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COVID-19: Employee Fever detection with Thermal Camera Integrated with Attendance Management System

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***Abstract*—We all know that this is a tough time of COVID-19 with which the whole world is fighting. It is a virus that has taken many lives and affected the lack of people across the globe. It is a virus that is transmitted with close contact and droplet and is not airborne. The common symptoms include fever, cough, and fatigue. This paper focus on proposing a solution that can help detect the virus and keep people away from the infected person. The solution uses a Thermal Camera, which has a heat sensor and can detect any difference in temperature, and the camera can be integrated with access control systems in many places like Hospitals, Police stations, Factories, Universities, etc. which has staff walking in daily. The camera will not allow access to the person having high body temperature as fever is a symptom for COVID-19 and that person can be further examined for the virus. Many doctors are getting this infection while treating people, if we integrate such a solution then it can be easy to save the lives of many others up to an extent.**

Keywords— COVID-19, employee, Fever Detection, Thermal Camera, Attendance management system

I. Introduction

The human race is continuously observing various levels of pandemics throughout history, out of which some were extremely disastrous to mankind. Since the last few months, humankind is once again confronting similar kinds of hardship in the form of the Novel COVID-19 coronavirus. This exponentially spreading powerful and invisible enemy was initially identified in the People's Re-public of China's Wuhan province. From 31 December 2019 this rapidly progressing epidemic of pneumonia arise within China, with numerous exportations to other countries. It has promptly changed the existence of millions by the pandemic as activities, travels, and social contacts have been severely restricted.

A virus is a life form evolved to seek out new hosts—as it must survive, be-cause its carriers die, and it must always stay one jump ahead of death. COVID-19 is a virus generated pneumonia-like disease. This disease is caused by a new coronavirus named SARS-CoV-2, which is similar to the virus that causes Severe Acute Respiratory Syndrome (SARS). As of today, 20th Oct 2020 there are 40,785,821 Coronavirus cases, with 1,124,972 deaths while 30,450,704 has been recovered. The distribution of country-wise cases is depicted in figure 1:

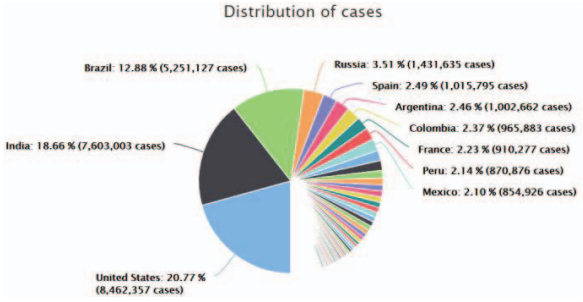

Figure 1: country wise cases [1]

According to world meter the overall coronavirus patients died, very fascinatingly the highest number belongs to the USA that is 225,410. The death toll was followed by India (115,552), Brazil (154,226, and so on [1].

The criticality of COVID -19 pandemics can be understood in Figure 2.

Figure 2: Covid-19 on world map [2]

The strategic objectives identified by WHO are" Interrupt human-to-human transmission including reducing secondary infections among close contacts and health care workers, preventing transmission amplification events, and preventing further international spread" and "Identify, isolate and care for patients' early stage".

In this paper, our work is focused on the mechanism to identify the infected person at an early stage which is one of the strategic objectives given by the World Health Organization (WHO) to fight with COVID 19. The study aims to find out the age distribution in which the virus has affected majorly. The people affected and died of the virus above the age of 80 are 3%, whereas the people who fall on the age sale

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of 30-79 are the most affected people covering around 87% of the total cases which is a huge percentage, the people who fall between 20-29 are 8%, and on the age scale of 10-19 the percentage is 1% and below 10 also it is 1% only. It is seen that the people who are affected the most are from ages 30-79 and the age of the working people falls mainly between 20-60 which is near. So, the model we proposed holds the utmost significance as it can catch hold of a common symptom i.e., in the employee which can save more people from being affected [3].

