Intelligent Healthcare System for Recuperation and Inoculation of Communicable Diseases

Sarika Jay\textsuperscript{1}, B V A N S S Prabhakar Rao\textsuperscript{1,*}

\textsuperscript{1}School of Computer Science and Engineering, Vellore Institute of Technology, Chennai

\textsuperscript{*}prabhakarrao@vit.ac.in

Abstract. Human life gets interrupted a lot when a communicable disease starts in a society. People are alerted a lot on a different basis and eventually, it leads to difficulty for continuing their normal life. This paper is focused on a communicable disease, the COVID-19, which gave an outbreak for all world counties into a state where their fellow human had to stop their daily job and stay back at home. Common people find it difficult to get treatment when they are identified as positive and also most of them lack the awareness of post covid recovery. The idea of this work is to create a healthcare system that initiates right from the covid test, appropriate treatment according to severity, post-recovery, and vaccination awareness and jabs. These units will have less human interaction and they will be fully automated till in need of pure doctor consultation. The automated system is programmed to identify the infection, its severity and prescribe the treatment accordingly, and follow up recovery needs. On-side, automated vaccination system will allow direct walk-in, identify the customer and do the needful.

1. Introduction

Communicable diseases are caused by infections that arise from various sources. And the same becomes contagious when it spreads from the infected source to another person through their discharge, body contacts directly. Common such diseases we are familiar with are Flu, Hepatitis, Measles, Rabies, HIV-AIDS, Zika. Historical research works have given advanced level vaccinations for the same and more effective curable methods have been found. Listed out in Table.1 are some of the commonly known communicable diseases.

| Disease       | Cause                      | Vaccine                  |
|---------------|----------------------------|--------------------------|
| Polio         | Feces contact              | IPV or OPV               |
| Flu           | Cough, Sneeze              | Flu vaccines like Afluria, Influvirin |
| Hepatitis A   | Contaminated water and food| Vaccines like Havrix     |
| Hepatitis B   | Body fluids                | Vaccines like Eradrix-B  |
| Rubella       | Cough, Sneeze              | MMR vaccine              |
| Whooping cough| Cough, Sneeze              | DTap vaccine             |
| Chicken Pox   | Body contact               | Varicella                |
| Zika          | Mosquito Bite              | ZIIV                      |
| HIV-AIDS      | Body contact               | -                        |

Table 1. Common communicable diseases
Many research works are still working on as these diseases still come up in society. But it has become easier for the healthcare organization to manage the disease and the spread of the same has been under control after various vaccine developments. People are aware of the disease by generations and have good awareness on the same. The upcoming generation is well vaccinated for many such diseases and provided with boosters. Many contagious diseases have been caused on a small scale widespread in many countries. The pandemic spread has started in the A.D era like the Justinian plague that had spread through Palestine. Leprosy started in the 11th century and grew into a pandemic during the Middle Ages in Europe. In 1665 was the great plague of London wiped off around 20% of the country’s population. The one that hit the world before COVID was SARS that broke out in 2003 that started with bats, passing to humans.

This work focuses on the current pandemic situation causing virus; COVID-19 - Coronavirus Disease 2019 is known to be a contagious disease which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). As per the WHO records, the first case was reported in Wuhan, China in December 2019. This has widespread all over the world, leading to an ongoing pandemic. Common symptoms begin to exhibit from one to fourteen days like cough, fever, cold, loss of smell and taste. Some people who were infected have not shown any noticeable symptoms, and some exhibited mild to moderate symptoms while others experienced severe. Studies have shown that older people are having high risk. Initially, during the widespread, the symptoms were similar to allergies and cold which the common people took carelessly. So, the comparison between these was given to the public so that they know what they are suffering from. Such an example is shown in the below table.2.

| TABLE 2. Major symptoms of COVID-19 in comparison |
|-----------------------------------------------|
| SYMPTOMS | ALLERGIES | COLD | FLU | COVID-19 |
| Body ache | Yes | Yes | Sometimes |
| Chills | Rarely | Yes | Yes |
| Dry cough | Yes | Yes | Yes |
| Fatigue | Sometimes | Yes | Yes | Yes |
| Fever | Rarely | Yes | Yes |
| Headache | Yes | Rarely | Yes | Sometimes |
| Itchy eyes | Yes | Yes | Yes |
| Loss of taste/smell | Sometimes | Rarely | Sometimes | Yes |
| Nasal Congestion | Yes | Yes | Rarely |
| Nausea/vomiting/Diarrhea | Sometimes | Sometimes | Sometimes |
| Runny nose | Yes | Yes | Rarely |
| Sneezing | Yes | Yes | Yes |
| Sore Throat | Sometimes | Yes | Sometimes |
| Breath shortness | Sometimes | Rarely | Yes | Yes |

‘Long COVID’ happens when patients after recovery from the disease experience wide effects for months and also result in multi-organ failures. This has led to many death cases around the world depending on their age and their immunity level. Some of the population survived but major life decline has happened as we can learn from the figure. Research works are still following up with the combination of many new technologies to study the different human cell behavior to the variants of the covid virus. The standard testing method is by detecting the nucleic acid of the virus using real-time transcription-polymerase chain reaction (RT-PCR), transcription-mediated amplification (TMA), or by reverse transcription loop-mediated isothermal amplification (RT-LAMP) from a nasopharyngeal swab.

