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Design and development of smart monitoring module for detection of virus

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ABSTRACT

The big issue encountered these days across the world is the spreading of virus. Early detection of the virus prevents it from spreading. The paper is presenting a method of an innovative real-time early detection of virus and monitoring system using smart wrist band linked with virus detection (VD) APP which is integrated with thermal imaging system, positioning system, optical system, and liquid controller. The smart wrist band detects high body temperature of the person who is wearing, position among the two people and displays the data on the APP which is further linked to Police through GPS. The proposed method has also provision to check the temperature of a person who is in and around to him/her who is wearing smart band and if the temperature is high than it will send a notification through GPS and using optical system it will take image of the concerned person which is further sent to the concerned authorities through APP. The proposed method also detects the person whether he is wearing the mask or not. The diagnosis of the screening process is less time consuming and less human interactions that might cause the spreading of the virus.

1. Introduction

With the advances in technology the different data is available, but the confront lies in how to recognize the knowledge leading better understanding of the disease pathology and take decisions as to the best of beneficial action [1,2]. In addition, the various aspects that can pressure or contribute to disease progression or susceptibility exhibits a challenge to the scientist in finding a therapeutic or preventative solution for different diseases. Viral infections of the gastrointestinal and respiratory tracts of healthy infants are known to be asymptomatic. The recognition of viral infections will become more responsive as sequencing and researchers produce human-infecting viral genomes [3,4]. Aentire virus particle, present on the outer surface of the masscell is identified as a virion. Virion consists of nucleic acid enclosed by a protein coat called capsid (together called nucelocapsid) and in case of enveloped virus, again covered by an envelope [5,6]. These virions are released from virus infected host cell. A virion after it is discharged from host cell can infect other surrounding host cells or can go to the environment and may then again get a chance to infect another host cell. After the virion infects a host cell, it no more stays as virion but releases its genome inside the host cell and then repeats itself within the host cell into many viruses (not virions). So, a virus is a small infectious agent remains within the host cell. A virus is just a small particle that has similar properties to life, but it is not alive. It cannot reproduce by itself [7]. Viruses are a bridge between the living(inside the host) and the dead(that is show no signs of life when taken out), some of them live in bacteria themselves and are called 'bacteirophages' which means 'bacteria-eaters'. Bacteriophages are viruses that infect bacteria and used especially in treatments where antibiotics do not work. Viruses are generally smaller than bacteria lie in the range of between 20 and 400 nm and round in shape. They are used in Biotechnology research in general and drug discovery specifically for molecular biology related activities (e.g cloning and transforming Cells) [8,9]. Viruses are biological entities made up of protein and nucleic acid (either DNA or RNA). Thus, viruses are devoid of their own synthetic machinary, hence are dependent on other living cells for reproduction. Viruses cause many diseases in human beings such as AIDS, hepatitis, chicken pox, herpes, measles, poliomyelitis etc [10,11]. In 1892; tobacco mosaic virus, 1898; foot and mouth disease, 1901; yellow fever virus was discovered. Corona virus is the new virus that has not been recognized in humans beforehand. A disease is what happens if get infected by a virus or other pathogen. There are other things that cause diseases as well. Disease on other hand side is any abnormal condition of the body revealed by group of symptoms. Diseases are either non-communicable or communicable. Growth or migration of living organisms in the blood multiplies into trillions going on years silently. Used blood glucose as food, migrates to spread diseases and discharged

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excretion in the blood [12,13]. Excretion contains antibody substances such as sorbent, fluorescent, cancer antigen, prostate antigen. In the name of virus or antigen tests are conducted to detect for antibodies in the blood. According to late middle english and advanced twentieth century dictionaries virus is a slimy liquid,poison. HIV test conducted by ELISA, where E is enzyme is the substance discharged by the trillions of klebsiella species living organisms. S is sorbent antibody substance (virus, sorbent enzyme, antigen, liquid poison, toxin). A is the antibody technique. Internet of things (IoT) is used for detection of different system related to virus [14,15].

