PREVALENCE OF INTERNET OF THINGS IN PANDEMIC

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Abstract: The current COVID-19 pandemic has created several problems now-a-days.

All these problems point to the inability to examine and scale the situation according to the intensity of the outbreak. Along with creating problems, this pandemic has exceeded many boundaries such as the provincial, radical, conceptual, spiritual, social, and educational. It has changed the fundamental nature of our society.

There is one answer to solve this problem and the answer is to utilize the technology in the best way. For controlling such a pandemic situation, a collection, analysis, elucidation of data on regular basis regarding the spreading disease trends should be done in order to predict the outbreak of major health related symptoms. A proper surveillance is required to cure any type of disease.

Surveillance- collection of data can be performed best with the assistance of technology like Internet of things.

As "Internet of things is an idea which comprises of interconnected frameworks which has the ability of finding data about a specific thing with the assistance of extraordinary identifiers and detecting capability."

The technological platform of IoT connected with the healthcare system is helpful in observing the infected people. This monitoring is done by the interconnected network offered by IoT. **[1]**

Implementation of such a technology will help to decrease the healthcare expenses and enhance treatment of the infected patients.

Therefore, this study is an extensive description about exploring and highlighting prevalence of IoT in pandemic.

Keywords: Internet of Things, Healthcare, medical IoT, IoT in covid-19, wellness, COVID-19, Hospitals, Pandemic, IoT applications, IoT devices.

INTRODUCTION

Pandemics cannot be predicted much but least one can do is to be prepared for it.

The current wave of COVID-19 pandemic has already damaged the growth engines of the world such as China, U.S.A, Italy and India badly.

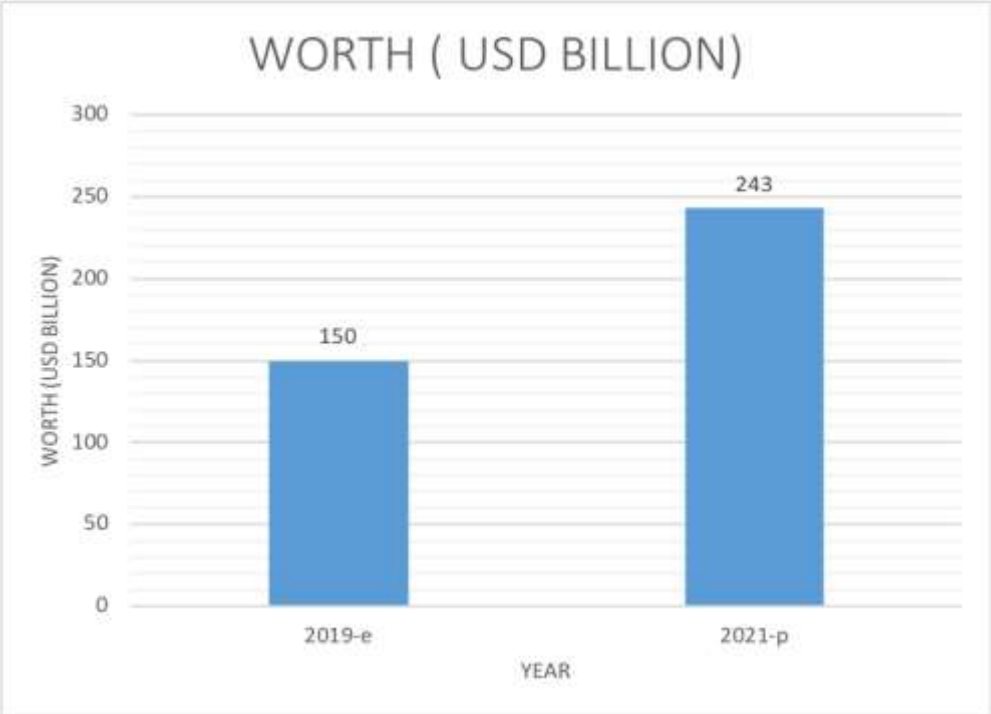
Many countries of the world are battling economic fatigue and declining growth as they are paying precious resources to fight with COVID-19 which includes public lock-downs. These lockdowns are going to trigger the economy of many countries.

As countries around the world are struggling every day to contain the virus, the deaths and infections are continuously rising.

According to Worldometers, the number of corona cases crossed 9,50,000 while the number of deaths crossed 48,000 on March 31, 2020. Although, it is widely believed that china has hidden its true numbers from the world.
However, there are many photos coming out of Wuhan which shows that the actual death count in Wuhan alone may be in tens of thousands.

When the entire world is battling a similar foe, we have all needed to grasp and embrace new advancements in technology and find their advantages, despite the fact that there is as yet far to go.
Technology plays a significant role in beating irresistible diseases, and the IoT is a significant piece of our innovation stockpile. Cost decrease, self-governing and remote providing care and analysis, just as recently accessible patient information are only a couple of the ways that the IoT is changing human services. What's more, with regards to disease control, remote and IoT advancements offer incredible arrangements and solutions. Thus, COVID-19 have been the epitome of the Internet of Things (IoT).

This term which is called as “INTERNET OF THINGS” was framed by Sir Kevin Ashton in the year 1998 when he was talking at the Massachusetts Institute of Technology. However, International Telecommunication Union in 2005 officially presented this term. **[2]**
The IoT was originally described and called as RFIT (radio-frequency identification technology). It was merged with the Internet which was based on the communication protocol agreement in order to accomplish administration of the information insightfully. But this idea has been broadened and deepened today.
In this technology, the Internet is utilized to connect various devices such as sensors, machines, individuals, and things to accomplish the relationship among individuals and things, things and things, individual based data, remote control and management. **[3]**
We frequently consider IoT a system of sensors and remote microcontrollers, yet this is just the physical layer of IoT. Comprehensively, the IoT is circulated registering for a huge scope. They evaluated 24 billion brilliant associated gadgets of the IoT which can gather and perform calculations on exceptional measures of information.
Experts have also stated that the IoT market was worth about $150 billion in the year 2019 and now it is expected that it is going to worth $243 billion by the year 2021. **[4]**



e: estimated; p: projected.

