A Novel System for Surgical Gloves Removing and Reusing - IoT Approach

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Abstract. COVID -19 is a threat to any living species. This has not left even animals. Hence, proper precaution should be taken to avoid the spread of this deadly disease. This affects humans, which cause severe respiratory disease. Glove is the important element to stop spreading. But proper removal of glove is not maintained. Fully automated sensor unit is built for hand sensing and gloves removal unit is designed using microcontroller device to remove the gloves. Mechanical setup with the rod is designed to remove the glove from hand. An output LCD display that display the step by step status of removal process. Gloves contamination is measured using thermal image camera. If the gloves are sensed as reusable then from the smart dust bin it is send to further sanitization process. Else the gloves are completely discarded. We know the COVID -19 stays in the surgical gloves for 8hrs. So the reusable gloves are proceeding for the further processing of sanitation and sterilization. Smart bin is placed to collect the reusable glove.

1 Introduction

World is affected by a dreadful respiratory diseases SARS-CoV-2 (Severe Acute Respiratory Syndrome). It is a complete collateral damage all over the world. Many countries are affected severely economically. All transportation, businesses sectors, schools are remain close till now still no positive improvement from the medical side to subside the disease. All look into the daily update of WHO (World Health Organization) report related to COVID -19. It started to spread from China, Wuhan state (Zhongnan Hospital) where, the first case was reported. Later it spreads rapidly and now it affects almost all the countries. It is started with the mild fever and later it turns out to be a severe respiratory disorder, which even leads to death. The dangerous diseases that have stared already take its count on death. And no outbreak in the medicinal is more concern. With the report of WHO social distancing, maintaining one meter distance between person and wearing mask are made a regular practice. Now government has made it as a mandatory rule in many countries. This has made the impact in such a way if any one violates rules they are punishable. Therefore, this COVID -19 is a threat to all living species. This virus has not left mercy to animals. Even cases are file that COVID -19 can affect to animals and they too die from respiratory disorder. This threat has rise up to 10
million cases by the end of August 2020. This may turn to double the rate of spread of the diseases if the current scenario is formulated. This cross the stages of community spread and many countries have seen the second wave of COVID – 19. Only this can be controlled, if all stand together and fight against it. Globally many researchers, academics [1,9], national governments agree to make this situation as more prioritized and word in research and development. With this pandemic situation WHO has developed nearly 150 guidance documents on various aspects of preparedness [11]. A weekly survey of reposts is circulated by WHO for the spread of this disease. The Figure 1 and 2, reports the spread of COVID 19 confirm cases world wide as per the report release 207. Through online and in-person training many concern was taking to the people even in remote areas. Through all possible social networking the spread of virus knowledge has to take to all age groups of people. WHO helped almost 80% of the country regional office to take collaborative initiatives for Global Outbreak Alert and Response Network (GOARN). It also helps to translate guidance and strategies into national plans. ACT tools have been launched to measure medical development [13]. The spread scale of this disease is more rapid and it even breakdown the most resilient health systems [2]. This does not have any pattern change and its states are more importance specialty of this disease. It changes its nature based on the geographical nature of the county. It is continuously changing its nature so prediction of anti bodies is delayed. When the Severity is taken then it is estimated as 20% cases are severe or critical, with an increased risk of spreading.

**Figure 1.** Number of confirmed* COVID-19 by WHO situation report - 207.

The WHO published strategic response and preparedness plan to tackle the disease spread. To limit the harm caused by the disease SPRP has set three objectives. First act of plan is to support countries to plan rapidly establish steps needed financially. It also maintains the correct supply of medicines and equipment evolving epidemiology and risks [3]. It is mandate to give guidance on latest technical training about it. Second, the research and innovation is given top priorities to find cure to SARS-CoV-2. SPRP can help fast track the research and development process and last tackle states that the operational planning during emergency condition.

**Figure 2.** Graphical representation of Number of confirmed* COVID-19 by WHO situation report - 207.
1.1 Coronavirus - Impact

Why is this COVID-19 seen very pandemic? What are its effects? We know globally all activities are stopped due to the pandemic outbreak. This COVID – 19 is a virus that causes illness in both human and animals. In case of humans this corona viruses cause several respiratory disorders started from common cold to more severe breathing problem as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The common symptom found due to the affect of this disease is cold and fever [4]. The COVID – 19 structures was shown in figure 3.

![COVID-19 structures](image1.png)

Figure 3. COVID-19 structures and the deposition of virus on the patient lungs causing difficulty in breathing.