The internet has become an essential part of daily lives and has developed at the speed of light. Between 1995 and 2016 [16,17], the number of users grows up from 44 million to 3.4 billion, and the number persists to increase. It is conceptualized around 1983- when Carnegie Mellon University modified a Coke machine to provide the ability to report its inventory and also the chillness of the newly loaded drinks over internet [18,19]. Thus, becoming the first internet-connected appliance providing useful information without human interaction. So IoT is like - where all the devices communicate via/through internet using Internet Protocol irrespective or independent of a specific network/telecommunication provider. The IoT has been defined by *InternationalTelecommunication Union* in Recommendation ITU-T Y.2060 (06/2012) as a worldwide infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on evolving and existing interoperable communication and information technologies [20,21]. IoT or Internet of Everything (IoE) as it's called nowadays is a more open approach where the machine is connected to a cloud [22,23]. It may be connected to one or more machines via cloud. Often the APIs would be available for other people to use and the access would be available to (registered) users. IoT uses cloud sometimes but Cloud and IoT are different [24,25]. Cloud computing is the accessibility of computer system resources, especially data storage. Cloud provides security and with the help of cloud any user can access information by means of phone or PC. IoT contains an element of Artificial Intelligence (AI) which makes data collection, its storage, processing and analysing possible. IoT systems uses different connections, using big data providers like Wi-Fi, LTE, and others, but smaller protocols also like ZigBee, Bluetooth, Thread and so on. IoT contributes large amount of data being generated across various domains like health care and biomedical analysis etc. IoT is integrated into the real world with sensors [26]. This helps interaction with the data sources and other devices in the real world. IoT devices are sensors that are connected to the IoT gateway that provide a route to the network to the data and this data transfer to the cloud as shown in Fig. 1.

The IoT sensors measure physical characteristics, like temperature, humidity, light, position, and many others, transforming the signal into digital data, that can then be analyzed and used for the consumer's need. Sensors can be installed in any device, due to the miniaturization tendency of microelectronics. Through this project, IoT based smart wrist device architecture is proposed.

Xie et al. [27] familiar area proced.ures agreeing with the request for idiosyncrasy distinguishing proof frameworks other than show stack layers and attack types. There is a ton of approaches to manage interface WSNs to the Web. It goes for using the possibility of the IoT remembering ultimate objective for extends the functional improvement of the city and to sustain its abilities. Honestly, the solace begins at the house where we are used to burning through most inside ongoing memory [28]. The ability to code and follow objects has process organization to turn out to be more and more productive, speed up forms, decrease blunder, avoid burglary, and consolidate perplexing and adjustable hierarchical frameworks through IoT [29]. IoThas venture out of its infancy and is just about changing the nearby static Internet into a wholly synchronized opportunity [30]. The advancement of the IoThas been resolute by necessities of general partnership that stay to profit extremely from the forewarning and stability managed by the capacity to finish articles the ware manacles in which they are install [31]. IoT is a mechanical displease that speak to the eventual fate of giving out and interchanges, and its development relies upon dynamic focused development in various very important fields, from remote sensors to nanotechnology. Misuse of informal communities with regards to the IoT has been explored in Ref. [32]. In any case, in last decade, the definition has been changed by including a wide scope of utilization like social insurance, transfer, etc [33]. This paper, it was planned to misuse informal community connections to distribute the assets to be had by a given keen things empowered for help web administrations useable by companions of their proprietor). Additionally, the exploration in Ref. [34] endeavors for the basis for the foundation of a supposed everywhere IoT design propelled by social associations of individuals. Creators of [35] explore the capability of consolidating communal and specialized systems and talk about the ramifications of supposed "socio-specialized systems" with regards to the IoT. The IoT vision [36,37] of unavoidably relating smart gear will give a special opportunity to empower a rich arrangement of developmental just as revolutionary applications and administrations [38]. Also, omnipresent and unavoidable figuring are key innovations altogether adding to the appearance of IoT.

With the aid of current technologies, the future of the Smart systems providing intelligent, powerful, and flexible support for people was envisaged. The proposed model presents a reliable, cost effective, and proficient source for providing support to human beings. It also helps them for proper diagnosis which may save the lives. The developed technology, if successfully implemented, may open a new panorama in healthcare systems and IoT area of countries like India. The novelty of this paper is in designing of a robust system for real monitoring of virus which is divided into different modules:

i. Robust design of Thermal Imaging System for self.
ii. Intelligent System design of Thermal and Optical Imaging System for person in/around.
iii. Design and implementation of algorithms for positioning, detection of face mask and liquid monitoring system.
iv. Design of communication module through GPS through a VD app.