This paper is categorized into five sections. In section II we discuss the brief literature review. After that in section III, we discuss the COVID 19 effects of workers. We discuss framework in section IV in which we present an idea to control COVID 19 in Stage I and Stage II by using strict screening measures by using thermal cameras. The scenario is explained with the help of the flowchart. In section V we discuss the comparison between different vendors /companies based on temperature, accuracy, and distance parameters. Finally, we conclude our paper in section V.

II. Literature Review

Various research work has emphasized the use of thermal cameras for fever screening at the airports for the purpose of restricting the travelers with high body temperature as they may endanger other passengers traveling in the period of the high risk of infection. The emphasis is on 3 main objectives here [4],

1) To determine the relationship between the core body temperature and those given by the thermal cameras. The results fluctuate because a per-son may possess elevated body temperature, and several other features like the humidity can become the hurdle in predicting the correct body temperature. So, as a result, we must choose the skin with high temperature to predict the correct result, and to avoid too many false positives, for example, the inner canthi of the eye can be chosen.
2) They also found a limitation that during the early and the later stages of fever the infected person does not possess a high body temperature and so he will not be picked by the camera.
3) The incorrect installation of the camera can also cause inaccurate results due to poor focus, long-distance from an object, and poor camera quality. So, the object must be near, and the resolution of the camera should be high enough.

The thermal camera technology is mounted inside a smart helmet in combination with IoT for monitoring and checking the real-time data. The working de-tails are that the helmet is having 2 cameras, one is the thermal camera for fever screening, one optical camera to gather information about the face detected, and it relates to an application [5]. Once a user is found with high body temperature, his details are sent to the health officer including the coordinates where he is currently. The detection of fever using thermal cameras is contact-less and time-efficient, unlike gun thermometers.

In the research work of a Kumar, A., et al., a model is proposed with the use of AI in different forms to make it easy to identify infected people, deliver food and services without human contact, thermal cameras for fever screening, the use of drones to disinfect public places, and more at this time of the pandemic. The focus is on the role of modern technology to quell COVID. The use of radiology images using AI to diagnose a disease in early stages as the coronavirus test are expensive, the abnormal respiratory patterns are also seen as a symptom and can be detected using the disease tracking system, prediction of a patient's health, and above all awareness and social media is helping to make people aware of all the facts which are important such as wearing a mask and washing hands regularly [6]. The use of technology to detect the disease dynamics helps in understanding the criteria which aid the spread of the virus.

The rapid fever screening at this pandemic is conducted with the use of infra-red thermography which is used to detect the infrared energy which is transmit-ted from an object and convert it into temperature. Here a total of about 176 people/subjects is recruited and the period was 20-days. The various parts of the face are scanned for obtaining the IRT reading from about 0.5 to1.5m and were then compared to the body temperature obtained using the traditional fever measurement methods such as mercury thermometer. After this, the resulting data has been fed into the correlation and regression analysis. As a result, it was observed that IRT reading gave the most precise result from the side of the face and was consistently determining the body temperature. This system can be implemented at the Airports and border crossings to check the travelers for high body temperature [7].

A new framework is proposed in the research work of Maghdid, H. S., et al., to detect COVID-19 which is based on a smartphone just by using sensors. The workflows of the solution are like first the symptoms should be realized which includes fever, fatigue, and dry cough. The framework tries to differentiate the normal fever with the level of fever of COVID based on the built-in sensor. A set of sensors is used whose reading is also set to detect the symptoms which exist in coronavirus disease. Also, algorithms are applied to these reading to check the human-health. There are four separate layers discussed in this paper, an input layer for reading sensor data, sensor configuration layer, analyzing symptoms to know disease layer, and finally, predict the diseased layer. The different sensors take data input like the temperature, the fatigue can be detected by the camera and the walk patterns, and finally, with the help of different sensors, the disease can be detected. The solutions prove to be cost-effective as it just uses the smartphone and the sensors which are today used by everybody [8].

