID-19, and the individual must isolate for course of therapy. Different IoT based gadgets, in such time may screen patients through a distance [14]. They may likewise spotless districts without human beings collaborations.

Instances of these sorts are execution of following wearable groups, sanitizing gadgets, and so forth. According to the Centers for Disease Control also Prevention (CDC) [15], best extreme individuals with slight manifestations can recover while remaining at home without receiving medicines, yet

there is no affirmation those individuals won't be re infected after their recovery. Reinfection may occur with divergent indications of COVID-19 [16]. About these possible reinfections in the next recovery stage, the probabilities of recurring manifestations and potential infection can be great. To stop that event, social separation must be applied by sending IoT gadgets counting groups, swarm checking gadgets, and so on to follow people to assure the reasonable distance is kept up. During Covid-19 epidemic, IoT innovation has avowed its value in helping patients, , specialists and other medical care suppliers. In this segment, we transitorily clarify different IoT gadgets also applications tallying drones, wearables, robots, IoT catches, also cell phone applications that are generally used in bleeding edge of battling COVID 19. The Table I records particulars of these innovations concerning this epidemic.

2.1 Wearables

2.1 Wearables

Wearables can be express as gadgets shared with whatever that can be put on. They are characterized as application empowered registering advancements that get and measure input though they are either worn or adhere to body, for example, groups, watches, glasses, and so on [17 – 19]. These keen wearables were intended for disparate purposes in many areas, for example, medical care, way of life, etc. Regardless of the fact that the protection of information is as yet an important issue for extending these gadgets, it is anticipated that medical services suppliers will burn through $20 billion every year till 2023 on wearable IoT gadgets to screen further patients [20]. IoT wearable gadgets shelter a shifted scope of various savvy wearable instruments, for example, Smart Thermometers [21, 22], Smart Helmets [23], Smart Glasses [24], IoT-Q-Band [25], Easy Band [26], and Proximity Trace [27]. Table II displays all wearable gadgets concerning their grouping with models.

Table 1: IoT Devices during COVID-19

Devices	Description	Pros	Cons
Wearable [17]	A technology that can be worn on body and used for receiving and processing of the data	• Constant monitoring • Improving the quality of patient's health care • Less hospital visit	• Security and privacy of data is doubtful • Small battery life
Drones [28]	An aircraft having cameras, sensors, communication systems can be flown with less or without human involvement	•Can perform different task including searching, monitoring etc • Can Reach to hard-access areas • Lower the operatives' interactions	• Quality of Service • Can have Security issue
Robots [36]	A machine that can perform actions like a human	• Less interactions by using remote diagnosis and treatments • Can perform maintaining activities like cleaning and sanitizing	• Privacy issues
Smartphone Applications [41]	A software designed to complete a task using a mobile device	• Cost-effective • Monitoring and Tracking	• Privacy and Security

Table 2: Wearable devices used in different phases of Covid-19

IOT based Devices	Functions	Phase	Example
Smart Thermometer [21,22]	Monitoring of Temperature · Increase the diagnosis rate	I	Kinsa, Rans Night, iFever, iSense, Tempdrop
Smart Helmet [23]	· Monitoring of Temperature · Taking face image · Less human involvement	I	KC N901 used in China
Smart Glasses [24]	· Monitoring of Temperature · Less human involvement	I	Rokid, Vuzix & Onsight
IOT-Q- Band [25]	· Tracking quarantined objects · Destroyable	II	Hong Kong electronic wristband, Electronic ankle bracelet in USA
EasyBand [26]	· Social separation monitoring · Alert the danger of closeness by using LEDs	III	Pact wristband
Proximity Trace [27]	· Monitoring of social distancing for employees in an organization · Tracing contacts of infected employee	III	Instant Trace TraceTag

2.2 Drones

Drones are airplane that are flown without or slight human involvement. In 1849, a drone which was loaded by bombs was used during the battle between Italy and Austria [28]. Drone is considered as an automated airborne vehicle (UAV) which works by the guide of sensors, GPS, and administrations. IoT utilization inside robots, called as Internet of Drone Things (IoDT) styles it plausible on behalf of robots to do a range of errands, for example, observing, detecting, conveying, and so forth [29]. Smart drones can be work via a cell phone and a which makes them solid in various fields for example, farming, medical services, and so forth Various kinds of IoT based robots, as well as Thermal Imaging Drone [30], Disinfectant Drone [31], Medical Drone [32], Surveillance Drone [33], Announcement Drone [34], and multipurpose drone [35] also are utilized voguish the medical care area also, in explicit, in battle in contradiction of COVID 19, will be talked about in this paper. An outline of such robots, alongside their models, can be institute in Table III.

2.3 Robots

As per Merriam Webster word reference, a robot named "a machine which looks like a living animal in being fit for moving freely." By way of a movement throughout the arranged robots development inside cloud and Internet of Robot Things was executed where it may do a few dissimilar errands to sort life simpler [36]. With respect to introduce pandemic, robots may be arranged as Autonomous robots [37], Tele robots [38], Collaborative robots [39], and also Social robots [40]. Table IV covers the basic highlights of these robots with models.