Fig.1: Impact of Covid-19 on IoT market.

IoT has already found its way in the healthcare sector with numerous applications in this era of coronavirus, for example, telemedicine, connected imaging, virtual monitoring of patients, connected health, connected worker, connected ambulance etc. because various life conforming benefits are being offered by IoT in healthcare which makes it an appropriate technology to put forward in difficult times like pandemic such as the recent COVID-19. "Health 4.0" was just conceivable gratitude to a few IoT applications.

Interconnecting imaging and radiology hardware or remotely screen patients is conceivable, for instance – and from that point a genuine "Health 4.0" is conceived. Freestyle's Libreview is probably the best case of this kind of 4.0 innovation. It is a product that permits access to records put into any glucometer of the brand. NFC technology is used at different levels and also the Blood glucose reader works using NFC and when the blood glucose reader is connected with the Freestyle's Libreview then, the patient simply moves towards the reader via the sensor. And, because of this the doctor can see the blood glucose at any instant. Charts are also available regarding the blood glucose level on a daily basis which gives a complete statistical data to the doctors as well as the patients.

Internet of Things can, therefore, be called an innovative and astounding technology which is providing information and monitoring several important things during the current pandemic COVID-19.

As in the contemporary difficult position, the number of infected people is getting increased daily so there is a huge need to use well sufficient, sorted out facilities. Internet of things essentially implies better dynamic and better reaction plans by providing more information. Both are indispensable in forestalling and controlling the spread of disease. Moreover, IoT has just been utilized to fulfil the asked needs in various areas.

Along with this, there are other major key roles that IoT have been playing since the beginning of novel Coronavirus are tracking the locations and movements of people using IoT based mobile tracking apps.

Aside from versatile GPS following, there are likewise other innovation use cases and examples demonstrating the more splendid part of the matter.

There are a few brilliant gadgets for home based on IoT like brilliant video entryway telephones, shrewd, careful cameras, savvy locks, keen lights, keen TVs, and savvy forced air systems (ACs) and every one of these gadgets, aside from adding to the accommodation of the mortgage holders and the residents of a premise, likewise prevent individuals from coming into direct physical contact with the other people such as milkman delivery person, newspaper delivery boy, online delivery agent, and the postman. Every one of these gadgets by being controlled by contactless voice associates, for example, Google Assistant, Alexa, and Apple Siri without much of a stretch help to prevent the infection through direct contact. Many other innovative applications are launched by various enterprises in this era of infection and will be discussed in this chapter. For example, SYOOK has launched a login-free "Social Distancing" App.

The demand for IoT is likewise increasing in the major APAC (Asia Pacific countries), such as China, India and Australia. As the COVID-19 outbreak has slowed down the economy of the countries, technological advancements will keep up the demand for IoT in major verticals like healthcare and utilities.

Apart from the applications launched, the disruption caused by COVID-19 in the economy will trigger a blast in the market of IoT.

A lot of big companies such as Infosys, Citius Tech, Tata Communications, Thought works and Hero Electronics are wagering on these right set of circumstances and a new study from JUNIPER RESEARCH has also found that the economic disruption which is caused by COVID-19 pandemic can also be overcome by the IoT market. **[5]**

Therefore, the ultimate goal of this research-based chapter is to highlight the prevalence of IoT in pandemic; various applications developed to stop and lesssen the spread of the novel Corona virus using IoT, advantages and disadvantages of the applications and other necessary findings related to IoT and healthcare.

WHAT IS IoT?

The power of the internet to collect the data using the sensing capability of devices and machines without human to the PC or human to human interconnection is called as Internet of Things.

It is a characterized plan of interdependent figuring strategies, advanced, and machine-like gadgets having the capability of conveyance of data over the system. This plan does not involve any human association at any extent.

All these examined gadgets are linked to their specific new distinctive confirmation numbers or codes. IoT is currently demonstrated development which sets about as a convergence to the countless strategies, prompt investigation, the reasoning of AI, tactile items, and so on. Additionally, IoT in every day working is perceived as the utility of the items or the machines serve the genuine prerequisites of individuals in different methods such as lighting apparatuses, indoor controllers, and other home machines that help in essential framework. **[6]**

HISTORY OF IoT

In the year 1982, the principle idea of the system of smart devices was discussed with an amended Coca-Cola vending machine at a private University in Pittsburgh- Carnegie Mellon, turning into the crucial machine related to Internet, prepared to report its stock. It also tells and notifies whether late stacked drinks were cold or not.

Mark Weiser produced the modern vision of the IoT on ubiquitous computing paper in 1991, "The Computer of the 21st Century", as well as academic venues, for example, UbiComp and PerCom. **[7]**

Reza Raji depicted the idea in IEEE Spectrum as "[moving] little bundles of information to an enormous course of action of centers, so as to fuse and automate everything from home mechanical assemblies to entire processing plants" in the year 1994.

The term “INTERNET OF THINGS” was framed by Sir Kevin Ashton in the year 1998 when he was talking at the Massachusetts Institute of Technology. However, it was officially presented by the International Telecommunication Union in 2005.

Since the conceptualization of IoT in 2005, the advancement of smart devices having sensing, communication and inciting capabilities quickened development in the previous years. Metal oxide semiconductor field-effect transistor is indeed the key driving force behind the IoT.

Sir Mohamed M. Atalla and DawonKahng invented the MOSFET in 1959 at the Bell Laboratory.

The MOSFET is the central structure square of most present-day equipments which comprises of personal computers, mobile phones, and many other organizations. MOSFET downsizing at a pace foreseen by Dennard scaling and Moore's law has been the primary purpose behind mechanical advances in the gadgets business since the late 20th century. MOSFET scaling has been connected

into the mid 21st century with propels, for instance, reducing power usage, creation of silicon-on-separator (SOI) on semiconductor gadgets and multi-focus processor advancement, preparing to the Internet of things, which is being driven by MOSFETs cutting back to nano-electronic levels with diminishing essentialness utilization. [8]

BACKGROUND OF IOT FOR COVID-19 PANDEMIC

Internet of Things (IoT) is a creative innovation which is providing data and observing framework during COVID-19 scourge.