A study was conducted to observe all the patients who were having symptoms of the coronavirus and were admitted to the hospital. All the required data was collected using the standardized methods and the researchers also interacted with the patients or their family members for getting the necessary details. In this study, it is observed that most of the patients were men [73%] amongst which 32% were having an underlying disease such as diabetes, hypertension, and cardiovascular disease. Also, 66% of these people were exposed to the seafood market. The symptoms include fever [98%], cough [76%], fatigue [44%], and the less common symptom were headache and diarrhea [9].

Getting a meaningful and accurate body temperature was always a matter of concern for mass fever screening. For this purpose, a reliable source of the hu-man body is required to obtain the temperature, and the fact should be kept in mind that the skin temperature does not solely depend upon the core body temperature but is affected by lots of other factors which

include the environment. With the use of a camera, it should not happen that the false-negative rate grows because with the growth of the false-positive rate the sense of false security will grow. The efficiency and accuracy of thermal cameras are evaluated while mass screening for fever. The methods which were applied are Biostatistics using regressing and ROC curve and the results clearly say that the use of thermal cameras is the major and correct tool for mass fever screening [10].

The thermal screening has been used for fever screening and the ism was to check how effective it is in detected the pandemic. For this purpose, two datasets have been collected, the first one had the cases which were detected at the early stages and were positive and the second contains the suspected candidates who were screened for fever at the airport. The actual sensitivity of the fever was detected, and the performance of the thermal scanner was also estimated. Upon arrival, it was observed that the results depend on how correctly we detect fever and how properly the Thermo scanner works. Some cases took medicine just be-fore the arrival to suppress the fever, in that case, the infected person does not fall into the detection but is still infected. S, to conclude the scanning itself is not sufficient for detection it is just a criterion [11].

The study is conducted to detect the coronavirus in early stages with the help of machine learning. The method which was used was the CT images of the abdominal of the patient. The CT images are then analyzed to check what different behavior the virus shows in contrast with the other virus. The detection used four different datasets by taking the patches of the CT images. The cleaning of data was done for feature abstraction. The machine learning algo that was used is the SVM (Support Vector Machine) algo with 2-fold, 5 and 10-fold cross-validation implementation of the classification. The parameters which were used are the sensitivity, accuracy, precision, and F-score to evaluate the complete process. It was also found that the best classification was done with 10-fols cross-validation with the accuracy of 99.68% [12].

AI has proved itself in the field of Medical sciences and now the tools with the help of machine learning are being used for the identification and decision-making process. The tools driven by AI hold the capability to identify the nature of the outbreak and forecast the behavior across the globe. For predicting such emergencies, the traditional learning approaches do not work so there was a need to implement active learning which involves the learner in determining what data it will be trained upon. Besides Active Learning the other model used is the cross-population train/test AI-driven model so that the automatic detection of the virus becomes possible. There is another model under the scope which is multitudinal and multimodal data that helps to support decision making [13].

In the research work of Nguyen, et al., a survey on how AI has proved to be life-changing to us in our day-to-day lives and how it is now contributing to-wards this pandemic. The various areas where AI has proved itself is the medical image processing using Deep Learning, a 3-D model for is introduced to take the volumetric CT images for Coronavirus named as COVNet using neural networks and the model produced about 86% accuracy. The use of AI with IoT has been widely used which includes the sensors from the smartphones to check the temperature, the use of thermal cameras that can be installed in smart cities to control the breakout by checking the mass fever which is a common symptom for the virus. Likewise, Machine Learning has also been used with the classifiers fed with the data from different countries which helps the authorities to take decisions based on the results predicted from ML [14].

It is observed that Computed Tomography (CT) is widely used to the method of detecting the coronavirus using imaging. The proposed study aims to find a model using deep learning which can be used to interpret the images of CT relieving the task of expert radiologists and contributing towards controlling the epidemic. This purpose a total of 46,096 images were taken from 106 admitted patients which include 51 confirmed cases and 55 patients from other diseases. The images were scanned under the model built to see the accuracy of the result compared to the radiologists. It was found that the model has a sensitivity of 100%, a specificity of 93.55%, and an accuracy of 98.85%. With the help of this model, it was seen that the reading time of the radiologist is decreased by 65% [15].