Table 3: Drones during Covid-19

IOT based Devices	Functions	Phase	Example
Thermal Imaging Drone [30]	· Able to capture temperature in gatherings · Less Human involvement	I	Pandemic Drone
Disinfectant Drone [31]	· Used for sterilization of infected areas · Prevent health personnel from getting infected · Less human involvement	II	DJI
Medical Drone [32]	· Decreasing hospital visits · Increase treatments accessibility	II , III	Delivery Drone by Canada
Surveillance Drone [33]	· Monitoring of social distancing in crowds and gatherings	III	Micro MultiCopter Cyient
Announcement Drone [34]	· Spreading info about COVID-19	III	Broadcasting Drone used in Spain
Multipurpose Drone [35]	· Temperature capturing · Disinfecting contaminated areas · Monitoring of crowded areas	I, II, III	Corona Combat

Table 4: Robot Devices during Covid-19

IOT based Devices	Functions	Phase	Example
Autonomous Robots [37]	· Detecting symptoms · Controlling social distancing · Sterilizing infected areas in hospitals · Checking respiratory signs of a patient · Gathering swab test	I, II, III	Intelligent Care Robot Spot Robot
Tele Robots [38]	· Decreasing the risk Of contamination for medical personnel's	II	DaVinci surgical robots
Collaborative Robots [39]	· Less healthcare workers' fatigue · Disinfecting places that are difficult to reach	II	eXtremeDisinfection Robot Asimov Robotics
Social Robots [40]	· Reducing mental stress	II	Paro

2.4 Smartphone Applications

These applications are computer programs intended to perform specified tasks inside a cell phone. Meanwhile there are almost 3.6 billion dynamic cell phones in current year, these IoT based phone applications could be successful in different fields, including medical care, farming, retail and so on [41]. Several cell phone applications have been developed for providing medical services , and some of them have been used in counter toward COVID-19, as charted in Table VI, in particular DetectaChem [42], nCapp [43], Social Monitoring [44], Stop Corona [45], Civitas [46], Selfie application [47], AarogyaSetu [48], eRouska [49], Hamagen [50], Coalition [51], BeAware Bahrain [52], TraceTogether [53], StayHomeSafe [54], and WhatsApp [55].

3. First Phase: Early Diagnosis

The way toward fighting COVID-19 is toward analyze it right on time on the road to forestall dissemination the infection generally. It will generously assist medical care suppliers toward mastermind healthier therapy plans, save more lives, also lessen pollution plus diseases. The initial phase in the initial analysis of COVID-19 understands its manifestations. As specified by the CDC in September 2020 COVID-19 has a varied scope of manifestations counting chills or fever, tiredness, cerebral pain, hack, muscle or body hurts, windedness or unease breathing, novel loss of smell or taste, clog or gooey nose, sore throat, retching or sickness, besides loose bowels. Among them, high or fever internal heat level is perhaps the most well-known manifestations of COVID-19 when the deliberate temperature surpasses 100.4 Degrees Fahrenheit or 38 Degrees Celsius [56]. Recognition cycle become quicker and effective using IoT gadgets as they catch information using their sensors also subsequently dissecting the information aimed at patients, medical care suppliers, specialists toward control, analyze and finally halt this infectious illness [57]. Diverse gadgets

of IoT might be used toward catch a portion of previously mentioned manifestations on a beginning Subcategories.

3.1 Wearables

Using wearable devices is considered as a well-organized means in retort to necessity for initial diagnosis throughout this epidemic [58]. Mounting such devices has ensured an extraordinary effect on preliminary uncovering of ailments. For instance wearable IoT gadget may sanction either respiratory symptoms of a sufferer is common or not. By such information patient may get slightly ups and downs in his/her health condition also choose to sort a medical appointment in advance a little further signs seem [59]. COVID-19 disease may be calmer to fight via proper wearable gadgets.

3.1.1 Smart Thermometers

An extensive ranging possibility of IoT intense thermometers has been formed towards collect reliable estimations of inner heat levels. It is such minimal effort, in early recognition of doubtful cases. Likewise, since utilization of infrared thermometers aimed at catching internal heat level can spread the infection more because of the closeness of patients and medical services suppliers, utilizing keen thermometers is strongly suggested [30]. As indicated by [60], thermometers of Kinsa have been broadly utilized in homes also the maker is presently ready toward foresee the utmost dubious territories (tainted by COVID-19) in every situation of USA dependent on chronicled fever of individuals. Supplementary savvy thermometers for example Tempdrop, iSense, Ran's Night plus iFever (appeared in Fig. 2) can account internal heat level whenever on a cell phone. Utilizing these gadgets in individuals' everyday lives may progress opportunity of spotting novel patients at initial point.