People are advised to follow social distancing, quarantining, covering cough and sneezes, handwashing, wearing masks. Several drugs have been invented by different countries and accepted by WHO, but primary treatment remains symptomatic. As this virus caused a world pandemic, we can say that the vaccination development for this was done in a faster phase than in the usual vaccination development style. And regardless of the environmental condition, some had major side effects and some didn’t show up their potential during phase trials.
The primary diagnosis [26] is based on the exhibited symptoms by the patients and the same is confirmed by the standard tests. Past infection is detected by the presence of antibodies produced by the body in response to the infection. WHO released several testing protocols, concerning that many countries have developed different serological tests also. CT-Scan of the chest has played a major role in detecting COVID-19 pneumonia. The scan looks similar to the infection of adenovirus. So, the scan along RT-PCR test confirms that the patient is positive for the virus. The pathology departments have found infection affected to lungs, Blood vessels, Heart, Liver, Nose, Brain, Kidney, and Spleen.

Major preventive measures followed worldwide are staying at home, wearing a mask in public, avoiding crowded places, maintaining distance from each other indoor space ventilation, avoiding the unwanted touch of nose and eyes, handwashing frequently, and getting vaccinated. The first vaccine was accepted for the emergency use authorization (EUA) which intended to provide immunity against this virus. Several phases of trials have been experimented with. 20 vaccines are authorized by at least one national regulatory authority for public use: 1 DNA vaccine, 2 RNA vaccines, 9 conventional inactivated vaccines, 5 viral vector vaccines, 5 protein subunit vaccines. Currently, there are 330 vaccines under development, which are in different phases. With the development of COVID-related vaccines, we came to know that these vaccines were developed in a fast mode when compared to the traditional vaccine development mode as shown in table 3.

| Table 3. Vaccination Development stages |
|----------------------------------------|
| **VACCINATION DEVELOPMENT**            |
| **PROCESS** | **TRADITIONAL PERIOD** | **ACCELERATED PERIOD** |
| Discovery  | 1-5 years               | Preexists               |
| Preclinical | 2-4 years               | 2 months                |
| Phase 1    | 1-2 years               | 3 months                |
| Phase 2    | 2 years                 | 3 months                |
| Phase 3    | 2-3 years               | 3 months                |
| Review     | 1 year                  | 1 month                 |

The pandemic stages have paved the way for many types of research in different fields like IoT, Robotics, healthcare, digital business, Artificial Intelligence, Educational sectors, Transportation, etc. Major Developments have happened and are still happening with further research works. People are getting customized to the new normal life and this pandemic has made them ready to survive and achieve everything with the snap of their fingers.
2. Related Works

Research works included those which were based on the COVID-19 virus-like how they react, image classification, gene identification, and some of them were based on the situation in the pandemic like post-recovery, vaccination inventions, surveys. The utilization of Unmanned Aerial Vehicles, (UAVs), drones, Artificial Intelligence, Blockchain, 5G, IoT in this pandemic situation was surveyed [1]. To the confirmed positive reports, much false news, information, and reports are generated daily which affected daily human life and also the world economy. This paper focus on this impact and how the mentioned technology will guide to overcome the effects of the pandemic that had a timeline as depicted in figure 2.

![Figure 2 COVID timeline](image)

The research focused on listing out the sectors which were economically impacted as listed in Table 4. We can infer that those sectors where the economy is having major input have been affected drastically like sectors of oil, construction. Sectors like tourism, education, automotive, aviation have hit bottom as people restrained them from traveling to places and their workplaces.

| Sector       | Determinant condition                                          |
|--------------|----------------------------------------------------------------|
| Oil          | Price drop, demand and supply variation, Restricted travel     |
| Construction | Labor shortage, Real estate drop, Financial crisis             |
| Food         | Protocol, demand and supply variation, supply chain variation  |
| Health       | Overload, high risk environment, resource shortage             |
| Telecommunications | High traffic, Reduced workforce, Network reliability   |
| Tourism      | Low ITR, Lack of customer’s trust, High rates                  |
| Automotive   | Sales low, Plant shut down, Stock price drops                  |
| Aviation     | High rates, Low revenue, high debt                            |

Many technologies, as well as new inventions, have been made to compact with the pandemic and help the common people to continue their normal life. Major research works happened in how to manage the healthcare situation. Smart devices (Figure 17) that humans wear for their daily purpose can be modified for health purposes and thus that can be used for communication through the internet from source to end like to health centers to know about the status of the patient who wears it and corresponding updates can be submitted. The flow of the same is depicted in the below figure 3.
Even though it’s easy to say that we can implement all these devices into normal life, there have been studies on the disadvantages and environmental impact while implementing the same into the world system. A possible solution for some of the challenges has been mentioned but the majority of them need high computational costs.