Furthermore, it is beyond to an idea that builds up the general design foundation which eventually permits the assimilation and exchange of important information or data between the individual and organizations. In the present circumstance, the majority of the issues are emerging on the grounds that the non-successful attainability to the infected people. This is the subsequent significant issue after the worry of antibody development. [9]

The utilization of the Internet of Things makes the attainability to the infected people very useful, and eventually they are provided with care and help so that they can escape the disease or pandemic.

OPERATIONS INVOLVED IN IOT FOR COVID-19.

IoT is a creative innovative stage to battle with COVID-19 pandemic and can satisfy huge difficulties during the lockdown circumstance. This innovation is useful to catch the ongoing information and other important data of the infected individual. [10]

- In the first step, the health data of people is monitored using remote monitoring system.
- In the second step, the virtual management is done through meetings and communications.
- The third step consists of analysis and controlling of the information gathered.
- At last, the report is attained and followed.

Fig. 2 shows the noteworthy procedures utilized by IoT for COVID-19.

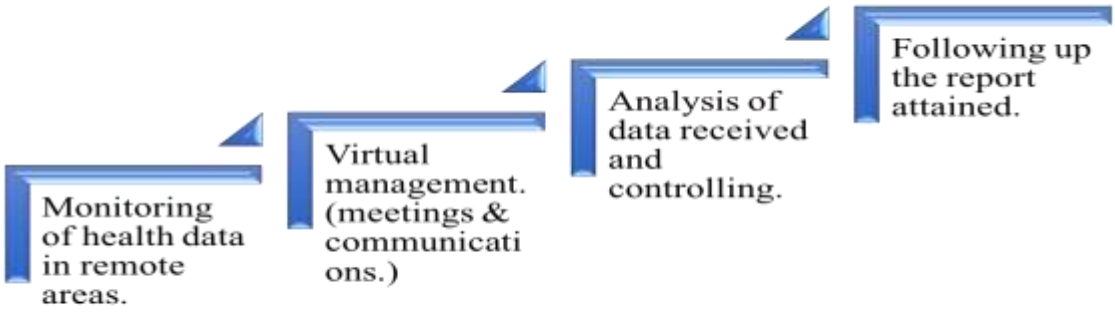


Fig.2: Processes utilized by IoT for COVID-19.

HOW IS IOT HELPING IN OVERCOMING THE DIFFICULT PHASE OF COVID-19?

1. REMOTE WORKING VIA IOT.

The standard for some organizations throughout the previous hardly any months was Remote working and will keep on being so at every possible opportunity.

Obviously, remote working is the same old thing, and it was at that point a developing pattern for a few reasons. Greater adaptability, permits organizations to save money on physical spaces, groups occupied in various areas working on specific issues and finding solutions are some of the benefits offered to us.

Indeed, even before the occurrence of the current pandemic, the IoT innovations that were of most enthusiasm to organizations are described below in the pie-chart. **[11]**

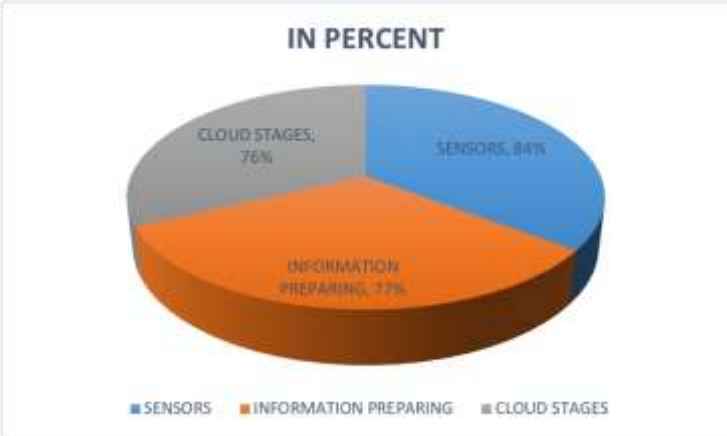


Fig.3: IoT innovations and its enthusiasm among the organizations.

Most likely it could never have been conceivable to keep frameworks operating without all the innovation we have embraced as of late: distributed computing, collective apparatuses, (for example, videoconferencing programming, venture the board, talks), remote PC access and gadget synchronisation, VPN, and portable first applications. What's more, it's actually this sort of arrangement that, as indicated by gauges, will become the most somewhere in the range of 2020 and 2021.

2. USING SMART ROBOTS BASED IN IOT FOR DELIVERING MATERIALS.

For mechanical support administrators, meeting social separation on a sequential construction system is a test. Numerous production lines should re-examine their design to fulfil all wellbeing guidelines, while others should work with diminished groups. For this not to prompt a breakdown underway, numerous organizations should depend on IoT to endure and mechanize forms.

Smart robots can be utilized, for instance, to convey important materials and food as now it is the situation to prevent infection in certain emergency clinics. A few organizations are utilizing automatons to make conveyances which are safe to be used at home. XAG and Huawei have changed over robots and automatons used to spread farming composts into disinfectant showers. **[12]**

3. CONTROLLING OF STOCK.

With the interruption of conveyance chains, control of stock was probably the greatest test for retailers and wholesalers which they faced in the lockdown period. Also, this trouble may proceed until the year's end. In any case, without a doubt, organizations that were at that point utilizing NFC marks to control stock all through distribution centres made their tasks simpler.

Furthermore, the systems based on trace and track utilized by several carrier companies have demonstrated the need to keep the online business in full activity and to deal with the deferrals in conveyances progressively.

Therefore, IoT has become an approach to offer a quicker and progressively straightforward support of the final shopper.

4. IOT AND HEALTH 4.0.

The healthcare sector has a lot to pick up from mechanical & technological advancements.

Starting today, we can discuss "telemedicine" and "intelligent medication" to go with patients who are at home or who can't make a trip to the clinic. A portion of the advances we apply in Industry 4.0 likewise have applications here. Interconnecting imaging and radiology gear or remotely screen patients is conceivable, for instance – and from that point a genuine "Health 4.0" is conceived.