Fig. 2. Wearable Smart Thermometers [22]

3.1.2 Smart Helmet

Protective caps through a warm camera have naked to be innocuous associated to an infrared thermometer weapon because of second rate human contacts [30].   In this gadget when incredible temperature is detected by warm camera on shrewd protective cap area additionally picture of the essence of individual are taken through an optical camera. At that point they shipped off dispensed cell phone by an alert as appeared in Fig. 3, with the goal that wellbeing official may separate the infected individual, and additionally specialists can continues activity [23].   Also, Google Location History might be bound together by savvy head protector to get places visited by supposed individual in the wake of uncovering [61]. Republics, for example, China, Italy, additionally UAE have applied this wearable gadget to notice masses in two meters from spectators [62]. Curiously such model has uncovered commendable outcomes. For instance KC N901 is a shrewd cap shaped in China which has an exactness of 96 percent for great internal heat level finding [62].
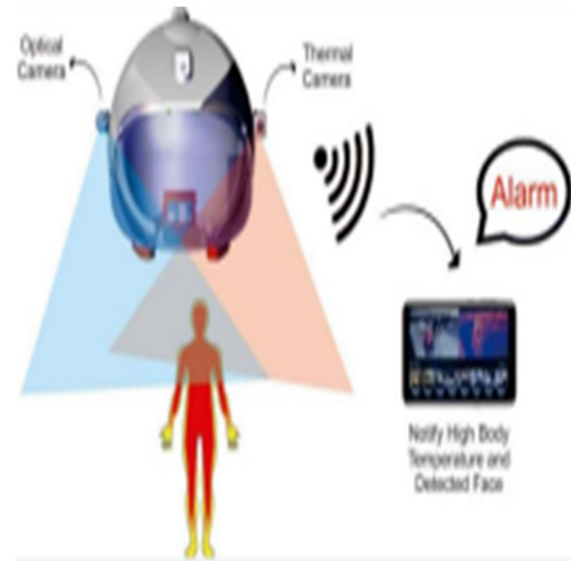

Fig. 3. Smart helmet used to identify temperature using cameras [23]

3.1.3 Smart Glasses

A new gadget i.e. IoT based spectacles as shown in Fig. 4. Optical along with warm   cameras have been used in these glasses to screen swarms [24]. Some of these glasses can be used to detect temperatures in individuals which permit recognizing the doubtful cases (people with high temperatures). Furthermore, Google Location History clears other activities thru catching spots visited by doubtful cases [24]. Some of the smart glasses are Rokid, keen glasses [63] and shrewd glasses. These glasses can screen upto to 200 individuals.   Additional illustration of gadget is blend of Vuzix brilliant glasses by Onsight Cube deep camera (see Fig.5). These gadgets are used to screen groups to identify persons with great temperatures and provide their data to clinical specialists [64].

Fig. 4. Smart Glasses for capturing temperature [24]

Fig 5. Vuzix Smart Glass [64]

3.2 Drones

As a rule, finding contaminated individuals in a group is significant in initial conclusion similarly manage of COVID-19 [65]. By means of Automated Ariel Vehicles (UAV) besides mainly IoT founded robots is one more normal method toward accelerate way toward verdict debased individuals also zones through this pandemic. Robot innovation might decrease human cooperation also can arrive at hard to get to areas [66]. Thermal Imaging Drone as appeared in Fig. 6 intended aimed at catching temperature of individuals in groups also can be utilized in the initial determination stage. This sort of robot might be joined by Virtual Reality as a wearable gadget toward distinguish individuals with great temperatures (fevers). This gadget diminishes human communications, yet it additionally utilizes less time contrasted with thermometer weapon gadgets [30]. Single illustration of this gadget is Pandemic Drone application created through a Canadian organization [67] aimed at far off observing plus distinguishing a little instance of contamination by temperature, catching, respiratory signs, for example, pulse, and any wheezing or hacking [68].

Fig 6: Thermal Imaging Drone [30]

3.3 Robots

Utilizing robots connected to IoT to help initial determination is an amazing utilization of these gadgets since they may help wellbeing laborers by preparing patients' medicines also bringing down work feelings of anxiety [69]. Without connection of people, self-ruling robot can aid battle in entirely COVID-19 stages. In primary stage, it can aid cycle of finding through gathering throat gauzes tests from patients with upside of forestalling clinical team in danger (nearby contact with patients) [37]. Fig. 7 portrays how cycle functions. A design of this gadget Intelligent Care Robot has been shaped complete an association among two organizations, Meditemi [71] and Vayyar Imaging [70]. This gadget recognizes indications of COVID-19 out of 10 seconds through utilizing touch less snappy examining of an individual inside a remoteness of 1 meter toward catch respiratory symptoms also temperature [72].

Fig. 7. Autonomous swab test robot

3.4 Smartphone Applications

Cell phone applications enabled with IoT consuming data for example Geographic Information System (GIS) similarly Global Positioning System (GPS) are broadly used during COVID-19 pandemic to distinguish infected persons from the healthy one [41]. Executing mobile phone applications with Internet of Medical Things (IoMT) provide support sufferer by providing them suitable therapies when they are at home. People can share their health information to the cloud received by IoT and get assistance about their health from specialists on the web. Using this, patients might be reinstated at home

without increasing infection. It charges quite less as compare to consuming an actual arrangement at clinics. It also permits authorities to make a superior move to deal with the pandemic later on [73]. Since commencement of the pandemic some mobile phone apps have been produced for COVID-19 which will be talked about in the upcoming segments.