CT images taken of the patients proves to be very promising in detection and follow-up of the disease and deep learning algorithms can be designed to do the same. The study aims to develop an AI-based tool for detection and tracking of Coronavirus which can be used to differentiate the people who are infected from others. There were many datasets collected from all over which also include the dataset from the Chinese infected area and there are various 2D and 3D deep learning models used which consumed and modified the existing AI models. Several experiments have been conducted to check the performance of the model to detect the positive patient by giving a score called “Corona Score”. The result analysis shows that the model gives an accuracy of 95%, sensitivity of 98.2%, and specificity of 92.2% [16].

The focus of the study conducted by Prasse, B., et al., is the prediction of the future course of the pandemic so that decisive actions must be taken to control the pandemic. A network-based model is composed to check the interaction between the cites to predict the prevalence of coronavirus in every city. For this the procedure is divided into 3 steps,

1) The confirmed cases data is pre-processed to get the time series of viral state for each city,
2) Next using the time series an unknown spreading estimate is taken,
3) The estimated result is a model which we can iterate n times to get the future behavior.

It was found that the network-based model predicts more accurate results as compared to the prediction model for each city individually [17].

With the increase in the popularity of IoT devices and sensors used for public surveillance, there is a major focus on machine vision at this time of the pan-demic. The sliding window approach (which is a binary classifier) in machine vision has gained major popularity. The area which is exposed from head-to-shoulder of the human body is an important region that can be used to detect previously before the use of a thermal camera for fever detection. One of the issues that are seen with the use of thermal cameras is analyzing the nature and the im-age quality in the real-world scenario as it may cause obstruction [18]. Another remarkable research by Mohammed et al., proposed the use of IoT for fever screening because fever is a common symptom has using IoT the diagnosis can be made less human interactive. The use of thermometer guns makes it vulnerable for the person checking

the temperature as he is also exposed to high risk, also it is not suitable for mass screening. So, the use of Drone is depicted to screen people for fever. Also, the use of Virtual Reality is shown to make the checking less human interaction so that there are fewer people exposed to it. A drone camera is sent to the suspected area with the thermal camera installed in it, the suspected area is scanned with the help of thermal camera to check whether there is a person with high body heat or not if somebody is found with high body heat than the suspects face images are taken with the help of an optical camera, and also the location is captured using the GPS and the location of the suspect is sent to the health officer with the live video streaming. The use of technology proves to give an extraordinary guarantee and has potential to fulfill the demand of the healthcare unit [19].

The study takes X-ray imaging as one of the mediums for COVID-19 detection. A deep learning model is created which can read the X-ray images which relieves the pressure on radiologist at the same time. 260 images were taken into GitHub and Kaggle for model development which includes the images from 130 positive patients and 130 normal X-rays. It was found that the proposed model achieves an accuracy of 100%, %, and sensitivity of 100% and specificity of 100% which greatly decreases the reading time of the radiologist [20].

The use of IoT cannot be neglected with collaboration to the healthcare units to control this pandemic. The technology not only increases patient satisfaction levels but also decreases the readmission rate in the hospitals. IoT helps in providing rapid treatment for the patients and the research endeavor discusses twelve important applications. IoT is defined as a collection of hardware/software/ network connectivity any other smart devices to collaborate them and provide support in data bifurcation and data collection. IoT enabled devices can help monitor the heart rate, the temperature, the glucose level, and many other parameters of the patient which reduces contact with the patient and in-crease the efficiency of the staff. It lists down some of the key features why IoT is important which includes [21]:

1) Cost-effectiveness
2) Minimized chances of mistake as human are prone to errors most of the time.
3) Effective control
4) High-ranking treatment
5) Intensified diagnosis.

IoT seems to be an efficient way to screen, diagnose, and treat the patient.