This paper comprises: Section 2 explains proposed methodology, Section 3 explains results of the proposed methodology, Section 4 explains conclusion and future work.

2. Proposed methodology

Viruses are necessitatingintracellular vermin that use the host cell machinery to make copies of them, chewing up resources and generally making a mess [39,40]. They can cause diseases. A disease is catchall term to describe any structural or physiologic dysfunction in a living organism, not related to a physical injury. A disease is a process which harms the body and can be caused by various reasons like bacteria, virus etc. On the other hand a virus is a microscopic being which looks for hosts to survive, virus does both good and bad to the body some viruses may cause us diseases but some viruses help in the working of human body. A latest research says that there might have been an ancient virus

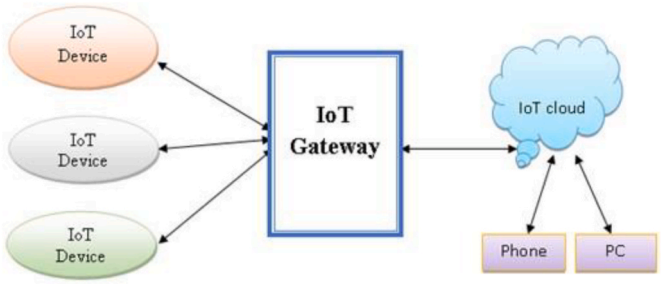

Fig. 1. IoT gateway.

which affected the early human beings [41,42]. The new coronavirus is a respiratory virus which spreads primarily through droplets generated when an infected person coughs or sneezes, or through droplets of saliva or discharge from the nose [43]. The smart wrist device which is linked with the Virus detection (VD) APP concept will be revolutionized and will evolve into a new epoch with new developments in ICT. This research paper, targets on thermal imaging system, positioning sensor, and in some cases liquid monitoring system, and optical imaging. The proposed smart wrist band is integrated into three segments as shown in Fig. 2.

The first segment involves*thermal imaging system* in which the input source of the mechanism consisting thermal camera, and mobile phone application. Infrared or Thermal camera systems measure the heat emitted from an object. The thermal camera does nothing that an ordinary camera does. We cannot locate and catch a camera taking visual picture, cannot locate and catch a thermal camera taking an IR picture; unless use the Mark I eyeball. If the temperature is above the threshold level than a message through GPS will go to the police and assigned mobile number. Second module is *positioning systemusing ultrasonic sensor*. If threshold level of thermal imaging is less, then it will check for positioning of the two people. If the position of two people is less than threshold than an alarm will beep in the mobile and it moves to third modulebut if the position is more than the set threshold than detection of face mask occurs. Third module consists of *optical imaging and detection system for face mask* for in and around person. This module will check the physiological parameters of people who are around the person wearing band. It will check the temperature and captures the image which will send to Police through APP. Device alerts and control data attained from level 3 can be exploited by different web applications for intelligent operating conditions. The data can be employed in various ways likealerts, messaging, and warnings. In some cases, like schools/universities/government department or MNC's, sanitization process also occurs.

In this paper, the Arduino IDE has been adopted that represents a cross-platform App. Ardunio UNO board is used with a computer stick driven by Intel processor. Hardware required for designing of mart robust system are Arduino, Android smartphone (4.0 or higher), USB Wi-Fi dongle (RPi 2-compatible), Raspberry camera module, 5V, 1A power adaptor with micro-USB output, LCD screen, USB audio adaptor (optional) and, ultrasonic sensor, servo motor,Wi-fi modem, A buzzer,