3.4.1 nCapp

Coronavirus Intelligent Analysis as well as Treatment Assistant Program (nCapp) shaped in China employing Web of Health Belongings on cloud stage. Such cell phone app is a mechanized finding framework with eight capacities that can be chosen by the client. nCapp can naturally create an analysis report dependent on mentioned information and surveys presented through patients. Conclusion is arranged keen on three cases: affirmed, dubious, or suspected. For the affirmed cases there are four conditions, counting "gentle, temperate, extreme, also basic are controlled by a doctor. Extraordinary medicines for these situations and different kinds of cases are characterized too. Other optimistic purposes of this sequence remember refreshing its own information base for request to improve its conclusion, making conference feasible for all wellbeing laborers, ensuring each patients are protected in long haul, lastly, having every one of these capacities freely accessible. When all is said in done, by utilizing nCapp the conclusion should be possible quicker and wide spread of sickness may be controlled simpler [43].

3.4.2 MobileDetect

MobileDetect is an application intended to recognize also control magnitude of COVID-19. Using this app client might unquestionably step through exam on home using a muffled swab. Aftereffects of the test will appear on mobile phone application within 10 to 30 minutes deciding client's wellbeing regarding Covid-19. Then the client can send the results of the test to his/her medical care specialist for further actions. This cell phone testing unit approved by Food also Drug Administration (FDA) may be useful thru crucial phase of a pandemic by bringing down spread of disease [42].

3.4.3 Stop Corona

Other than entirely usage aimed at initial case location, one more methodology is consuming an information base of caught every day wellbeing information. The reports incorporate communicate with others, indications, also areas. Stop Corona application [45] prescient heat maps dependent on illness spots. Such application gathers data by its clients around their day by day wellbeing status also create report and heat maps dependent on that. Created report will be available just toward wellbeing specialists. Subsequently, when a client shows another indication and declares it, incident will be show up on new report also at last specialists will have the option toward make an appropriate move and distinguish the debased territory quicker due to reported new manifestations.

4. Second Phase: Quarantine Time

Subsequently cycle of recognition it is important toward disengage also afterward screening patients whether in a hospital, clinic or at home. Isolation does not only affirm cases but can be used as a measure for doubted patients in different zones or city areas or states [74]. After being diagnosed of Crona, the patient have to stay at home, isolate himself in as separate room away from other family members, so that the virus don't transfer to other people. The duration of isolation depend on recovery speed. This is completed to keep suspected transmission from infected cases or regions toward other individuals. Using IoT gadgets at this stage could aid genuine difficulties, for example, dispersal of infection patients, control their respiratory pulse, etc. [75]. Isolation time is intended to reduce the dispersion of infection to other individuals.

4.1 Wearables

IoT wearable gatherings have set up favorable results toward shield patients from stopping disengage domains. Utilizing wearable gatherings is a functional answer focused on ensuing cases. This gadget is related with perseverance mobile phone application over Bluetooth all through disengage period and clinical administrations experts may typically screen entire cases at ordinary stretches by

means of a net interface. Furthermore vulnerability a sufferer doesn't have posse on their leg or arm potentially stops separate zone, alert will transported off guidance trained professionals and they have agree to call patient aimed at explanation of condition

4.1.1 IoT-Q-Band

Fig. 8 displays a wearable device named IoT-Q

Band. Such technique has been used in Hong Kong where authorities have used an electric wristband associated with a mobile phone application to trace individuals arriving at airports for 14 days [54], [76]. Moreover, specialists in US have implemented one more sort of this model by means of electronic lower leg arm groups (lower leg screens) to separate people who won't stay in isolation [77].
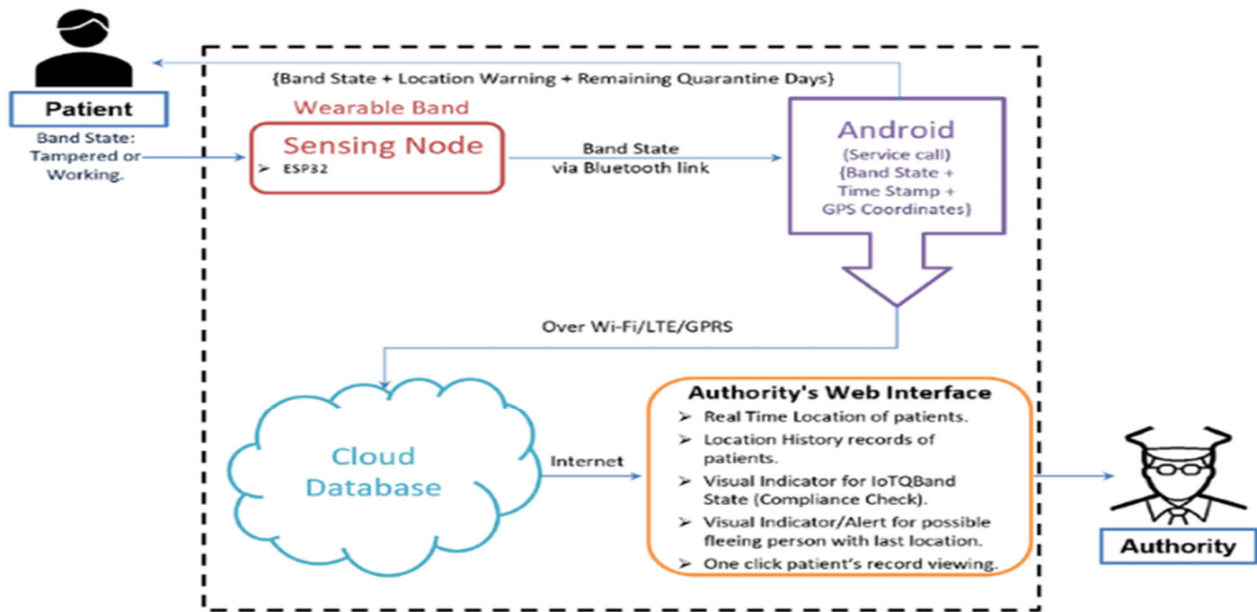