There is this framework of healthcare developed in the current era using IoT and is given below: **[13]**

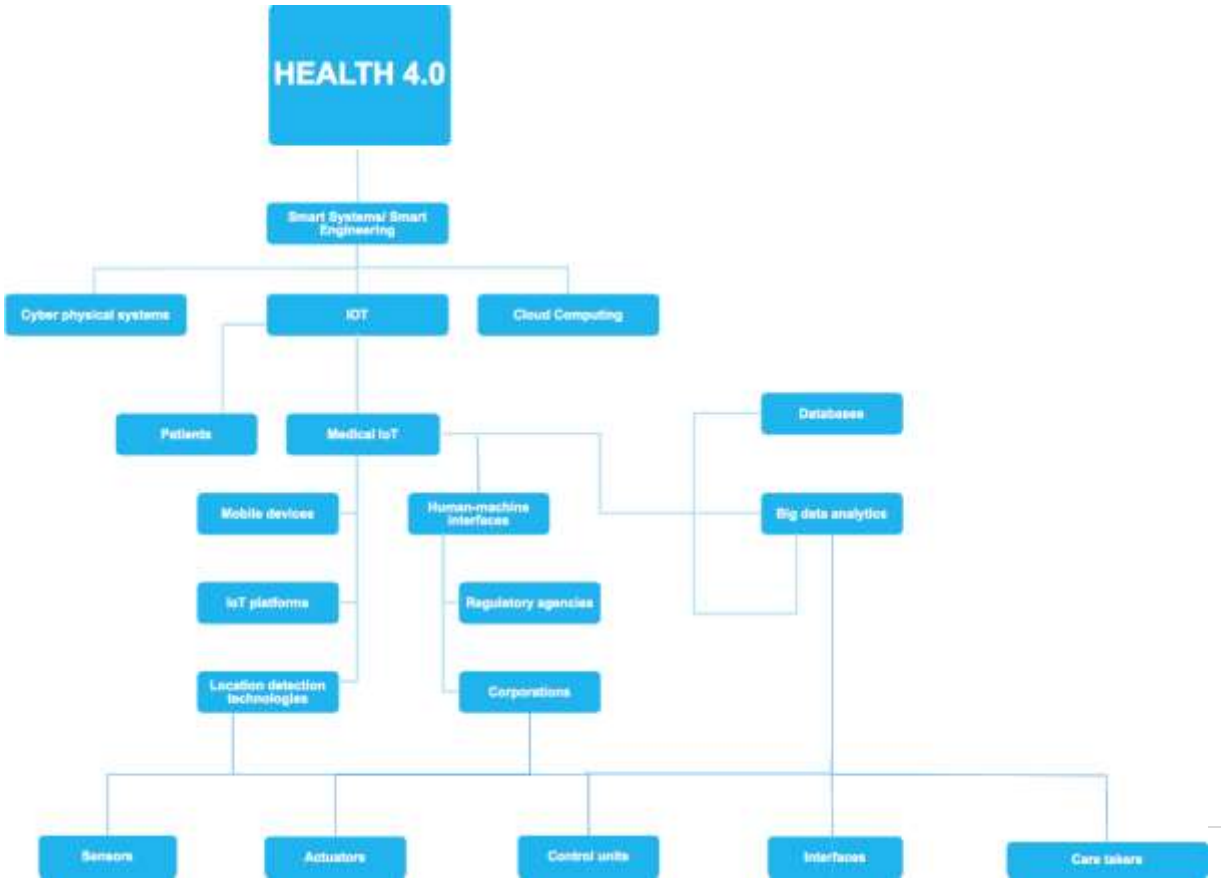


Fig.4: Healthcare framework based on IoT.

5. DIGITAL CONNECTIVITY OF HOSPITAL DURING COVID-19 PANDEMIC USING IoMT.

IoMT technique permits the Healthcare and clinical work force to use its very much associated system of administrations and offices while providing treatment to the infected. These interconnected administrations incorporate the very much organized channel of efficient advances, a computerized checking framework, smart medical care, information examination apparatuses, cloud-based processing, smart bed offices, filtering machines, and so forth and these all offices are additionally adjusted with the genuinely necessary internet based plans in particular; remote constancy, Bluetooth, modem, and so on.

VARIOUS MODELS PROPOSED FOR MANAGING A PANDEMIC USING THE INTERNET OF THINGS

In the past few years, the world has seen ascent of different viruses and diseases like SARS, ZIKA virus, EBOLA and now COVID-19.

This kind of viruses are an uprising threat which can leave all of us shattered.

Although, many cities have made a huge progress in order to safeguard their physical systems by ensuring good infrastructure so that they can stay vigorous and anti fragile during the natural disasters such as earthquakes, tsunamis, hurricanes etc.

But pandemics have shown that these methods are not enough when it comes to access our society during biological disasters.

Now as we are living in a new era of digital world, IoT can prove to be highly beneficial in keeping the pandemic under control.

The Internet of Things has seen explosive growth in some years and is making great growth in the healthcare industry as well.

Grand View Research stated that the world's largest and most trusted Business Intelligence enabled market research database-IoT market for healthcare will reach USD 534.3 billion by the year 2025.

Many researches have been done on potential of IoT in managing a pandemic. The various techniques that have been proposed are demonstrated below:

SMART DISEASE SURVEILLANCE BASED ON INTERNET OF THINGS

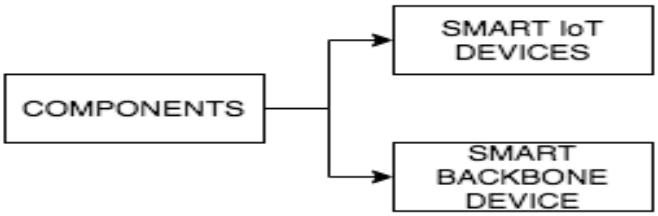
The Central health ministry needs to keep a proper check on the cases reported in order to know and be aware of the current situation during a pandemic.