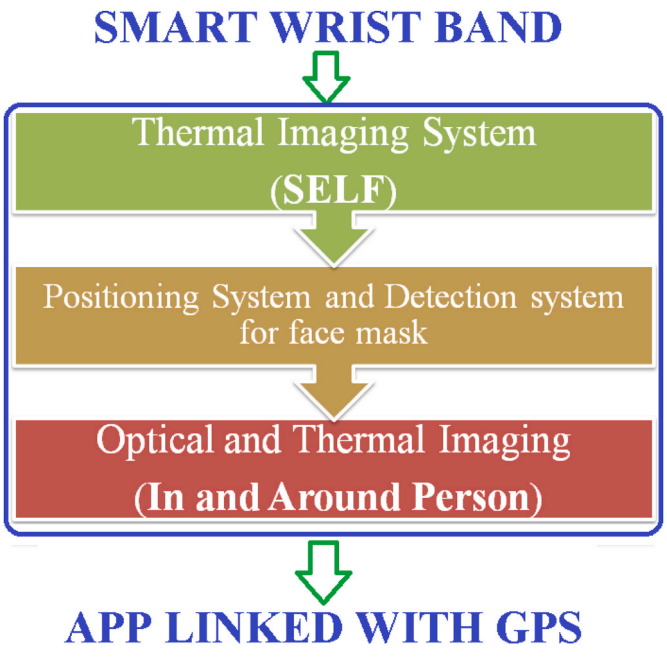

Fig. 2. Proposed robust system for real monitoring of virus.

12V transformer. The communication services that are employed in a smart wrist device are 4th generation, 5th generation, worldwide interoperability for microwave access (WiMAX), Long-term evolution (LTE), ZigBee, cable television (CATV), Wireless fidelity (Wi-Fi),& satellite communication. Arduino consists a physical *programmable circuit board*, *IDE (Integrated Development Environment)* that runs on computer-used to write and upload computer code to the physical board. Programming for arduino is quite easy with simple syntax. Arduino Programming is very similar to C++. Arduino Uno is a Microcontroller and good one as it is base for all the projects involving advance microprocessors and microcontrollers. It has 6 Analog and 14 digital pins. Arduino is a small single board computer that can be put to work very quickly with a minimum of technical knowledge. Initially it was based on the Atmel AVR family of microprocessors, though as its popularity increased, other processors such as ARM have been added to the range. The system delivers a notification if detecting temperature higher than normal temperature. The GPS module determine the position coordinates after tagging it and a notification is sent to assigned smart mobile through a GSM. The real time monitoring system for detection of virus is shown in Fig. 3.

Fig. 3 shows the proposed smart wrist band for early detection of virus including thermal imaging system, positioning sensor, detection system for face mask, optical imaging etc. The first section of the system engages the input source of the mechanism that consists of the thermal camera, and mobile phone application. Thermal imaging systems are an important tool for determining heat transfer and changes in temperature. New, inexpensive thermal cameras and imagers detect infrared radiation emitted from an object and relate that to an understandable image [44,45]. Abnormal patterns of heat cannot be seen with the naked eye. Also, we often cannot get close enough to a subject to sense any differences. This all means that thermal imaging can be a big help for companies reliant on rotating equipment. Thermal cameras turn these heat signals into visual images [46,47]. Thermal imaging is the usage of infrared radiation to help create on image for humans to see and analyze the surrounding temperature. It can be used in low light, low visibility areas. First, all objects emits infrared radiation. The higher the temperature, the more infrared radiation it emits. Thermal cameras is a device that sense/detect the radiation and display the iconic blue/purple and red/yellow image to see the differences in temperature, where blue/purple is cold and red/yellow is hot. The key to understanding a problem with these images comes in knowing the difference between a normal and abnormal color for a particular area. Some will automatically be hotter because they are rotating and creating energy. However, there will be tones that are too hot and indicate a problem. The more sensitive the system, the better the chance of detecting faults. Abnormal heat signatures are often the sign of a piece of machinery that is malfunctioning. Often there is too much friction being generated between bearing and couplings on a rotating system, and this leads to heat. If the temperature is above the threshold level than a message through GPS will go to the police and assigned smart mobile number. But it is less than threshold level than it will lead to second module positioning of the two people is checked.