One more research endeavor proposes to use machine learning algorithms to identify the coronavirus in combination with the mobile phone-based survey. It focuses on the immediate quarantine of the person who has travel history recently with the help of web-survey conducted online. The data collection help in initial screening and early recognition of the person under infection. Artificial Intel-ligancy has been used to classify the people and put them under the category of high-risk, moderate-risk, negligible-risk, and no-risk. And finally, we quarantine the people who fall under the category of high-risk to decrease the chance of spread. The use of AI and deep learning has proved to be very effective in the field of medical sciences for diagnosis and decision making. The algorithms used can be elaborated further to recognize the individuals who might show mild symptoms of infection [22].

A model is proposed which find out the total number of new positive cases daily at different intervals of time and they have different contribution to infection suspect. Based on past days confirmed cases, a multiparameter model is proposed which sets the infection rate of the past few days into groups with time as the differentiating parameter. When the data is categorized into groups it is feed to the,

1) Computational ISI model for the calculation of infection rate,
2) LSTM model to calculate the deviation estimation of the infected cases and
3) To the NLP model to understand and extract features from the relevant news of various cities and countries. The AI-based model for predicting COVID-19 with the help of embedded NLP gives important information that is given by the government or the participation from the public in predicting the disease.

The prediction model has shown high consistency with the actual positive cases which shows that the model can be used to predict the transmission laws and developing trends among the public [23].

The research endeavor discusses about the SARS which was an epidemic in the ear 2003. It was also having the common symptom fever which also is a symptom for COVID and like COVID it was also an inflectional disease transmitted from one person to other. A person with a temperature of more than 38°C is considered for having a sign of the disease so, fever screening was a standard protocol for all the people visiting hospital etc to reduce the risk of infection. For identifying the fever thermal cameras were used for mass screening. Use of thermal cameras is a less time-consuming process and requires less contact between the patient and the doctor [24].

The trend of detecting fever using the thermal camera has shown that there is data inadequacy on normal and a febrile subject. The study is conducted on 191 children out of which 173 were normal and the rest were febrile, and the purpose was to provide some data which can be used by the infrared screening system for future recognition of febrile and normal children. The major areas which were used to take the temperature were axilla using clinical thermometer, tympanic ear temperature, temperature of the inner eye canthi and the temperature of the forehead. There was a good correlation found between the axilla and the inner canthi of eye and showed the potential for future thermal screening fever detection [25].

The study shows that after the SARS pandemic, thermal fever screening solutions were deployed in the airports, but these are expensive and nor portable, so a system was developed which was compact and cost-effective to screening the people for fever. The technology used was micro electrical mechanical system which had silicon wafers fabricated. The maximum temperature of the face was having a correlation between the axillary temperature. The proposed solution was promising to screen the people in pan-demic [26].

After SARS in 2003, fever screening using thermal cameras has become popular to keep an eye on the infectious person and control the pandemic. But it was observed that measuring the facial temperature alone cannot help in identifying the infected person to a great extent as it is influenced by several other factors such as environment,

humidity etc. So, a compact radar-based system can be used with the thermal cameras which measures the respiratory and the heart rate of the patient to better detect the disease [27].

III. Effect of COVID-19 on Employees

Certain sectors are continuously providing the services despite the total lock-down. These services include the health care workers: the doctors, the nurses, the cleaning staff, the police, the bankers, etc. These are the essential and emergency services that have to function, and the people are paying a big price and the effects are devastating. For example, the whole hospital staff is gathering daily and serving the people. In this situation, there are chances that these people them-selves can get affected and in turn on not being detected and affect many others. These people have put their own lives in line to save many others at the time of this coronavirus pandemic, due to which many have died, and thousands are test-ed positive [28].

With the solution provides we can detect a common symptom which is fever using the thermal cameras, and if the person is detected with a temperature high-er than normal then the person will not be granted access. Once a person is detected with high body temperature, he/she can be taken into further observation to check whether the person is positive for the virus or not. In this way, if the person is positive then we are restricting him to enter the workplace premise which may help in saving many working at the same place [29].