For this, a proper surveillance is required for the regular collection and analysis of data. The smart disease surveillance system which is based on IoT is proposed to make disease surveillance more efficient, accurate and successful and this proposal can also help in determining and identifying the various disease trends. **[14]**

This proposal was proposed in 2015 and it is mainly for a vast network of innovative and smart devices which can naturally process and examine the information which is put into it.
Further, the devices can process the data and send it to the central health ministry. The data which is expected to be amended regarding the spreading of the disease is only sent.
As soon as the central health ministry gets the data it can further take the necessary steps to prevent the spreading of disease.
This will likewise assist the individuals to conclude about the quickly spreading disease.

SMART DISEASE SURVEILLANCE:

"Smart disease surveillance is an innovative proposal to improve and accelerate the current procedure of surveillance and furthermore making it exact at national level timely."



The components of Smart Disease Surveillance are depicted below:

The primary part of IoT is RADIO FREQUENCY IDENTIFICATION (RFID).
It can quickly recognize the moving or still entities. The primary point of IoT is to monitor the objects with the help of internet. One active RFID sensor fitted main server will be registered with the health ministry. This server is a smart IoT device which will analyse the data entered. **[15]**
The server has the following tasks:

· Gathering the trending symptoms from the information entered.

· Analysing the information and making reports out of it.

· Checking if aggregate indications can be an indication of another malady.

After gathering the data, reports are created by the smart devices and then the results are passed to the health ministry through the mode of internet.

The Central Health Ministry will henceforth get a more precise study and malady surveillance using IoT based Smart disease surveillance system.

The smart servers will continue to pass the data to the backbone which will help the Ministry in making decisions so as to prevent the upcoming disease.

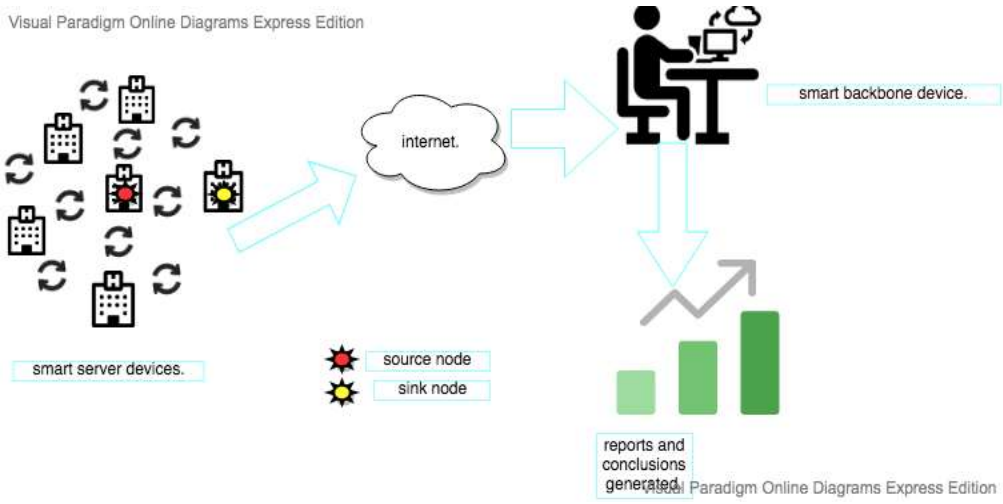


Fig.5: Conceptual view of Smart disease surveillance system.

In the network, there are different nodes formed by several smart devices

Source node: The node through which the data is being sent currently.

Sink node: The node which accepts the data and transfers into the internet is the sink node. It can also manage higher data rate and it can also pass the data timely to the internet.

If the present scenario of the country INDIA is considered then it can be concluded that a need for proficient disease surveillance system is there.

The above explained system based on IoT will be a significant advancement in the fields of science & technology.

IOT PCR FOR SPREAD DISEASE MONITORING & CONTROLLING

DENGUE, which is a mosquito borne viral disease having the potential of producing a pandemic developed as a genuine general wellbeing concern. According to WHO, the number of people getting affected has increased 30 times in the past fifty years. Various zones in Eastern and Southeast Asia, are getting influenced by this DENV. **[16]**

During such sort of virus outbreaks, specific areas are required to be screened by the disease control centres. Numerous endeavours have been done for improvement of compact, easy to use, and worthwhile frameworks for point-of-care (POC) diagnostics. This would likewise make an Internet of Things (IoT) for medicinal services by means of a worldwide system.

WHAT IS AN IoT PCR?

An internet associated simple to use PCR designed by high schoolers. PCR is a technique which is used to amplify specific parts in a DNA molecule.

The IoT system presented here is a low cost DNA replication connected to the internet. This is a compact system which weighs 170g and the physical measurements are approximately equal to 60*100*34 mm3 outfitted with Bluetooth between the android remote instrument and PCR. The researchers used it to test complementary DNA of a DENV template (MCA) which further could also be utilized for the detection of RNA.

The unit sent this information once the DENV was detected including the GPS coordinates to a centralized location through the network, consequently helping the specialists to map the spread of virus. [17]

Two basic experiments were performed; first was conducted with 4 samples mixed with contents of the cDNA of DENV. This experiment was performed to verify the PCR system while the second experiment consisted of actual field test having 3 samples and NTC. The output amplification data was displayed along with PCR unit number, time of test finish and GPS coordinates and transferred to the smartphone via Bluetooth.

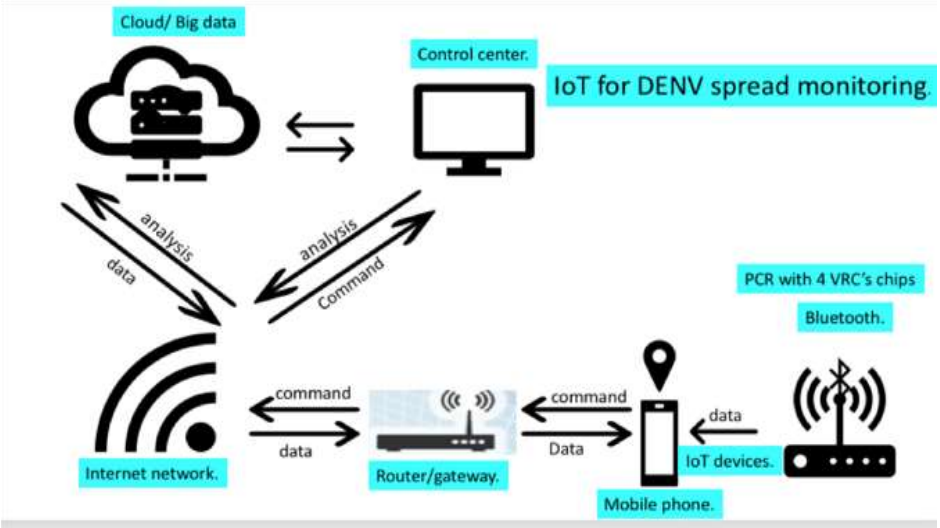


Fig.6: The conceptual diagram shown above demonstrates the integrated IoT system that is based on PCR. The results originated from the detection are uploaded automatically with the help of a Bluetooth interface to the mobile phone. With this framework, coordinates of the test spot are sent by the means of world- wide system. The outline showing spreading of disease in different zones is generated in few seconds.