Social distancing just sounds isolating and depressing which is the opposite of what we need right now. Its more than just a phrase. Words are powerful and should not be underestimated in terms of how it affects the psyche. Physical distancing on the other hand is clear and definitive and means what it says: to keep distance physically. On the other hand, a world in crisis will NOT fare well if we are socially distant. By staying 6 feet apart "physically" distancing from each other. Social Distancing actually means to not talk to each other at all. This not only means Social Isolation but can lead to division and unrest. If the position of two people is less than particular threshold than it leads to third module but if it is less than threshold than it checks for the face mask and optical imaging.

The 3rd module is to check the face mask used in/around people. If face mask is not there than it clicks the image and through APP it will alert to the health officers/nearby police station. In some cases, like university/schools/government departments/MNC's sanitization

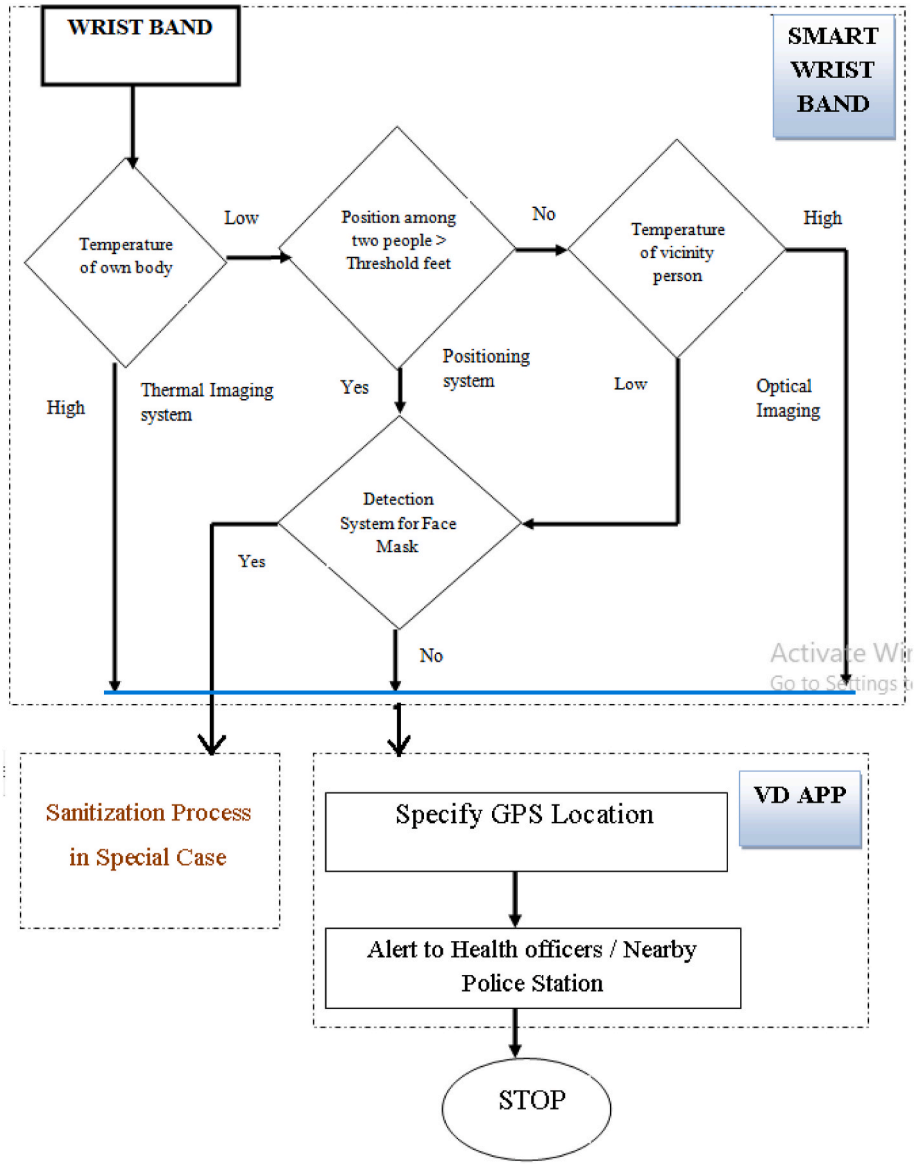

Fig. 3. Real time Monitoring system for early detection of virus.

process occurs [48,49]. Container is fixed to an ultrasonic sensor that is placed over it. Ultrasonic sensors and monitoring systems have wide range of similar applications. In this paper it is used to measure, compare container depth and liquid level [50,51] as shown in Fig. 4.