IV. Framework to Detect an Affected Employee

The framework includes the idea where we are trying to find out a common symptom of coronavirus COVID-19 which is fever. We are trying to detect a high temperature of the employee using a thermal camera, and if a person is having a high temperature, he is not allowed to enter the office premise and is kept under further observation [30].

A. Methodology

A complete scenario which we are using for this idea that is our proposed model is depicted in figure 3. Here, one Access Control System is used which is having a Thermal Camera integrated with it. Access Control Systems are the security solutions that are these days found in many places like Universities, Industries, Factories, and many more to verify the identity of the employee so that no unauthorized person is allowed to enter the premises.

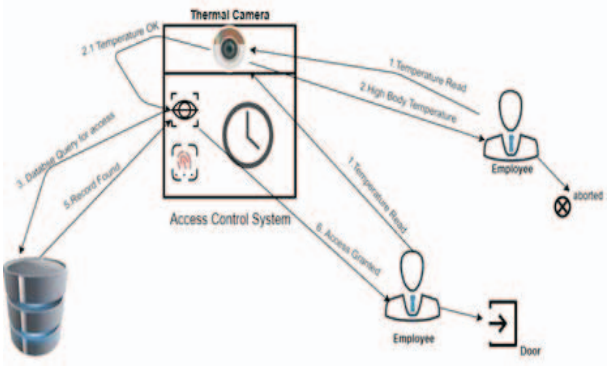

Figure 3: Proposed Model

Thermal Cameras are solutions that are used to sense the temperature of the human body. These cameras are so smart that if you are carrying a hot cup of coffee along with you, it will not be misguided and will give approx. accurate results. These two solutions are integrated so check that if a person is having a high body temperature that means he/she is suffering from fever. Fever is considered to be a major symptom of COVID-19 hence we can retain that person from entering the office premise and can take him to further observation to check whether he is positive or not. The chances are the person happens to be a negative for coronavirus which is good, but in case he is a positive person, then we are successful in keeping him away from many people who could be infected otherwise.

When a person stands straight in front of this thermal Camera integrated Access Control System, First the Thermal Camera sense the temperature of the employee, if the temperature is high then the employee is not granted access and is sent back or the login process is aborted for that employee, and on the other hand if the temperature is normal than the control is transferred to the Access Control System.

When the control is transferred to the Access Control System after getting a green signal from the Thermal Camera, it starts further processing which includes querying the database for the record of the person. If the person is found in the database of the system, he is granted access. As we are giving this solution in the scenario of COVID-19, we emphasize not using the Biometric Access Control System as many people touch the same. It is advised to use the Face Recognition system or the Retina Scan for this purpose to avoid many people touching the same surface. The solution is only suited for the places which have the record of its employees, because then only we can integrate it with the Access Control System. This is not suited for places such as Malls, Theatres, Metro Stations, etc. The solutions are proposed to help the emergency worker who is working at the time of complete lockdown also like Hospitals, Police Stations, Banks, and others. Thermal Cameras are also used these days on airports so bifurcate the people having high temperature. But there it is a manual task to watching the camera and bifurcating the people which may fail because of the human error like the person keeping an eye on the camera might miss some of the people. Such type of errors is removed in the case of automatic solution which is proposed as it does not involve the human and so no human error can occur.

The scenario is also explained with the help of the flowchart given, shown in figure 4.

- The person stands in front of the system, the temperature is read by a thermal camera.
- If the temperature is less than 99°F, then the control is sent to the Access Control System.
- If the temperature is more than 99°F, the process is aborted, and the employee is not granted to access the workplace.
- Access Control System checks for the record of the employee in the database.
- If the record if found, then the employee is granted to access the workplace.
- If the record is not found, the employee is not allowed to enter.