Fig. 8. IoT-Q Band workplace classification [25]

Table 5: IoT based smartphone applications used in covid-19

Application Name	Function	Origin	Platform	Phase	Rating	Downloads	Review
nCapp [43]	This application provides consultation to control the patient health by using database	China	Cloud	I	-	-	-
DetectaChem [42]	Providing low cost COVID-19 testing using a kit and smartphone app	USA	Android	I	4.2	5,000+	31

Stop Corona [45]	Use to collect daily health reports , also used to access location to build a map for high risk areas	Croatia	Android, iOS	I	3.0	100,000+	3,448 total
Social Monitoring [44]	Use to track patients with Covid-19 infection , Access user information by government authorities because of privacy concerns	Russia	Under Development	II	-	-	-
ClearSCAN app Selfie app [47]	Monitoring patients using their selfies sent to it randomly	Poland	Android	II	-	-	-
StayHomeSafe [54]	Monitoring individuals at airports by using a wristband and a mobile	Hong Kong		II	-	-	-
TraceTogether [53]	Provide information to the people who were in close contact with diseased persons	Singapore	Android, iOS	III	3.1	1,000,000+	3,131
Civitas [46]	Informing perfect time for suspected cases to leave for necessities	Canada	Android	II		100	
Coaltion [51]	Informing individuals about detected cases who have been in contact with them	USA	Android, iOS	III	4.2	1,000+	21
eRouska [49]	Capturing physical contacts between user also people	Czech Republic	Android, iOS	III	3.6	1,000,000+	7,901
Social Media Whatsapp [55]	Provide healthcare services to people without making them visit to the hospitals	Singapore	Android, iOS, web	I, II, III	-	-	-

COVID-19 Gov PK	Provide information about the number of affected person for each province in country. It also Provides facility to the citizens to check the availability of Hospitals, beds, ventilators and labs near them	Pakistan	Android, iOS	II, III	4.2	500,000+	6,951

4.2 Drones

Using drones expects a huge occupation during seclude time to lessen the amount of COVID-19 cases by cutting down the joint effort of clinical administrations workers through patients also contaminated regions. For instance, drones in such stage may help clinical consideration workers also Patients via sterilizing zones or passing on clinical cures to patients [78].

4.2.1 Disinfectant Drone

Keeping regions sterilized and sanitized throughout the isolate period is significant and this may be accomplished through utilizing specific sort of robot named a Disinfectant Drone [82] (See Fig. 9). Such robots may lessen pollution of infection besides furthermore forestall medical services laborers from receiving tainted. Company DJI delivered such robot with capacity toward clean 100 meters in a single hour. Such sort of robot has additionally been utilized in Spain aimed at sterilizing purposes [81].

4.2.2 Medical or Delivery Drone

Clinical robots have established their capability toward starting period of COVID-19 wherever they move COVID-19 test units, tests, or else clinical provides among labs plus clinical concentrations toward get rid of human being coordinated efforts (See Fig 10). Moreover, such a robots generally lessen crisis facility visits and addition permission to clinical thought by passing on clinical cures to patients or alternative clinical concentrate quickly. Figure 10 is depicting the medical drone.

Fig. 9. Disinfectant Drone [66]

Fig. 10. Medical drone used for transferring medical related stuff [66]

For instance, by means of clinical robots in China and Ghana has accelerated end through cutting transport period [79]. One more sort of transport drone throughout COVID-19 made through Delivery Drone Canada Inc., which may transfer COVID associated items, counting test units also swab tests. Such sort of robot may be furthermore used aimed at various initiatives, for instance, postal and staple organizations though COVID-19 attested cases are segregated in their homes throughout the seclude time [80].

4.3 Robots

During the isolate time stage, robots assume a significant part in getting clinical staff far from separated patients [83]. For instance, robots can be utilized in an unexpected way, for example, catching respiratory symptoms also furnishing help toward patients by their medicines or food.