After obtaining information incorporating the body temperature, and GPS position delivered by Arduino through sequential communication, values are transferred to the Web to access this information.

3. Results and discussion

A virus is one of many causes of disease. A disease is anything that makes you ill. A disease can be caused by viruses, bacteria, parasites, congenital conditions, genetic conditions, or just old age. If your body isn't working properly, that is, in general terms, a disease. Viruses are the cause of a particularly class of diseases which have a few common characteristics. This study proposes a smart wrist device with a VD app that has ability for detection of virus automatically from the thermal imaging systems, positioning system, detection system of face mask and optical system with less human interactions using IoT [52]. IoT refers to devices that are connected to the standard Internet, being able to provide and use data. All IoT enabled devices are Connected Devices, but not necessarily the other way around. The connected devices are pretty much every day devices like phones and tablets and computers, the Internet of things is primarily sensor based and instead of being a fair shake between client and server the client is usually more "dumbed down" and the logic and processing are pushed to the network and server and to connected devices. Also, with the Internet of Things, new and legacy devices in the household and neighborhood gaining radios and sensors and novel communication and network protocols working together to achieve a greater purpose than each individual part. IoT refers to internet monitoring and control of equipment whose primary purpose is other than communication or computation. Evolution of IoT has been gradual with technology stack being built in fragmented fashion but recently it has gain momentum and has caught media attention because technology has evolved, hardware cost has reduced, and internet population is growing fast. In this paper all the simulations were carried out in Tinker cad to get the physical idea of the proposed structure. Tinkercad is a free, easy-to-use app for 3D design, electronics, and coding. With Tinkercad you can quickly turn your idea into a CAD model for a 3D printer. Tinkercad is an easy-to-use tool for creating digital designs that are ready to be 3D printed into physical objects.

The thermal camera technology is integrated to the smart wrist band

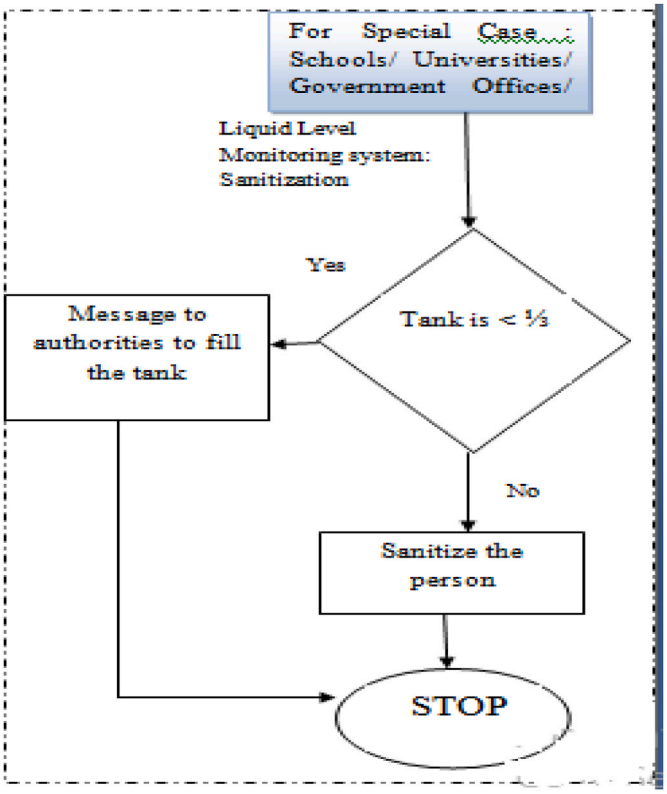

Fig. 4. Sanitization process.