Fig.7:There is this test showing the DENV in Xi'an. The red dots represent the individual cases, more cases with are in contact with each other are represented with a larger dot. The results are displayed on both inside the TFT screen and on the smart phones. So here DENV has been tested and the same framework can be applied to screen different infections, but the system has to be handled by the professionals. The system was connected through Bluetooth an can become an important block of IoT and can be used as a device to safeguard the things and to conduct early detection and diagnosis as the information gathered through the system can be used to prevent and detect pandemics.

GLOBAL TECHNOLOGICAL DEVELOPMENTS TO OVERCOME CASES OF COVID-19

Hence, to endure and make the normal individuals logically careful about the ongoing pandemic, the legislature of India has impelled an application. The application is named as – Arogya Setu which is a mobile phone app, intended to produce a relationship among the huge possible human administrations organizations and the citizens of India. Likewise, the versatile app called as – Close Contact is impelled for its customary people living in China. This app educates the app user regarding the closeness to the crown constructive person.

With the objective that an extra thought can be considered while going out. The government of United States of America is before long going to dispatch a comparative sort of portable application for its regular folks toward the finish of April 2020.

Taiwan was the most unsurprising to have progressively number of instances of COVID-19 after China. In any case, Taiwan promptly prepared and initiated crystal clear approaches for any possible COVID-19 case noticeable evidence, covering, and asset arrangement to watch the stability of the network. Taiwan incorporated its national medical coverage database with its movement office and took index to incite the production of enormous data for assessment. They have likewise utilized this most recent innovation. The innovation incorporates checking of travel history, QR code, and so on for the supposable identification of the contaminated ones. **[18]**

NOTEWORTHY APPLICATIONS OF IoT FOR COVID-19 PANDEMIC

While everyone around the globe is finding different ways to fight with the pandemic, here we take some time to discuss the prevalence of IoT technology in pandemic. The IoT is now paving way for new revenue streams by providing real time tracking of vehicles and monitoring feeds of passengers. This helps in knowing about the travel histories of the passenger and identifies if the passenger needs to be isolated or not. The two developed countries China and South Korea are as of now tracking and examining the movement of the infected patients and furthermore of the people who have been in contact with the bearers of the deadly disease. Also, many companies are using devices such as drones as another method of delivering the food supplements are other essentials to the patients. Many apps have been developed and are being developed through IoT so as to manage the pandemic remotely. **[19]**

In 2011, an app called FLUPHONE was created at Cambridge University to track where and with whom the potential flu carriers had been.

The China's ALIBABA has built up ALIPAY HEALTH CODE APP, which each citizen of china needs to introduce on their telephones. The app uses a 3 colour code to inform the user if he or she can have a free movement in public spaces or transportation. The green shows that they are allowed to do so while the yellow colour depicts limited movement and red colour shows total quarantine.

IoT research specialist Dilip Sarangan suggests that the world health organization should start pressurizing the nations to execute the use of IoT devices at the very beginning of an infectious disease outbreak before they become into a pandemic. Although, we can find that IoT applications are being used well in most of the developed and developing countries such as India in order to monitor public's health.

The governments are now finding new ways to deal with COVID-19.They are relying on different instruments such as sensors and powerful algorithms instead of flesh and blood spooks. The government is implementing these new surveillance tools based on IoT so as to fight with COVID-

19.The health specialists are motivating patients to interface with the doctors remotely via an app so that the doctors can guide them further.

An application called as MaNaDr, is helping patients in Singapore to check in with their doctors on regular basis and report them about their symptoms. Also, if their condition is getting worse the healthcare providers can call for an ambulance.

One of the smartest city; Singapore which is also called as the hub for technology and healthcare innovations, has witnessed a number of innovations based on the Internet of Things which are helping to cope up with the COVID-19 crisis. Some of them are listed below:

1. **IoT enabled Tele-Ventilator:**

A company named as ABM Respiratory Care which is a medical device company has showed their creativity and intelligence by developing an innovative ventilator which helps the healthcare specialists in monitoring the device from anyplace on the planet.

Due to the COVID-19 pandemic a problem has been highlighted regarding the shortage in number of ventilators and also there are less healthcare professionals to manage the ventilators. As the chances of spread of virus increases if the healthcare professionals check the patients manually through their frequent visits, so this ABM's Tele ventilator solves this issue by empowering the medicinal services experts to screen the patients and alter the ventilator settings through their online site from anywhere. This device enables several important characteristics which are usually required in connectivity systems such as time-valuable, sensible, consistent telemetry and enormous scale secure access without complex set-up. **[20]**

2. **Employee screening:**

One of the several companies RAMCO SYSTEMS, is exploring new methods to reduce the COVID-19 "surface area" in the environment of office.

Currently, an innovation lab in Singapore has found and developed a RamcoGEEK -facial recognition-based time and attendance system

This system consists of recording of temperature with the help of thermal imaging technology. This technology is inserted into an access control screen and IoT door. Therefore, it can restrict the people who have high temperature from entering the office. Along with this, it also sends alerts to the manager if the staff is moving with high temperature in the office. **[21]**

3. **Mitigating virus spread:**

PENSEES is an IoT company which has released a really efficient Non-contact Body Temperature Monitoring system. PENSEES has developed this system so that the spread of COVID-19 can be lessened.