**Table 5. Challenges during technology implementation**

| Technology | Challenges |
|------------|------------|
| Bluetooth  | Pass through walls which will cause unnecessary flagging with unknown contact. Contradicts with social distancing norms. Functionality differs with Bluetooth chip sets. Centralized database raises privacy concerns. |
| GPS        | Extreme low precision makes to rule out GPS for contact tracing apps. High privacy issue as any person can track user's absolute location |

For every implementation, we do face challenges(Table.5), and methods are driven to tackle the same. While combining the listed technologies into a whole system it will be useful for all organizations to make faster transactions and ease the common life.

We are in the generation where people spend half of their time on mobile phones. Initially, during the pandemic, many mobile apps were released which eased people to know about the current situation. Research works based on mobile apps [2] reviewed the current information systems and resulted in
what should be improved more in the utility of the pastis work can be extended more implementing an app for an Intelligent health unit in future(Figure.4). When a patient is tested positive for the virus, further treatment tests include chest CT scans, ECG which are mainly completed while the patient is admitted to ICU to self-quarantine and to maintain the health unit management easier. Continuous health monitoring is required for an ICU patient which leads to developing an IoT-based system for the same mentioned purpose [3],[4],[8]. Integration of unobtrusive and wearable sensors to the ICU patients and the same implemented for real deployment in the Brazilian health unit. When we develop a system for a unit, we need to know the start and end of the system and which leads to developing a use case similar to figure.5. This method can be utilized for developing a whole automated health care unit.

Figure 5 Hospital Use-case diagram

When a patient is tested positive for the virus, further treatment tests include chest CT scans, ECG which are mainly completed while the patient is admitted to ICU to self-quarantine and to maintain the health unit management easier. Continuous health monitoring is required for an ICU patient which leads to developing an IoT-based system for the same mentioned purpose [3],[4],[8]. Integration of unobtrusive and wearable sensors to the ICU patients and the same implemented for real deployment in the Brazilian health unit. This research work can be utilized majorly for this paperwork and can be extended to other units including ICU. This setup is depicted in the below diagram of figure.6 where cloud infrastructure is used to deploy the hospital-related data, maintain the AI module as well as hospital module. The patient’s data and status are the primary details for the system along with the hospital details of staff, instrumentation, etc.

Figure 6 IoT based ICU unit

The uncontrollable spreading of this virus has made the same cross from country to country within which government itself was not able to control at the initial stage and leading to stay-at-home principle and releasing rules like to avoid crowded areas. The mentioned IoT can be used to trace the contacts of the virus which will help to mitigate the source person and further widespread from the same person can be avoided [5]. This model can be utilized for the organization to trace the source and quarantine the whole unit and half of the social spreading can be shut down. The new incoming source of the virus can be found and the tracing can be done backward also as shown in figure.7.
In general, many research works had led to the awakening of the IoT during this pandemic. Works include identifying this technology’s contribution and its evolution and the difficulties faced at the implementation time [15]. This work can be developed for sensor-based intelligent health units which will help in managing the pandemic and to make normal life easier.

The most common preventive measure is social distancing which was accepted by WHO. But people in their busy lives fail to maintain social distancing and gather at crowded places. A robot that helps in surveillance on social distance monitoring [7]. This is developed by mounting cameras and 3D light detection and ranging sensor on the robots’ legs. Using a crowd routing algorithm will promote social distancing which will help people to align accordingly. A general go-through of how IoT-based systems can be implemented during a pandemic is shown in figure 8.

A tremendous amount of data is being collected from the past two years which is related to the pandemic that helps for research which leads to data classification and analysis of the same into different sectors. With all these technologies, WHO has mentioned that COVID-19 would have spread in even more velocity and could not have been able to control. Data plays a major role during this pandemic. Each country’s data related to covid-19 helps the research work a lot and those data falls under the big data category. Analysis of the same requires models and good computation. The Flow is depicted in figure 9 as discussed.
The LeGO-LOAM mapping system shows each corner and crosses off a place and draws a direction in which the robot can travel across to sense COVID protocol. The patrol flow is chosen in such a way that there is a higher chance for crowd gathering. Robotics research has been increased to fight COVID-19 and modeled for future pandemics.[7]. Similar research to map the human density was deployed using a Toyota Human support robot (HSR) which is equipped with autonomous navigation, RGBD sensors for vision, and Lidar. The developed framework gets the 3D human joint technique for tracking and modeling using Gaussian distribution. Grid-based mapping allows identifying the human density.