and combined with IoT technology for keeping an eye on the monitoring process to get the real time data. A thermal imaging camera detects the body surface's temperature by capturing and detecting different levels of infrared light. We cannot see this light with the naked eye, but if the energy is high enough, can believe it as heat. Each object releases a different type of infrared radiation, and thus heat transfer occurs. For instance, only half of the Sun's energy is emitted as light. The rest is infrared and ultraviolet light. The more the head radiates an object, the more infrared radiation is transmitted. Thermal cameras see this radiation and transform it into an image that we can see with our eyes through colors. This is similar to how night vision cameras can capture invisible infrared light and make it into a picture that we can see. Inside the thermal camera, there are some small measuring devices. These devices capture infrared radiation, which is called a microblometer. The microblometer measures the temperature and provides a pixel that is a suitable color. Most thermal cameras have a lower resolution than modern TVs and other displays. A good resolution for a thermal camera is 650 × 460. All objects above absolute zero (−273.15C) emit infrared radiation (IR) in proportion to their temperature and wavelength. Thermal vision cameras consist of a lens that allows only IR radiation to pass through (such as a doped germanium lens) and impinge upon a thermal detector (such as Mercury cadmium telluride or indium antimonide) sensitive to the IR wavelengths being measured (usually 8–13 μm or 3–5.6 μm). This IR radiation is then changed into an electronic signal and digitally processed to a screen where the signals are displayed as a visible image digitally colorized to reflect the intensity of the infrared radiation impinging on the IR detector. The smart band is equipped with infra-red thermal cameras (as shown in Fig. 5) that allow temperature measurements of self. If thermal camera envisages high temperature body, then it generates high concentration levels of infrared spectra.

A thermal imaging camera detects the body surface's temperature by capturing and detecting different levels of infrared light. Each object releases a different type of infrared radiation, and thus heat transfer

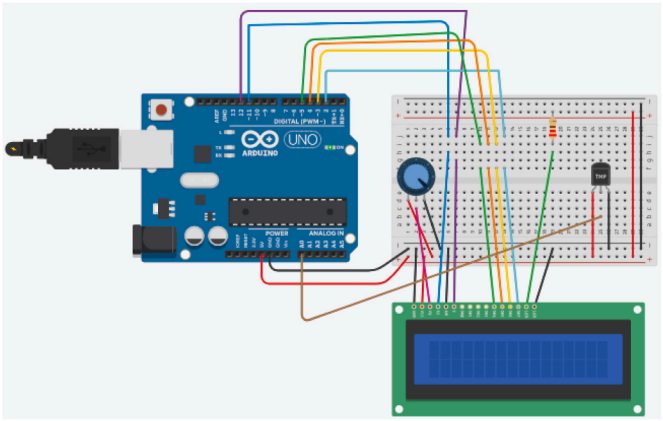

Fig. 5. Temperature Scanning module.

occurs. The second module is use of ultrasonic sensor. If the distance is within range than the module will check for the distance among the peopleusing module shown in Fig. 6. Distance sensors, ultrasonic, measure the distance of a target from the sensor and send a signal that represents the distance.

For social distancing, a person should at least 6 feet away from anybody else. In families that are home; however, many people are there is the total. There is confusion from state to state, how many people constitute a group. Some governors have allowed 10 only, some 50. There is a pastor who has flaunted this rule and brought a congregation of 1000 together. Because one infected person can transmit the virus to two or three others and then those would exponentially transfer the virus to 8–9, it is very important that we keep social distancing in place. The fewer people together, the harder it is to transfer the virus. If we stay apart, maybe the virus won't spread so rapidly, and give health care a chance to have to treat less people at a time. If the distance is more than the set threshold then it will detect the face mask but if the position is less than the threshold than it helps in detecting the fever of person who is around his/her vicinity and captures the images through optical camera and let the authorities informed through GPS via VD app. In some cases, like university/Government offices/MNC's), sanitization process occurs. An IoT based automatic smart sanitization tank that represent the Liquid Level Monitoring system that has mechanisms to keep the user alerted in case of sanitization tank is about to empty (as shown in Fig. 7).