The most common symptoms were fever and cold [2]. Some may experience with nasal congestion, runny nose, sore throat or diarrhea. In some cases people get infected by who does not have any of such symptoms. Most people get out of these without any special treatments but older people and those who have problem with high blood pleasure and other heart and lung disease are affected severely [3]. This is spread from person to person, when the infected person sneezes or coughs. Then small droplets of virus from their body are spreads to the environment. The droplets fell to the land of any objects and when any person is touch, the droplets then it spread to healthy person.

| Surface Type                          | Life time on Surface |
|--------------------------------------|----------------------|
| Metals (doorknobs, jewellery, eating utensils) | 5 days               |
| Wood                                 | 4 days               |
| Plastic                              | 2 -3 days            |
| Stainless Steel                      | 2 -3 days            |
| Cardboard                            | 24 hours             |
| Copper                               | 4 hours              |
| Aluminium                            | 2 -8 hours           |
| Glass                                | 5 days               |
| Ceramic                              | 5 days               |
| Surgical Gloves                      | 8 hours              |
| Paper                                | 5 days               |

The healthy person if breath the virus or touch the virus where it landed and unknowingly touches his/her mouth, eyes and nose then it goes inside any human body. Therefore, it is advisable to have 1
meter distancing when we talk with a person. This can stay for long time in the landing objects. The

table 1 represents the duration of SARS-CoV-2 in various metals and house utensils.

1.2 Protective measures

Be updated with the precaution and information release about COVID-19 outbreak by state and local
public health authority. The spread of this disease is started from china but we see it is be sustained in
major cities and spreading is slow down. We can reduce it by:

- Regularly cleaning our hands by sanitizers or soap to stop spread of virus into our body
  through hands.
- When we come across the person with cough and sneezing 3 feet (i.e., 1 meter) distance.
- Our hand is the source of virus that gets inside our body. So, avoid touching eyes, nose and
  mouth. Because we place hands in many areas where, there may be change of virus particles.
- Look around the people we stay, if any person shows respiratory problem inform it to
  regional hospital and maintain distance with the person’s family members.
- Self isolate if we feel even mild cold and avoid contact with family members.
- Calling in advance the health care facility is more importance so that we could stop spread to
  other family members.

1.3 Role of Doctors and Health care workers

As we know the world is totally stopped due to this pandemic outbreak there are some people who are
in frontline on to stop spreading of this disease and to find cure. Globally people are insisted to stay
indoor the frontiers who work for us to stop spread of the disease [5] and they are preferring the
smarter ways to reduce the stress like smart farming [6] & expect low power models of computations
[7 & 8]. India has received the first case of virus with the travel history from abroad. Doctors and
health care worker are working excruciatingly day and night for the welfare of patients even after
knowing the severity of the disease. Without the proper cure it makes situation too worse for doctors
and other health care worker. Doctors have to attend patients and also they have their own family. So
risk of spreading virus to their own family members is too high. The threat of catching the disease and
that may spread to their family members they stop being to go to their homes. They also extended
their duty hours even they work 18hrs per day [9 & 15]. With the report of doctors from AIIMS who
continuously monitor the COVID – 19 patients, they could not get a solution for treatment of this
pandemics outbreak. With Personal Productive Equipment (PPE) government insists continuously
about the important of the wearing mask and gloves to reduce the chance of spreading of the disease.
With the PPE kit doctor face much difficulty and they are in the apathetic situation that wearing of
PPE kit more than 7hrs is not possible. But with this continuous work in corona ward, it is meant
mandatory to wear mask and gloves. The study says that several doctors and health care persons are
affected with SARS-CoV-2 while treating patients. The Indian Council of Medical Research (ICMR)
filed a report that the chance of virus to spread to doctors is too high. There are certain procedures to
remove gloves and mask [15]. But because of miss leading in the procedure they may have the high
risk of getting this pandemic disease. Wearing of PPE equipment is another issue which was shown in
figure 4. It has multi layer of protective clothing which profuse sweating. Spectacles and Goggles fog
up affects the clear vision. The breathing trouble also there in using face masks and goggles.
Lowering the mask and removing the gloves is often done by the doctors due to breathing difficulties
[16] and it is more better to biomedical based wearable devices to cause the changes [17 & 18].
Hence, to make them more comfort on removing the gloves and mask is regular habitual of doctors. It increases the risk of spreading the disease from patients. There are certain procedure to follow while removing and wearing of gloves and PPE. However, those are not following properly and doctors and health care people are affected by SARS-CoV-2. So, the proposed a system focuses on the ways by which reduces the risk of spread of disease.

2 Proposed Methodology

When the gloves are removed often by the doctor, they do not follow the procedures properly. The dangerous virus stays in gloves for 8hrs. So it is important to follow the procedure to stop spreading of the disease.