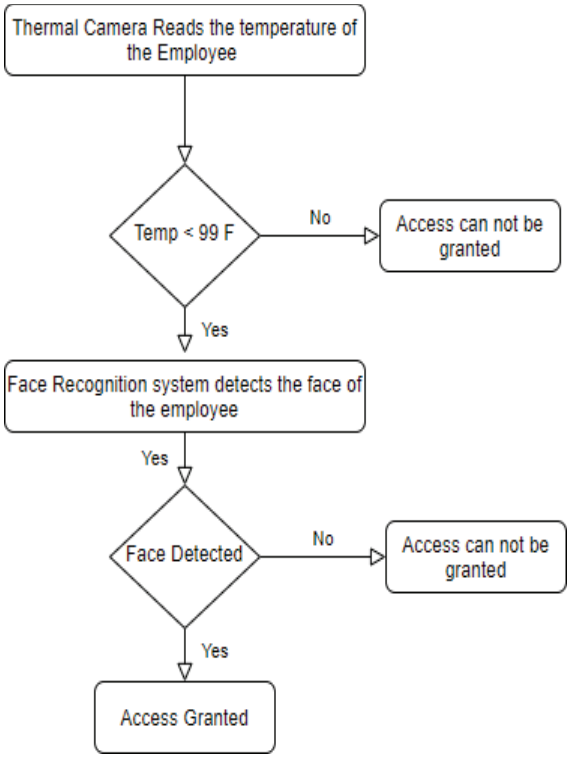

Figure 4: Flow chart

B. *Advantages of the Proposed Model*

Thermal Cameras are currently being used in Airports to scan the people traveling and coming from foreign cities to check their body temperature. At the time of this pandemic, it is important to keep infected people away from other people because the disease spreads with a rapid rate increasing the death rate day by day.

Use of thermal cameras at the airport is not an automated task, it involves a hu-man effort to check the camera constantly and look for people who are being alarmed. The advantage of this model is that the human effort of constantly looking at the camera is removed as we have integrated it with the access control system. The system in addition to giving alarm for the people having a rise in the body temperature will not be allowed access inside the office premise which reduces the risk of an infected person entering and infected many others.

C. *Comparitive Study*

Table 1 shows a comparison chart between the different vendors / companies who are into these types of products.

TABLE I. COMPARISON CHART

	Different products		
Features	***Hikvision***	***Dahua***	***ZKTeco***
Temperature	30°C - 45°C	30°C - 45°C	30°C - 60°C
Accuracy	± 0.5°C	± 0.3°C	± 0.3°C
Distance	0.5 – 1.5 m	0.3 – 0.7m	30 – 50 cm

D. *Future Scope*

So far, we have discussed the advantages of the model proposed. But there are certain limitations to the model currently which may include the accuracy of the camera. The Thermal Camera which we are integrating here does not give the ac-curate measurement because of the installation faults, it gives the measurement approximate values. It is correct to a certain extent, but it is not perfect. The future scope of it is that the camera can be advanced to give accurate results. The accuracy issues of the camera can be worked upon and removed to give a better and correct result. Also, there may be conditions when an infected person does not show an increase in the body temperature and therefore will not be picked by the solution proposed and will be allowed to enter the premise. In the same way, there may be situations when the person is recovered from the infection and still shows an increase in body temperature and therefore will not be allowed to enter.

V. CONCLUSION

Coronavirus disease (COVID-19) is a transmittable disease. It is a new virus that is why it is known as a novel coronavirus. There is no vaccine available to stop COVID-19 till the current date. It is a situation that is affecting everyone's life. We are focusing on employee situation. In this paper, we propose a solu-tion that can detect the higher temperature of the employees. Our solution is based on the thermal camera which is integrated with an access control system of the organization. The employee with a high temperature will not be allowed to enter the organization. He may be infected with COVID-19 and this person can be further examined. We have discussed its advantages and future scope. There are some limitations like the camera accuracy and situations which are not in control like an infected person not showing the higher temperature or uninfected person showing increased temperature. But with little limitations, this solution can help in employee safety.

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