Based on the map, the robot (Figure 10) initiates the social distance and the spot sterilization is conducted by the cleaning robot(Figure.16). The research has shown good results among the crowd gathering and was effective. The same can be further developed for more situations like in hospitals that need more focus on sterilization. While listing out the diagnosis method for COVID-19, the most accepted test was nasopharyngeal swab sampling. The sample is collected from the human nose deep inside and the swab test is conducted to know the presence of the virus in the respiratory system path. While taking the sample, the agent who conducts the test has to go close to the patient which is a risk of receiving the virus. This can be achieved by Intelligent robot assistance [9][10] which further development can assist in imaging assessment also [12][31]. The robotics process for collecting the swab is shown in figure.11. In general, when a swab test is taken, human reacts when they feel uncomfortable while collecting the sample from the nose. As a robot, it should detect the resistance also and act accordingly.
Experimental results were based on the performance of force sensors of the robot and swab sampling procedures were experimented on the animals. The implementation of the robots in different scenarios has many advantages and disadvantages during this pandemic. Departments of COVID screening, diagnosis, disinfection, surgery, logistics, health care units, and interpersonal problems during this lockdown and pandemic. With the study as guidance, a new robotic initiative can be developed and make the pandemic life easier. As discussed, humans get to know much information through their mobile phones that will be either through an application or social media apps. People do share their experiences through social pages and thus situational information can be acquired. A study conducted on the same lead to characterize the propagation of the information.

People discuss the situation when there is news or new rules implemented or any other upcoming trends fall. People post their opinions, situations, and also issues faced during the pandemic [22] (Figure.12). Classifying the above-mentioned information helps to attain which is original and which is fake and the source can be understood easier. The attitude of the public can be understood and appropriate measures can be taken and also can awake from the crisis. When people started to follow lockdown, the majority of the population stayed back at home. This led to avail food from outside when they craved for hotel cuisines and those who were unable to cook for themselves. Instead of using delivery persons in the pandemic to avoid the spread of the disease, robots were initialized and drive in through units also has robots to receive the request, process, and deliver it to the driver customer [11] and trained robots for catering business purpose research work was also done [17]. A usual flow of the same is sketched in the below figure 13. This can be further implemented in the normal life pattern also which will ease the human job and interpretation. Challenges included the economy and design issues and also foot traffic in stores and also germ transmission occurs if a customer comes in contact with the hardware pieces of equipment.
Other than health units, one of the major fields that moved extremely forward is the education sector. Students right from age 5 have started attending classes online and the popularity of the online courses and certification have increased tremendously [14]. Evaluation of the same on how people intake these e-learning methods and their health impact has been a research topic and which will lead in more opening to the opportunities. A survey was conducted among the students who were adopting e-learning methods during this pandemic(Figure.14) like studying new courses through online mode or completing University studies. Students preferred e-learning rather than commuting to the study centers. Results show that because of e-learning there has been a great reduction in paper production and thus impacting the forest. Travelling and commutation of the students have reduced which led to reduced emission of Carbon Dioxide. Major disadvantages are those regarding mental health, social life, and physical health.

In general, IoT can compact this pandemic and also in future mainly in three concepts, initially for tracking the widespread and tracing the source, monitoring a patient with positive body wearable devices, Digital twins like PDT [16]. This stated work will include all new technologies like AI, IoT, Robotics, Blockchain which will lead to ease in managing the pandemic. All together we can summarize that IoT provides many solutions for such pandemics.[23] As we discuss all these robots and devices that come in contact with the human body as shown in the figure.15, it's indeed important to think about whether the contact point does not cause any skin trouble and sensory issues for humans and the intelligent agent respectively.
Many inventions regarding the robot skin and based on that research have been developed to ease contact usage. Robot skin is one of the most important features of this intelligent system from which many sensors are in build and help to collect the data from the target. Rigid components and films are most commonly used for this purpose but this does not give a complete human interface. One of the works developed for advanced skin is by composing a carbon black polyurethane sponge sensor unit and enhanced with further geometric structures. This resulted in excellent movement stability and flawless response and ensured long-term perception. The system is accomplished of cucurbit uril-loaded polyurethane sponge arrays acting as sensors [18]. Human prefers when the opposite agent behaves in the way they understand and prefer the same texture and language and it will affect to show their attitude socially and personally and also when attached to their body it works according to their need without creating any discomfort [20],[24].

It is in need to ensure that while in contact, the human feels smooth and safe to interact ensuring that the rays or the touch won’t cause harm for them. So, the designing features will include skin softness, instant response, and stiffness that’s not constant. The research on Coboskin [19], a collaborative robot skin was based on the mentioned qualities and expectations. While talking about stiffness, it is based on the air pressure variation in the robot skin.