As shown in Figure 5a and 5b the improper way of removing the mask may leads to chance of spread of disease. Many researchers who test the virus for getting proper vaccine, health care workers who dispose the medical wastes and other medical representatives use these kinds of gloves regularly. But removal procedure is not properly formulated then they may get chance of spreading of virus. There are different types of gloves available in the market. But we study about the surgical gloves which will be used by doctors regularly. With the proximity sensor and image processing technique [5] the complete automated process for gloves removal is done and that reduce the spread of the pandemic virus like SARS-CoV-2.

2.1 Fully automated sensing and Gloves removal block

Fully automated sensor unit is built for hand sensing and gloves removal unit as shown in the Figure 7. A microcontroller that gets input from the sensor and the other unit connect to it and performs the activity of completely automated hand gloves removal. With the image processing the gloves can be separated as reusable and non-reusable. Smart IoT device with training algorithm performs the operation with lower power consumption [19 & 20]. If the gloves are sensed as reusable then from
smart dust bin, it is send to further sanitization process. Else the gloves are completely discarded. We know the COVID-19 stays in the surgical gloves for 8hrs. So the reusable gloves are proceeding for the further processing of sanitation and sterilization. A movable rod is used to remove the gloves from the hands. They are placed inside the sanitizer block to avoid infections. Ionizing rays are passed to movable rod each time, when one person completes the removal [21]. Ionization is the used to remove the microbiological [7 & 8] contamination in the rod while removing the gloves. High voltage electron beam 10 MeV is passed and gamma rays with radioisotopes Co-60 and Cs-137 are used for removal of microbiological contamination. With the passage of gamma rays that has the capability of killing micro organism. Co-60 is widely used because it can be easily manufactured from natural metals. This gamma radiation sterilization is more for larger scale in commercial manufacturing and also in hospitals [16 & 14].

![Sanitizer Block Diagram](image)

**Figure 6.** a) Sanitizer block diagram and Circuit implementation for sanitizer block b) Gloves fit in movable rod

This is declared as safe to use by US Center for Disease Control and Prevention, the United Nations and the World Health Organization. The ionization radiation is passed based on the range coated in [1].

### 2.2) Methodology

The working of the sanitizer block is to sanitize the movable rod each time after removal of gloves. When any health care worker is in need of removal of gloves, then they march downward from the sanitizer block towards the automatic hand sensing unit which, is also placed inside the sanitizer block [3] like a cardiac pacemaker to heart [2]. For the health care worker who tries to remove the gloves an automatic sanitizer block will sense the hand and removes the gloves. This helps them from prevention of virus spreading. Infrared proximity [10 & 6] sensor is used for automatic detection of presence of hands as shown in the Figure 6 a.
Figure 7. Complete automated mechanism for removal of gloves

When the presence of hand with gloves is detected then the sensor signals are transmitted to the microcontroller. Hence, the movable rod is inducing a start with the solenoid drives. The voltage variation cause the solenoid drives to get movement of pushing and pulling of movable rod. We have contact free environment, which will reduce the spread of virus. This is highly preferable in the current situation of COVID-19. We know that because of frequently wearing and removal of gloves the doctors and other health care worker are not often maintain the follow up procedure for removal [11 & 12]. Hence there may a chance of spreading of infection inside the body through hands. The sanitizer block contains the automatic hand detection unit when the hand with the gloves is place it will sense the type of glove and an rod from the sanitizer block take its path downward to collect the gloves.

The health care worker should fit the hands inside the removable section of rod as shown in the Figure 6 (b). Then a pull down a movement to removes the gloves from the hand. When the gloves removed from the hand, again the IR sensor will detect the completion of process and proceed to next level. In the next step, the camera captures the image of gloves and further processing is done at gloves contamination block. Display section in the Figure 6 displays the hand detection message, completion of glove removal message and the next step of segregation of reusable and non-reusable gloves. Smart IOT device performs the calculation related to the result obtain [4 & 19]. Once the gloves are being removed they are disposed to the smart dust bin for the further process. The gloves can be classified to reusable and non reusable in this process. It is done by smart dust bin which have a colour sensor to measure the quality of the gloves as one parameter. Gloves quality is measured in mile. The figure 8 shows the identification of different surgical glove. In medical field mostly two types of gloves are used which is Nitrate and latex. The first step in the process of reuse of glove is to identify the type of glove. Usually gloves are available in 2 to 15 mile of thickness [15 & 16]. Threshold is set to differentiate the glove as mentioned in the figure 8. If the threshold is maintained between 0.15mm then it should be a type of nitrate glove else it will be identified as latex glove.
Gloves contamination is done using thermal image camera. With the white representation of warm, hot and bright object the image is segmented from its surrounding. The blobs in the infrared image are extracted and intensity of the image is adjusted with the mean of original image. During segmentation the edge detection and spoken filtering process are done. The first order statistics is given by,

\[ T = k_1 \times \mu + k_2 \times \sigma \]  \hspace{1cm} (1)

For low resolution image \( k_1 = k_2 = 1 \) and for high resolution image the value if \( k_1=k_2= 1.5 \) to 2. The values of \( k_1 \) and \( k_2 \), are determined manually. “T” value should be maintained greater than 255. Two step processes is done for feature extraction and it needs to be located first [14 & 3]. Then secondly threshold is obtained from region grown around the defected seeds. Threshold for image \( f \) should be \( T = f(i,j) \), agglomerated of \( T \) with n pixels are calculated. The brightness is maintained as multiplication factor of \( n \) and \( T \). This is repeated until the boundary of the pixel is reached.