4.3.1 Tele Robots

Telerobots are for the most part worked indirectly by a human and can offer a different kind of help, for instance, far away end, distant operations, and far away cures for patients while there is no human being correspondence throughout the cycle. For instance, a clinical specialist may check patients' high temperature without taking interchanges with them thru consuming these robots. Alternative model is

Fig. 11. DaVinci telerobot

daVinci cautious robot which is worked through a trained professional whereas patient is in ensured partition of plastic sheet as shown in fig. 11. This aids with preventing illnesses by acting operations distantly [84]. It can avoid close contact between surgeon and patient during surgery [84]

4.3.2 Collaborative Robots

Shared robots recognized as Cobots (Fig. 12) are proposed robots if here is a essential aimed at a movement completed by individuals. They are not by way of invaluable as per telerobots for this epidemic, and then instead throughout detach, this sort of robot may cut down clinical consideration workers' shortcoming similarly as way their interchanges by patients [38]. For example in India Asimov Robotics is proposed aimed at seclude time to assist patients in withdrew locales with chores, for instance, making food also giving medication then besides thwarting clinical consideration workers from being around there [39]. Alternative outline of this robot

throughout this stage is eXtremeDisinfection robot (XDBOT) that is executed through Nanyang Technological University in Singapore. Such robot may disinfectant solid toward get to regions, for instance, below a bed, also moreover may be distantly dealt with versatile stage   toward avoids any   nearby   contact   among   individuals   also contaminated locales [39], [85].

Fig. 12. Human operated collaborative robot

Self-administering usually works with less or no human involvement and can be used in different situations to like to disinfect infected areas in crisis facilities, transmit patient's prescription and to monitor their respiratory symbols. These can achieve reduce threat of illness for clinical workers and others as well [86]. A disinfection robot made via Xenes [87] is used for cleaning as well as decontaminating   areas   with   disease   and microorganism. Figure 13 shows how Xene perform disinfection process using UV lights. Another model of this robot is UVD robots which are built by a Danish association and are aimed to saniotize clinical areas using UV lights and has capability of abolishing DNA of infections [88].

Fig. 13. Xenex disinfectant autonomous robot [86]

4.3.4 Social Robots

As demonstrated through CDC [89], separating also confining patients be able to possibly source mental prosperity issues as well. Toward thwart such social robots are planned to talk with patients throughout that time. Handiness of these robots in this epidemic is to aid decrease mental exhaustion also strain throughout detach also season of physical isolating [38]. Single outline of such robots is Paro [40], which may aid patients throughout their control by way of a   pressing factor easing device, as per showed up in Fig. 14.

Fig. 14. Paro social robot can avoid the effect of quarantine [38]

4.4 Smartphone Applications

The most basic piece of an isolate is monitoring patients while they are disengaged. Following patients utilizing cell phones during isolate time is another generally utilized way to deal with alleviates and control the spread of this infection.

4.4.1 Social Monitoring

A compulsory perception application named Social Monitoring in Russia [66] has been made through public power toward follow patients which are resolved to have COVID-19 also should be quarantined in their households. Patients are expected toward demand QR (Quick Response) code each period they need toward wander out from homebased or disengage zones [90].

4.4.2 Selfie App

Such application was prepared in Poland consolidated by Geo-region also facial affirmation development toward follow patients who have been encouraged to halt at home intended for 14 days. Patients be able to excuse presenting this app yet therefore, they will develop astonishing visits as of subject matter experts. By means of application patients will be drawn nearer to direct selfies self assertively unfailingly [47].

4.4.3 Civitas

A Canadian wireless application that has been planned to cut down COVID-19's influence. With customer's distinctive verification code this app talks with experts to applicate an authority that lets customer toward take off from house [48].

4.4.4 StayHomeSafe

StayHomeSafe application is measured by way of a blend of wireless applications also wearable gadgets [49]. It has been executed in Hong Kong where novel makes a big appearance at the air terminals are provided a wristband that may be coordinated by a PDA to set confine territory with potential gain of geo fencing development utilized by application.

5. Third Phase: After Recovery

COVID-19 pandemic have terribly affected various   organizations,   financial   matters   and commercial centers. By following tough limitations and   secured   social   instructions,   countries   are gradually opening once again. This is the phase where each individual needs to encounter with added alerts. Limitations on actual administration and social separating should be executed in the way to ensure the contamination won't spread again [91]. In such scenarios, we feature effort of IoT novelty in struggling COVID-19 epidemic after lockdown.

5.1 Wearables

Meanwhile businesses are progressively taking employees back toward working environments, understudies are protection to schools also economy is recoiling back aimed at resuming, there ought to be approximately assurance procedures to protect everybody from this infection. Wearables are gadgets that may be used toward follow clients' nearby interactions with others also furthermore aware them if social removing isn't looked after [92].