As we understand that even a robot skin is crucial for a whole system, development work based on the robot-human interaction should be in such a way that the system identifies the human and to be a real personal assistant. One of such works that can be implemented to assist the post-pandemic life care is of Lio [28] and also collaborating with body parts if needed [20], that has personal care assistant tasks that help within staffs and patients also [25]. Researchers can access the raw data from this robot through its ROS setup and that can help in further examination of the situation faced. As a robot, navigation, and mapping are also important which is fully accomplished in this model and with the main factor of battery life that withstands up to 8 hours. Ensuring ISO13482, with all safety measures for real-time deployment can understand that robots can be used in the healthcare system [29],[30] and
many entrepreneurship ideas are encouraged especially during this pandemic to tackle the virus and its spread.

Humans also expect the robot to understand their emotions when they react to the news, like when WHO releases COVID-19 guidelines protocol [21]. This work can be extended for understanding human emotions [27] and how they feel during the positive period when they are diagnosed and while they are in the recovery stage. People also seek help and assistant to manage their life in pandemics and also post covid recovery phase(Figure.17). Incorporating the discussed research works can be added with the existing technologies and managing protocol to introduce a whole healthcare system that’s fully automated till the core and reducing the human interaction which will ease in the healthcare day to day life and enabling a better and healthier all together environment.

Chest CT scan images help to identify the severity of the infection and assessment of the same helps to identify pneumonia caused by the COVID-19 virus. Deep learning models have gained more accuracy and efficiency in CT images assessments. Based on the mask generated on the CT images by the model’s classification is completed and further assessment of the severity is rated. Multi-class classification has helped the research model to perform better than the previous models[32]. All these images related research works show the importance of the same in the pandemic. So, imaging detection and management have a very important role in the health sector. Methods such as Computed Tomography, Magnetic Resonance Imaging(MRI), Positron Emission Tomography -CT, ultrasound of Lungs are widely used during COVID -19 diagnosis. These methods urge to improve their quality inaccuracy as well as performance.

Machine learning models such as Support Vector Machine (SVM), Logistic Regression(LR), Decision Tree (DT) are used to analyze the social media messages to know the human mentality towards the pandemic. Social Media comments are extracted and these models are applied to them for the classification of comments. This results in understanding what are the key issues faced and discussed by the common people during the pandemic and what they look forward to [33]. Research work to understand the difficulties faced by people during the pandemic, which is also a sentiment analysis approach helps in identifying the emotion and knowing the situation better[39].

Due to the protocols and restrictions like stay at home and social distancing, people refrain from visiting any places like shops, hospitals, etc. They rely mostly on the internet to know the facts, to get deliveries, to book an appointment, etc. Many chatbots are developed in general to assist the work but research happens on chatbots that are specialized to handle COVID-19 related issues[34]. This character-based chatbot helps in giving the true information that is verified from the sources and helps the customer with their queries. This was also deployed among the participants and good feedback was achieved. Such chatbots with further development can be implemented for the post-pandemic recovery phase assistance, vaccination booking, and also during the home quarantine treatment phase.

As per the WHO norms, wearing a facemask is one of the efficient ways to reduce the spread of the contagious virus. But, if the facemask is not worn correctly, it will not help to achieve the goal, instead, it will initiate more spread. So, monitoring of the same is required in public places and an
algorithm for the same is developed[35]. This idea falls under the object detection algorithm in which deep learning models show higher performance in feature extraction. Many models are undergoing research for the same and overall results show which model performs better in different scenarios depending on the crowd density and situation. Along with proper wearing of a mask, one important protocol is social distancing. Before stepping out from their dwell place, they prefer to know if the destination is a crowded place or not and also if it is safe to visit the same. Mobile tracker apps which provide such information with the help of Wi-Fi and Bluetooth are of good use along with the patent tracing. This eventually helps to know who had come in contact with the infected patients [36].

Discussion regarding IoT-based works related to pandemics was mostly based on how to deploy the technologies in the sectors that handle the pandemic cases. Behind work of the same like Privacy and security is also prone for the research work[37]. All the devices should be secured and never compromise on any risk. Research work has been classified into five components: Key management and cryptography solutions, Privacy-preserving solutions, control access and authentication, blockchain, and intrusion detection. Monitoring patient health during a pandemic is a very important task ensuring the patient and the treating worker are not at high risk. So, predicting the disease based on the symptoms remotely is a major work that helps to tackle the situation. The intelligent model proposed[38] Health symptoms are monitored continuously and the model predicts the disease and their further results based on. Forecasting of symptoms is executed and the pattern is classified using the k-means algorithm.