As fever is the most common symptom of this virus, so becomes the most important alternative to detect the infected person.

This non-contact body temperature tracking device includes infrared thermal body temperature measuring and an intelligent FR access with n integrated temperature screening module.

It also comprises of convenient warm temperature screening framework with FR ability.

As tracking the quarantined people within the homes, offices or other places have become a challenge for the authorities, so people tracking and historic contact tracing solution based on IoT technology for manufacturing companies and IT companies is given by SenseGiz. This helps in tracing the employees if they have been in contact with another employee who was diagnosed as COVID-19 positive.

This alert helps in enforcing social distancing, prevents over-crowding and also enforces geo-fencing in some areas. **[22]**

4. **Contact tracing:**

Nodle.io launched coalition is an IoT start-up which is a contact tracing application. This app safeguards privacy of the user.

This coalition works on Nodle's Bluetooth low-energy powered network in order to communicate with the nearby devices.

As soon as one downloads the application and turns the Bluetooth on the application begins to record one's encounters with other's coalition users nearby. And to keep up the privacy these encounters are stored locally on the cell phone. **[23]**

5. **Connected thermometers:**

These thermometers are being used to screen patients by the hospital staff. This device is built up by VivaLNK's which is a California-based health start-up. This gadget utilizes IoT Access regulator by cassia to get constant information of patients from the sensors. These sensors wirelessly transmit the data for remote monitoring to the nurse's station.

SPHCC- Shanghai Public Health Clinical Centre in china is currently using the temperature sensors to monitor COVID-19 patients. There are 7 more hospitals which are using the same concept. **[22] [23]**

6. **IoT Buttons:**

IoT buttons are designed by Visionstate which are being used in hospitals of Vancouver. Instant alerts are sent by the IoT buttons to the management regarding cleanliness and maintenance issues that may post danger to the public.
This technology empowers tracking of alerts and staff response and also empowers monitoring of cleaning activities in high-traffic areas.
The IoT buttons operates on battery and are automatically connected to the network. The IoT buttons can be used in nurse's room, rest rooms, common areas etc. **[17] [18]**

A new smart device called SOAPY CARE has developed and called as "SMART SINKS", which adheres to the WHO hand hygiene guidelines and obtains real time hand washing reports for all the users.
These smaller scale stations which are somewhat water coolers use IoT sensors to apportion off the specific measure of cleanser or sanitizer that ought to be expected to wash the hands and also set the temperature of water required to wash the hands appropriately.
Soapy care's systems can be found in United states, Africa, Asia and since the COVID-19 pandemic their cell phones are not being stop ringing.

A field emergency hospital was set up in Wuhan, China during the outbreak and this hospital was staffed fundamentally with IoT robots so these IoT robots could deliver clean and sterilize meds to the patients and furthermore take their body temperature.
This whole set up helped the hospital staff to lessen the chances of spreading the virus.

Mayo Clinic in U.S.A is talking to the "producers of remote screening tools about ways to keep nearer tabs on patients with COVID-19 who do not need intensive care."
Also, to keep the non COVID patients protected and sound at home different other IoT gadgets measure "wellbeing measurements, for example: internal heat level, pulse and glucose a few times each day and are put away on the cloud with the goal that the specialists can keep a check if the readings are anomalous."
Along with collecting the data related to individual health statistics, the IoT is tracking the community level data which gives a wider view of evolution of the virus.
Such wellbeing following applications introduced on cell phones which examine the information patterns like an ascent in internal heat level in the topographical region can give pieces of information to developing groups of cases.
The "U.S HEALTH WEATHER MAP" which is raised up by the kinsa insights provides a representation of amassed information on influenza disease. Healthcare specialists can therefore use the maps in order to distinguish the topographical zones where there is an increment in disease and look as if protective precautions are being taken to slow the spread of COVID-19. **[24]**

An article named “IoT to track urban mobility changes during pandemic” was published by Matt Johnson on May 4, 2020.

This article expressed that another organization between the University of Wollongong and Meshed IoT is set up to enable the policymakers to see how individuals are responding to the changing limitations forced by the legislature as the nation is presently coming out of disengagement. **[25]**

KEY BENEFITS OF USING IOT IN COVID-19

IoT is an inventive advancement as it confirms and ensures that every single contaminated person suffering from this virus is isolate. It is useful for a legitimate checking framework to track patients during quarantine. All most at risk patients are followed efficiently using the web based system. This advancement is used for the biometric estimations like pulse, heartbeat and glucose level. **[26]**

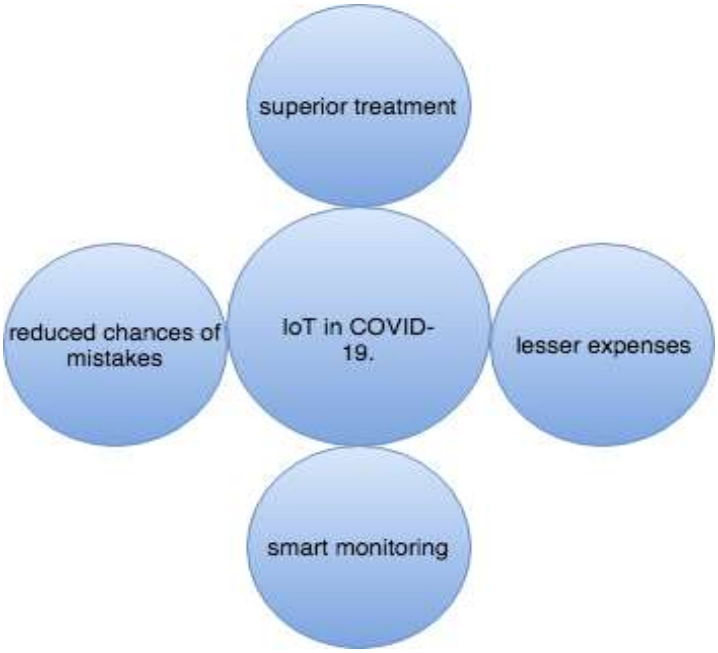


Fig.8: Key merits of IoT.