Hamadani’s based algorithm is not fully automated the centre crossbar is detected by considering 50 pixels for each seed. Olio\’s method is an automatic detection with dilated wavelet set [18]. Optimal threshold image is obtained with the maximum level of sum of two class entropies which is represented by histogram. Many algorithms were proposed to get the accurate result. But we use local intensity based neighbouring operation. This has the capability to brighten the dark area and dark the brighter area. And in the second stage this does vies-versa. This technique has an assumption that the defect is present at the brightest area. Consider the pixel \( f(i,j) \) with the grey scale representation from \( f(i-1, j-1) \) to \( f(i+1, J+1) \). This can be simplified as \( Z \). The figure 9 shows heat variation on non-detective gloves.

Figure 8. Flow Chart to Identify the type of Material

Figure 9. Heat variation on Non – Defective Gloves
\[ Z = \prod_{k=0}^{6} z_k \] (2)

IBO and IDO is given in equation 3. Pixels are normalized using maximum pixel value is obtained after each iteration.

\[ g(i,j) = Z \]

\[ g(i,j) = \begin{cases} \frac{1}{Z} & \text{for } Z \neq 0 \\ 1 & \text{for } Z = 0 \end{cases} \] (3)

![Flowchart for Quality Inspection of Gloves](image)

**Figure 10.** Flowchart for Quality Inspection of Gloves

Pixel got reallocated with the histogram image processing. IBO can be applied repeatedly and IDO is applied only once. In need of further separation IBO is applied again. Mean absolute thresholding is calculated with max and min values obtained. With the obtained results the defective glove is identified. The quality inspection process for the glove was shown in figure 10.

### 3 Results and Discussion

The value of k1 and k2 determine the threshold results. The high resolution and low resolution image have different impacts. The values have been adjusted for different images as they have variation in the resolution shown in the figure 11 and 12. The histogram plot representation of fault detection is also shown.

**Sample Glove 1**

**Sample glove 2**

**Sample glove 3**

*Figure 11 a) Histogram plot of faulty gloves b) Fault detection in gloves*
Number of defected glove is analysed. IR analysed the 97% of the defects correctly. 8 out 9 defects are shown perfectly. Reliability of IR sensor camera identifies the fault carefully.

![Figure 12. Number of defects](image)

Pareto chart analysis for faulty gloves. This is also known as 80/20 rule. The data set is taken after the pre processing and image segmentation. The value of Pareto gives 20% value with 80% problems. The set of 10 is processed to find the defect percentage. The defective glove is identified from the batch and they are segregated. Identifying different defect using Pareto algorithm is shown in the figure 13. (b).

![Figure 13. a)Pareto chart for Defect gloves b)Accuracy graph](image)

Accuracy is one important factor to consider which is shown in figure 13b. Surgical glove is used to avoid the harmful germs that get inside our body. So the proper sterilization and checking of defects is done with 97.5 per accuracy that shown in the figure.

4 Conclusion

SARS-CoV-2 a deadly virus which affects all over country and it cause severe respiratory problems. The wearing of gloves by health care person like doctors, medical representatives and medical trash collectors are to be taken care for preventing further spread of dangerous disease. Hence our proposed model provides the proper way of removal of gloves and it uses the smarter technology on classifying them and the information are processed via IOT cloud. The lifespan of that virus is 8hrs in gloves. The associated sensor unit for detection of hands and the movable electronically controlled rod to hold them and smart dustbin to separate them are connected together to enhance the virtual understanding of the proposed model. Henceforth, proper removal of gloves and the contamination leave are connected measured and stored in the cloud for the future purposes also the hardware block is controlled by the microcontroller which gets input from the sensory unit and actuators connect to
it. It activity performs the automated hand gloves removal followed by sanitation and gloves classification. Also the reusable of surgical gloves after sterilization is composed using image processing technique. Smart bin is fitted with the entire model to collect the gloves and image processing technique is used for classification of reusable and non reusable glove. The faulty glove and reusable glove can be collected separately using smart bin. Henceforth, a better community can build using this model which focuses the cut down of spreading from the origin of creation.

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