3. Proposed Work

The whole idea of this Intelligent healthcare unit is to avoid human interaction and give the customer a true experience of a human-human interaction and give a healthier fulfilment. The System flow starts 1) when a customer enters the system to identify whether he has been infected with a virus or not. The first intelligent system will be fed with whole possibilities and the result will be based on the symptoms entered by the customer.2) If he tests positive, based on factors such as age, health history, severe symptoms, the patient will be directed towards the prescribed diagnosis by the Intelligent system.3) Examining the diagnosis results, a final decision will be made with a human-Expert system interaction.4) Mobile application developed especially for this helps the patient to track the next visit to the unit and analyze self.5) When the patient recovers from the infection, they can use this app to find new life methods, new habit development, and also interactive sessions to come out of their pandemic state.6) Customers can also visit to get the vaccination slots. The initial process will happen through the mobile app and book their slot when its peak hours and flow/Else it will be shown as walk-in available. The person can show their valid ID card to the system. After validating basic health details, they will give the jabs and be notified for further shots and also 24*7 helpline if any symptoms after the shots.7) In general, a virtual personal assistant in the app will be available all clock around and basic patient queries will be answered.

The architecture shown in figure.18 is a gist of the system explained above. The human-human interface will happen when the patient is with serious illness and is really in need of personal assistance. Patients have the full right to ask for the same. A face recognition model is developed for the initial verification process. The customer who enters the center should initially present their valid ID card and the system cross-verify the photo from the ID and the customer's face. Once the customer is properly identified, the screen pops up for basic details entry like First Name, Last name, Communication address, and phone number. The system stores the basic details of each customer who enters the center. The customer is asked to download the health center app and log in accordingly with the needful information like phone number and name. With the initial screening, the system prompts with symptoms entry where customer can enter their symptoms. Based on the entry, the model classifies if the person is prone to virus infection or not. If the person is identified as positive, He is
subjected to a confirmation test like RT-PCR. They can give their sample and go back home. Once the result arrives, it is informed via app to person.

If the test results are positive, he is subjected to come to the hospital and do the diagnosis test prescribed which will be the information shared by the center through an app (Figure.19). So, the patient can come directly to the testing center and conduct the test. The diagnosis method is purely based on a machine learning algorithm which is identified based on the symptoms. If the customer feels even more complicated, he is free to ask for a human interpretation for further proceeding with the treatment. Diagnosis methods like scanning, maple collection will be complied by robotics method under the human eye. If the person is having severe symptoms like high fever, breathing trouble, they will be moved directly to the emergency unit under human interpretation. Once the diagnosis result arrives, the customer will be suggested to do the needful accordingly like to do home quarantine and consume prescribed medicines or getting admitted to the center.

If a person gets admitted to the center, the patient will have 24*7 human surveillance along with robotics and intelligent system accompanied. This reduces the visit of health workers to the patient and maintains the system properly. The whole system will be kept on sterilizing and also ensuring that patients are not infected through any means. If the initial model result is negative, and if the customer feels any trouble or some other health problem, he is directed to a doctor for further consultation as the
model derives the result based on the entered symptoms and its training. Patients under home quarantine will be in frequent contact through the app with the help of a virtual assistant. It will assist in giving medication and analyzing the symptoms' seriousness level. The patient should be polite and cooperate through the mobile app communication and if they need, they can contact the doctor through the app also.

Once a patient recovers from the virus, the app will help them to recover by giving exercise tips, home assistance like in delivery, and suggesting nearby places for purchases. This assistance is common for all app users and along with this vaccination slot booking is enabled. Many apps exist for vaccination slot booking and people spend half of their time entering a one-time password, this can be minimalized by face recognition methods or fingerprint sensors. The person can check whether a slot is available or a direct walk-in. As discussed, the goal is to reduce maximum human interaction, and overall, behind all intelligent systems, a human is present to monitor if any fault occurs or in-person help is required. But all general works including identifying the person, lab experiments, basic consultation will be initiated by different computer program models and robotic systems. The novelty of the proposed system lies one how the existing manual work system gets automated and only manual work by a human is to monitor the automated system. A large time and human work can be gained and protect from further spreading of the disease as social distancing and contact is highly reduced in this case. Higher productivity and high efficiency of this Intelligent system will reflect a lot in the economy.

4. Results

The result of this system is for a hassle-free health organization visit for a person and the majority of the citizens prefer all these new technology interventions as it eases their job. The majority of the intelligent systems give out the best accuracy and valid results(figure.20,21). But in some cases, it may give fault results when there is a lack of base data for a particular unit like automated swab test, ICU related decisions. So, it’s in need to endure that the results are cross-checked and verified by a medical expert till a certain stage where the accuracy is achieved to a higher rate and the prediction result is to the mark.