A LAST WORD ABOUT INDUSTRIAL MAINTENANCE AND IOT

Maintenance disappointments can be lethal for the individuals who are attempting to keep themselves under control. In the event that you can't hazard more personal time this year, prescient support merits your consideration. As we know, for instance, that various sensors such as temperature and acoustic estimation sensors are compelling at distinguishing issues. This permits the experts to examine the outcomes and settle on increasingly emphatic choices about the work they have to perform and with what seriousness. Another favourable position of a significant number of these prescient upkeep strategies is that, when connected to cloud-based support programming, they additionally permit reviews to be made distantly – virtual examinations – to show up at a determination without truly getting to the site. Additionally, all breakdowns and appoint undertakings can be followed by the support administrator distantly with the help of computerized maintenance management system associated with the cloud. [27]

ISSUES FACED WHILE IMPLEMENTING IOT IN COVID-19 PANDEMIC

The major concern while utilizing INTERNET OF THINGS in the on-going pandemic circumstance is majorly about the security of the data.

The sending and receiving of data should be done effectively so as to preserve its privacy. This is important and basic from the perspective of wellbeing. The other major point is about the thought to be taken while organizing the data from the devices connected to the network.

The figure given below portrays the summarized point of view on issues and difficulties in actualizing IoT for COVID-19 pandemic. [28]

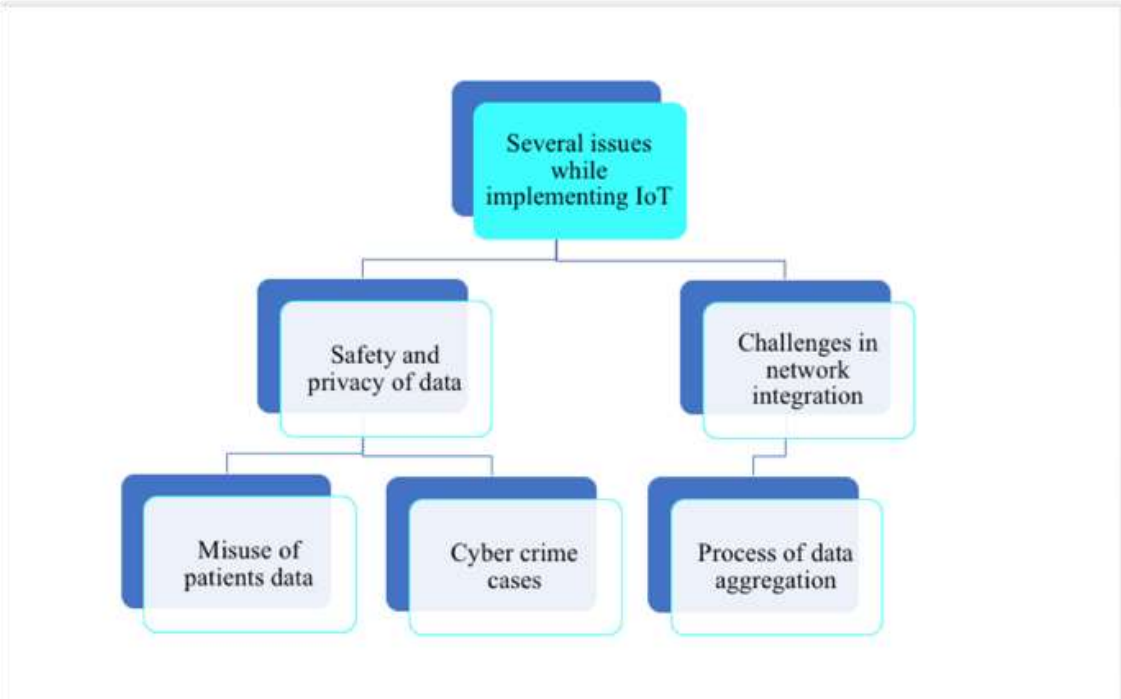


Fig.9: Issues in implementing IoT.

RESULTS & DISCUSSIONS

"IoT has consistently existed as a computerization device yet this interruption has upgraded selection of IoT simply as it accomplished for collective virtual gathering stages".

The quick move to remote working game plans has additionally observed the ascent of internet of things (IoT) associated gadgets all the more conspicuously not long previously, and in the repercussions of, the current pandemic.

A prolonged time period wherein "social distancing" transforms into the standard will achieve increasingly imperative reliance of mechanized arrangements in a scope of businesses. On the other hand, many restrictions are imposed in the countries which also include movement restrictions. The offices are shut and people are getting used to the term called as "Work from Home".

In such kind of scenario, the time frame for a return to the normal living which includes office-working is highly uncertain. By and by, the governments and organizations are thinking of returning to the normality. They will consider measures to prevent the spread of COVID-19. The move from biometric that is finger-or thumb-based staff support/get the opportunity to control systems to those

subjected to touch-less advances, for instance, facial acknowledgment based on IoT is one of the potential examples we may observe. **[29]**

Obviously, the impact of IoT on the COVID-19 pandemic has quite recently begun and is most likely to go up in coming months. While much is up 'til now dark on how this condition will spread out, clearly advancement is all around arranged to help attempts, governments and society take on the risk. In any case, what is critical to note for both the venture and purchaser is that IoT isn't just about interfacing gadgets, it is tied in with utilizing and breaking down the information these gadgets gather to accomplish a result. **[30]**

CONCLUSION

The problematic situation of COVID-19 which we are facing now-a-days is not totally prevented but restricted to least harm using the technology, INTERNET OF THINGS.

We all know that gathering of data from all the corners of the world is essential in limiting the devastating impact of this and future pandemics.

The more we gather data, the more we become efficient at handling such pandemics. Internet of things does this gathering of data through its interconnected devices through which a report is created on daily basis about what is happening around the world.

It is also essential that those who are connected with these devices make their data available to the researchers. The government and businesses who are managing unconnected devices should also be aware that in this modern world, connecting devices remotely and analysing data generated in safe environment is necessary so as to protect the most vulnerable in the society.

The situation which we are in now-a-days would not have been the same without the fruitful innovations made using the IoT technology.

With legitimate execution of this innovative technology, we can make a more secure condition to battle with pandemics.

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