5.1.1 EasyBand

As countries bit by bit continue occupations and business focuses after lockdown Easy Band [26] is maybe best IoT contraptions toward guarantee people are performing social isolating. Such wearable contraption that is composed with Internet of Medical Things (IoMT) is recognizing also getting data as of various devices. Easy Band working inside a precise range also displays expected peril through its LED beams uncertainty individuals are uncommonly almost each other. Meant for example in case somebody wearing an Easy band gravitates toward to a different person inside 4 meters band will begin motioning to attentive both also retell them to avoid each other. An equivalent model for such apparatus is Pact wristband [93] (see Fig. 15) that warns familiarity of persons by means of a vibrator and ringer.

Fig. 15. Easy band process of tracking

5.1.2 Proximity Trace

This contraption helps mechanical experts with keeping up social isolating in every practical sense. Such device which may be annexed to a solid body or cap, cautions labors when they sink toward to each other by a clamorous sound. By means of this device laborers will have the alternative toward zero in on their slog devoid of obsessing around infection from disease. Fig. 16 demonstrations in what way this follow may twig to the mechanical experts' solid cap. Too, Instant Trace, showed up in Fig. 16 worn by way of an ID has very handiness which urges agents toward keep up social eliminating then follow tainted laborer's contacts [27] [92].

Fig. 16. Instant trace worn as badge [92]

5.2 Drones

As disease arrives After Rescue stage a huge number have been utilized because of the returning, which assists organizations with continuing working in a protected way. Expanding social mindfulness by observing the groups and broadcasting data is the principle reason for executing these gadgets throughout this phase.

5.2.1 Surveillance Drone

Surveillance drone was planned also created by way of a powerful method to screen jams if there should be an occurrence of individuals' inability to organize social eliminating. MicroMultiCopter [33] complete in China also Cyient [94] dual sorts of

robot are from India. MicroMultiCopter drone consumes likewise been furnished using speakers toward declare significant data from specialists that will be talked about in following sort of robot inside such stage.

5.2.2 Announcement Drone

Such sort of robot is fundamentally proposed aimed at broadcasting in locales by little accessibility to Internet. For instance, specialists in Spain besides additional European countries utilize such a robot to announce protest of social isolating also various standards by speakers [95]. Another country Kuwait used this robot to impart "get back" messages to persons in get-togethers [96] (see Fig.17).

Fig 17. Announcement Drone

5.2.3 Multipurpose Drone

Practice of IoT in medical care is currently growing A multipurpose robot termed Corona Battle, [35] has been done in China by blend of some excess categories of robots which may protect sum of planned targets referred to in three stages immediately. Such robot may be conceded on in any COVID-19 phases.

5.3 Robots

In period of after recuperation, everyone has to distinguish meaning of social eliminating wherever to alleviate spread of infection.

5.3.1 Autonomous Robots/ Spot Robot

As a result of this time of COVID-19, self-administering robots may be utilized toward power over social eliminating. For example Ad [97], a four legged robot agreed in Singapore in the direction of resemble a canine, retells people to practice social isolating straightforwardly puts. While this robot may be controlled distantly, it is moreover fit for moving data to a web interface aimed at additional noticing. [98]. Fig. 18 is Spot robot for checking demonstration of social isolating also significant advantages are productive checking, cost viability, suitable therapy, less mix-ups, and outstanding findings [99]. Some cell phone applications have been grown explicitly in light of the pandemics challenges related with returning advance which will be shrouded in such portion.
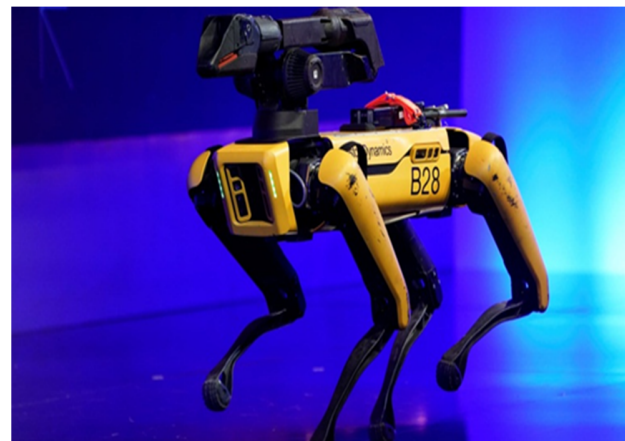

Fig 18: Spot Robot for Social Distancing

5.4.1 Aarogya Setu

It is a connection subsequent app aimed at individuals toward practice on their cell phones toward expand familiarity with also battle in contradiction of this infection [100]. Aarogya Setu is envisioned for improved correspondence among wellbeing specialist co-ops and individuals. In the application, the client will be inquired as to whether the person has any side effects of COVID-19 or has as of late voyaged universally. Dissecting the info information from the clients alongside their following data Aarogya Setu can advise the client on the off chance that the person has had contact with somebody who is now or later turns into an avowed case.

5.4.2 TraceTogether

Application named TraceTogether dispatched by Singapore [53] to find data by means of a mixed ID as of people who were in neighboring interaction with each other. Obtained data won't be used till a near, by communication recognizing verification is arrange. Such data consolidates term of visit also social remoteness will be taken care of for 21 days aimed at communication following causes later on.