![Figure 20 COVID detection using CNN algorithm](image)
Figure 21 Accuracy for symptom classification

Discussing the vaccination unit, proper interrogation is required as a thorough background check is required. Because in future, the shot should not lead to severe health problems related to this organization will serve all basic requirement like getting a doctor appointment, purchase medicines, seek mental health support, find a companion, etc, in general, those utilities that people always rely on the phone. Implementing this system on a small scale will create a huge impact on people and health workers as it will be easy for them to manage a lot. Consider the current situation to get a vaccination shot. A health worker collects the information about the customer and enters the details to the Government website and waits for their approval. Afterward, they are proceeded to a token system and have to wait for their turn. Initially, people had to look for a slot and see which is available, for each check one-time password is generated and slot booking also happens in a hassle.

Compared to this new system, once a patient or a customer register in the health organization app, they can do facial recognition and enter the system, slot booking will be done by the intelligent system and the intimation will be given for confirmation to the customer. This allows them a hassle-free visit to the organization. Once they visit on the specified date, the system can verify them with the authorized ID card and proceed with them for the shot. In general, social distancing protocols and a huge amount of time are saved. Human interpretation is less and their working time is also reduced a lot and focuses more on monitoring the models and intelligent systems.

5. Conclusion

The pandemic has led to the so-called “New normal life“ and we all are slowly getting adapted to all new technologies revolving around us. People right from age 5 depends on the internet for education, purchases, job, transactions, etc. which had led to a stage where they cannot live without internet and mobile devices. In such a state, the majority of them get used to a system where they look for less human interaction and fewer outwork situations and try to do all chores from their home. This health organization is idealized in such a way that it meets all human expectations and achieving the same through an intelligent and automated process, human friendly. In the future, more implementation and facilities can be added according to the need of the common person and with the situation. A similar concept can be indulged for other communicable diseases also.

References

[1] Chamola, Vinay, et al. "A comprehensive review of the COVID-19 pandemic and the role of IoT, drones, AI, blockchain, and 5G in managing its impact." Ieee access 8 (2020): 90225-90265.

[2] Islam, Muhammad Nazrul, et al. "A review on the mobile applications developed for COVID-19: an exploratory analysis." IEEE Access 8 (2020): 145601-145610.
[3] de MoraisBarroca Filho, Itamir, et al. "An IoT-Based Healthcare Platform for Patients in ICU Beds During the COVID-19 Outbreak." IEEE Access 9 (2021): 27262-27277.
[4] Rathee, Geetanjali, et al. "ANN assisted-IoT enabled COVID-19 patient monitoring." IEEE Access 9 (2021): 42483-42492.
[5] Garg, Lalit, et al. "Anonymity preserving IoT-based COVID-19 and other infectious disease contact tracing model." Ieee Access 8 (2020): 159402-159414.
[6] Chen, Zhiming, et al. "Autonomous social distancing in urban environments using a quadruped robot." IEEE Access 9 (2021): 8392-8403.
[7] Alsamhi, Saeed H., and Brian Lee. "Blockchain-Empowered Multi-Robot Collaboration to Fight COVID-19 and Future Pandemics." IEEE Access 9 (2020): 44173-44197.
[8] Vedaei, SeyedShahim, et al. "COVID-SAFE: an IoT-based system for automated health monitoring and surveillance in post-pandemic life." IEEE Access 8 (2020): 188538-188551.
[9] Wang, Shuangyi, et al. "Design of a low-cost miniature robot to assist the COVID-19 nasopharyngeal swab sampling." IEEE Transactions on Medical Robotics and Bionics 3.1 (2020): 289-293.
[10] Shen, Yang, et al. "Robots under COVID-19 pandemic: A comprehensive survey." IEEE Access (2020).
[11] Sharma, Ajit, Philip Zanotti, and Laxmi P. Musunur. "Drive through robotics: Robotic automation for last mile distribution of food and essentials during pandemics." IEEE Access 8 (2020): 127190-127219.
[12] Wu, Shengzheng, et al. "Pilot study of robot-assisted teleultrasound based on 5G network: A new feasible strategy for early imaging assessment during COVID-19 pandemic." IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control 67.11 (2020): 2241-2248.
[13] Le, Anh Vu, et al. "Social Density Monitoring Toward Selective Cleaning by Human Support Robot With 3D Based Perception System." IEEE Access 9 (2021): 41407-41416.
[14] Agarwal, Avani, et al. "Effect of E-learning on public health and environment during COVID-19 lockdown." Big Data Mining and Analytics 4.2 (2021): 104-115.
[15] Ndiaye, Musa, et al. "IoT in the wake of COVID-19: A survey on contributions, challenges and evolution." IEEE Access 8 (2020): 186821-186839.
[16] Firouzi, Farshad, et al. "Harnessing the Power of Smart and Connected Health to Tackle COVID-19: IoT, AI, Robotics, and Blockchain for a Better World." IEEE Internet of Things Journal (2021).
[17] Lin, Ting-Yu, et al. "Takeout Service Automation With Trained Robots in the Pandemic-Transformed Catering Business." IEEE Robotics and Automation Letters 6.2 (2021): 903-910.
[18] Ye, Zhiqiu, et al. "Design and Implementation of Robot Skin Using Highly Sensitive Sponge Sensor." IEEE Transactions on Medical Robotics and Bionics 2.4 (2020): 670-680.
[19] Pang, Gaoyang, et al. "CoboSkin: Soft robot skin with variable stiffness for safer human–robot collaboration." IEEE Transactions on Industrial Electronics 68.4 (2020): 3303-3314.
[20] Nicholson-Smith, Chloë, et al. "A multi-functional lower- and upper-limb stroke rehabilitation robot." IEEE Transactions on Medical Robotics and Bionics 2.4 (2020): 549-552.
[21] Ajibo, Chinemye Augustine, Carlos Toshinori Ishi, and Hiroshi Ishiguro. "Advocating Attitudinal Change Through Android Robot's Intention-Based Expressive Behaviors: Toward WHO COVID-19 Guidelines Adherence." IEEE Robotics and Automation Letters 6.4 (2021): 6521-6528.
[22] Li, Lifang, et al. "Characterizing the propagation of situational information in social media during covid-19 epidemic: A case study on weibo." IEEE Transactions on Computational Social Systems 7.2 (2020): 556-562.
[23] Pathak, Nidhi, et al. "IoT-to-the-Rescue: A Survey of IoT Solutions for COVID-19-like Pandemics." IEEE Internet of Things Journal (2021).
[24] Leng, Yuquan, et al. "Wheel-Legged Robotic Limb to Assist Human With Load Carriage: An Application For Environmental Disinfection During COVID-19." IEEE Robotics and Automation Letters 6.2 (2021): 3695-3702.
[25] Sobrepera, Michael J., et al. "Perceived Usefulness of a Social Robot Augmented Telehealth Platform by Therapists in the United States." IEEE Robotics and Automation Letters 6.2 (2021): 2946-2953.