The liquid used in spirit levels is generally an alcohol (ethanol), commonly dyed green, yellow or light brown. This is the case instead of water as water freezes easier and provides more friction, preventing bubble movement, hence less sensitivity to change in level. Robust design of Thermal Imaging System for self has been designed and

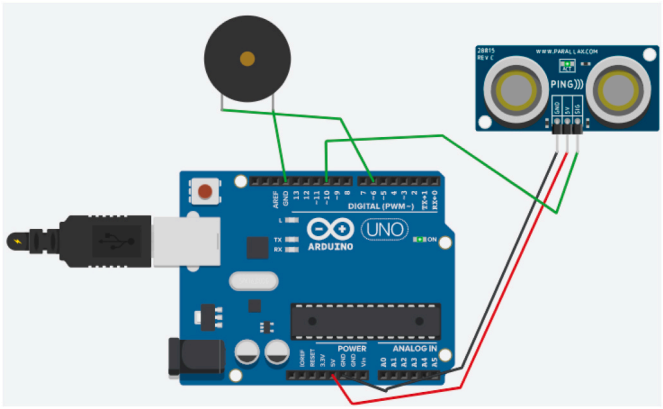

Fig. 6. Social distancing module.

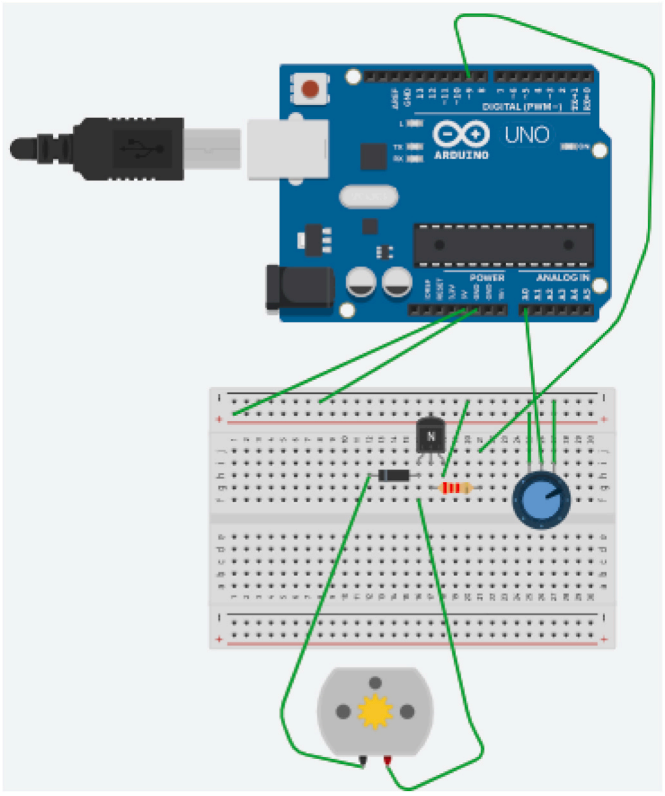

Fig. 7. Liquid Level Monitoring system.

implemented. Intelligent System design was of Thermal and Optical Imaging System for person in/around. The designed and implementation of algorithms for positioning, detection of face mask and liquid monitoring system. The proposed method possesses better capabilities to detect the virus early and efficient way as compared to proposed/developed methods as reported in literature [53,54].

4. Conclusion

This paper proposes a smart wrist device with a VD app that has capability to detect the virus automatically from the thermal imaging systems, positioning system, detection system of face mask and optical system with less human interactions. The thermal camera technology is included to the smart wrist band and combined with IoT technology for observing of the screening process to get the real time data. The smart band is equipped with infra-red thermal cameras that allow temperature measurements of self. If thermal camera visualizes high temperature body, then it creates high intensity levels of infrared spectra. If is within range than the module will check for the distance among the people. If the distance is more than the set threshold then it will detect the face mask but if the position is less than the threshold than it helps in detecting the fever of person who is around and captures the images through optical camera and let the authorities informed through GPS via VD app. In some cases, like university/Government offices/MNC's), sanitization process occurs. An IoT based automatic smart sanitization tank that represent the Liquid Level Monitoring system that has mechanisms to keep the user alerted in case of sanitization tank is about to empty. Future work includes the development of hardware based on proposed methodology in this paper.

Declaration of competing interest

The authors declare that they have no known competing financialinterestsor personal relationships that could have appeared to influence the work reported in this paper.

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