5.4.3 Hamagen

This communication following app was made in Israel. Hamagen practices GPS development toward see whether the client has been hip neighboring communication with an individual who endeavored positive for COVID-19. In such app for assurance, private data won't leave the mobile phone till the customer settles on [50].

5.4.4 Coalition

Coalition [51] practices IoT advancement also square chain phase to provide a protected communication following system. In such application customers are allocated with sporadic IDs so that by acknowledgment of some fresh cases customers who were hip neighboring communication with individuals' cases will be educated.

5.4.5 BeAware Bahrain

An interaction following app completed in Bahrain such cautions individuals when they are pushing toward polluted zones by a distinguished COVID-19 incident or else uncertainty they were in neighboring connection by an inveterate incident [52].

5.4.6 eRouska

Such application screens also gets slightly closeness among its customers. Uncertainty one of clients' test turns positive designed aimed at COVID-19, such app will teach the more concerning the conceivable sickness so they can proceeds an action round their prosperity condition [49].

5.4.7 Social Media – Whatsapp

World has about 3.8 billion customers by means of online media as of April 2020. This figure of customers makes a mind blowing chance toward complete telemedicine clinical consideration maintain using on the web media applications throughout this pandemic. Maybe utmost standard app is WhatsApp. This app offers such chance toward patients to direct distantly with their PCPs by

means of virtual get-togethers that will provoke reducing clinical facility look in on by patients. By means of this methodology is appropriate toward all stages throughout COVID-19 pandemic [101].

5.4.8 COVID-19 Gov PK

It shows statistics about number of total affected individuals with disease in each province of Pakistan with disease using a dashboard. It also provides facilitation to the citizens to search the availability of nearest Hospitals, ventilators and testing laboratories [102].

6. Discussion and Future Work

Coronavirus is measured as both a worldwide wellbeing emergency and a global monetary danger. The limitations set up reaction to the COVID-19 pandemic has devastatingly affected numerous organizations, commercial centers, financial aspects, society also our lives. The full wellbeing, social, also monetary outcomes of this pandemic also its limitations will set aside effort to be completely perceived also evaluated, be that as it may, there are loads of continuous endeavors in exploration and mechanical networks to use various innovations to recognize, treat, and follow the infection to alleviate its effects. Web of Things (IoT) innovation has indicated auspicious outcomes in initial identification, isolate time, then after recuperation as of COVID-19, in any case, by way of we become familiar with infection also its conduct we ought to change also improve our methodologies in various stages. For instance, it is fascinating to incorporate Artificial Intelligence (AI) also IoT innovation to utilize AI ability to limit co-operations among medical services laborers and

patients in all stages. Another model is utilizing touchless innovation with the assistance of different data sources, (for example, motion also voice) will be productively lower spread of the sickness and end pandemic sooner [103]. Additional examination should be complete on persuading affirmed instances of COVID-19 to stay in isolate to alleviate spread of the infection. Also, how IoT gadgets may help separated patients effectively for their everyday life. After lockdown as organizations then commercial centers are opening bit by bit, how IoT gadgets may be fused in organizations to shelter both wellbeing also effectiveness. Response to those inquiries will draw in significant consideration in both examination and mechanical teaches also open new exploration roads here.

One of the principle worries about utilizing IoT gadgets in various periods of this epidemic is security matter where patients are approached to share their data. Certainly, it is a major worries for each patient so characterizing secure channels aimed at correspondences or using diverse encryption procedures prior to sharing private data would be a potential exploration region.

Having IoT-empowered Smart urban communities can be incredibly useful in battling the current and future pandemic through cooperation between clinical focuses, urban communities, and so on [104]. Alongside previously mentioned IoT applications, Allam et al. [105] features significance of the idea of Smart City organizations while world is battling with COVID-19 pandemic. Savvy City framework may assist individuals with keeping up social separating by the usage of keen transportation frameworks including swarm observing, shrewd stopping, and traffic re-directing [106]. As a piece of keen existing in the Smart City, shrewd home IoT-based advances may likewise decrease disease pace of COVID-19. Aimed at example, Smart home

doorbells also security frameworks may be actualized for keeping clients from contacting surfaces so that there won't be any defilement of infection through contacting those sorts of surfaces [107].

7. Conclusion

As the world reacts to the COVID-19 pandemic numerous methods have been used to battle the disease. One such technology is Internet of Things (IoT), which is extensively used in healthcare. During the COVID-19 pandemic, such technology showed very interesting outcomes in the fight against this disease. In this article, we take a look at the IoT devices recently offered to support healthcare providers and authorities throughout the COVID-19 pandemic. We analyze IoT-related technologies also their application in three stages, including initial diagnosis, quarantine time and subsequent recovery. At each stage, we assess role of IoT-related technologies, counting consumables, drones, robots, IoT buttons, also smartphone apps, in the fight against COVID-19. IoT technologies can be very effective in this pandemic; however they are furthermore important for privacy protection. By successfully implementing IoT technology safely, more patients can be confident that IoT devices can participate in their treatment process. As a result, health officials and professionals can take more effective action in the event of a pandemic. Doing this can greatly reduce the consequences of these types of illnesses, including infection, hospitalization and death.

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