[26] Chen, Yurong, et al. "MAMA Net: Multi-Scale Attention Memory Autoencoder Network for Anomaly Detection." IEEE Transactions on Medical Imaging 40.3 (2020): 1032-1041.

[27] Fu, Changzeng, et al. "Using an Android Robot to Improve Social Connectedness by Sharing Recent Experiences of Group Members in Human-Robot Conversations." IEEE Robotics and Automation Letters 6.4 (2021): 6670-6677.

[28] Miseikis, Justinas, et al. "Lio-a personal robot assistant for human-robot interaction and care applications." IEEE Robotics and Automation Letters 5.4 (2020): 5339-5346.

[29] Wang, Mingzhong, Chongdan Pan, and Pradeep Kumar Ray. "Technology Entrepreneurship in Developing Countries: Role of Telepresence Robots in Healthcare." IEEE Engineering Management Review 49.1 (2021): 20-26.

[30] Lv, Honghao, et al. "Teleoperation of collaborative robot for remote dementia care in home environments." IEEE Journal of Translational Engineering in Health and Medicine 8 (2020): 1-10.

[31] Dong, Di, et al. "The role of imaging in the detection and management of COVID-19: a review." IEEE reviews in biomedical engineering 14 (2020): 16-29.

[32] Enshaei, Nastaran, et al. "An Ensemble Learning Framework For Multi-Class Covid-19 Lesion Segmentation From Chest Ct Images." 2021 IEEE International Conference on Autonomous Systems (ICAS). IEEE, 2021.

[33] Graham-Katio, Boma, et al. "Analyzing COVID-19 Tweets using Health Behaviour Theories and Machine Learning." 2021 IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH). IEEE, 2021.

[34] El Hefny, Walid, et al. "Chase Away the Virus: A Character-Based Chatbot for COVID-19." 2021 IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH). IEEE, 2021.

[35] Nowrin, Afsana, et al. "Comprehensive Review on Facemask Detection Techniques in the Context of Covid-19." Ieee Access (2021).

[36] Alepis, Efthimios, Virvou Maria, and Polychronis Kontomaris. "Covid-19 Mobile Tracking Application Utilizing Smart Sensors." 2021 12th International Conference on Information, Intelligence, Systems & Applications (IISA). IEEE, 2021.

[37] Ferrag, Mohamed Amine, Lei Shu, and Kim-Kwang Raymond Choo. "Fighting COVID-19 and Future PandemicsWith the Internet of Things: Security and Privacy Perspectives." IEEE/CAA Journal of Automatica Sinica 8.9 (2021): 1477-1499.

[38] Nandy, Sudarshan, and Mainak Adhikari. "Intelligent Health Monitoring System for Detection of Symptomatic/Asymptomatic COVID-19 Patient." IEEE Sensors Journal (2021).

[39] Shanthakumar, Swaroop Gowdra, Anand Seetharam, and Arti Ramesh. "Understanding the Societal Disruption due to COVID-19 via User Tweets." 2021 IEEE International Conference on Smart Computing (SMARTCOMP). IEEE, 2021.