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EFFICIENT GLOVE EXTRACTION AUTOMATION SYSTEM

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ABSTRACT: This paper focuses on the automated gloves removal system. In many industries, gloves are used frequently, but there is no proper system for their removal. In the medical sector, this becomes a critical issue that professionals face every day. There is a high risk of contaminating surfaces with germs during surgeries, and medical professionals must change gloves regularly. However, there is currently no automated system for glove removal; it is still done manually. The manual removal process is inefficient and time-consuming, and it also increases the risk of contamination. Therefore, this paper proposes an automated glove extraction system. While automatic glove-donning machines already exist on the market, there are no machines specifically designed for the automated removal of gloves. The proposed glove extraction system could not only be applied in the medical sector but also extended to industries such as pharmaceuticals, chemicals, and food processing, where safety and hygiene are paramount. The paper presents simulation results prior to the implementation of the prototype system. MATLAB programming and Wokwi.com, an online platform for simulating Arduino projects, were used to simulate and test the system's functionality.

Keywords: actuators and sensors, glove extraction and medical sector.

1. INTRODUCTION

The importance of frequent glove changes in the health sector is due to the high risk of spreading germs and infections to the patient and staff. However, there is an automated glove-donning system and there is no automated glove-removal system. Therefore, an automated glove extraction system can reduce the spread of germs, ensuring the process is both safe and efficient. With the automatic glove donning and removing system, the chemical industry and food industries enhance their efficiency without the need for manual hand sanitization. In these sectors, gloves are frequently removed for reasons such as healthcare protocols or food processing (Johnson & Rivera, 2022).

The industry implemented the automated glove-donning system that considers the requirements and efficiency of the medical sector as well as other sectors (Kapoor 2023; Tan 2024). It will take more time to remove gloves manually in emergencies and it is a significant challenge to healthcare professionals (Emerald Insight, n.d.). The most disadvantaged factor is germ infection among both patients and staff, it is high-risk in the medical sector (MACFOS, 2020; Robosavvy, n.d.). The main contribution of this paper is to introduce an automatic glove removal system and implement based on simulations. For future development, we suggested implementing the glove extraction system in the prototype and safe disposal. Due to infection, we focus on a proper automated system for disposal of gloves and sanitise the hands.

2. METHODOLOGY

The system was designed as mentioned in Fig. 1. The process begins with an ultrasonic sensor detecting the user's hand and sending a signal to open the door of the machine. The door is then opened using a rack and pinion linear actuator. Once the door is open, the user places their hand inside the machine, positioning it on a vacuum cup attached to an electric linear actuator, which is equipped with a slightly larger vacuum cup. Next, two additional linear actuators, each fitted with a slightly smaller vacuum cup, descend from above to grip the wrist area of the glove. The mouth of the glove is then widened as these actuators, along with a third actuator, move forward parallel to the hand, removing the glove. The removed glove is immediately directed into a bin. After this, the actuators return to their starting positions, ready to repeat the process for the next glove. Table 1 mentions the component list and technical details of the system design.

Table 1. Component list and technical details

Component List	Technical Details
Infrared (IR) Sensors	3.3V to 5V DC, 10-20 mA, 0.1W
Electric Linear Actuators	12V or 24V DC, ranges from 0.5A to 5A or more, depending on force and speed, 180W
Motors	12V DC, range from 0.5A to 2A, depending on the motor size and torque requirements, 5W
Actuators Operation	12V or 24V DC, from 0.5A to 5A, depending on the specific function and actuator size
Vacuum System	12V DC Mini Vacuum Pump, 12V DC, 1A to 5A, depending on the pump's capacity and usage
Solenoid valve	5W, 12V DC
Mini Vacuum Pump	48W
Arduino Mega 2560 Board	0.25W
Relay Module	4W
RF module kit	1W
LCD	0.5W

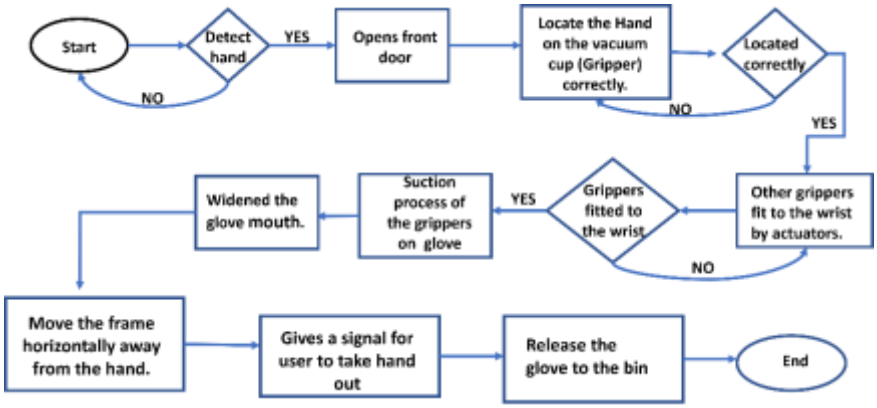

Fig. 1. The flowchart of the glove removal system.

To facilitate the initial testing and validation of our code, we utilized Wokwi.com, an online platform for simulating Arduino projects. Although the platform had limitations in terms of component availability, we employed similar components and made necessary assumptions to approximate the behaviour of our actual system. This approach enabled us to develop and test a preliminary version of our control code. The code was successfully compiled on Wokwi.com without errors, providing a robust foundation for further development.

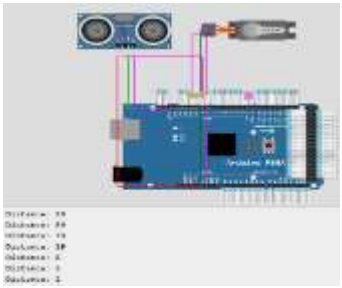

Fig. 2. When the distance is 2cm, the servo motor works.

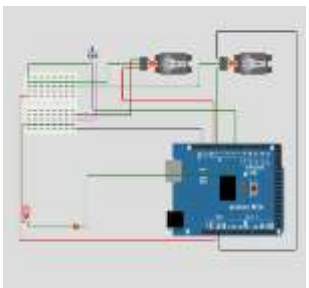

Fig. 3. Actuators moving forward.

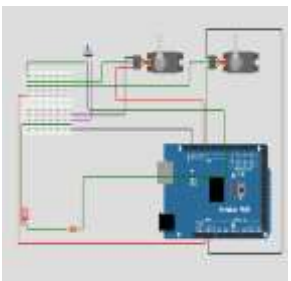

Fig. 4. Actuators moving backward.

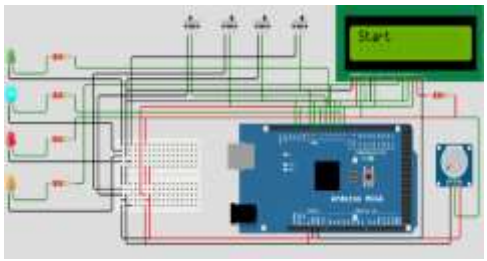

Fig. 5. The system display “Start”.

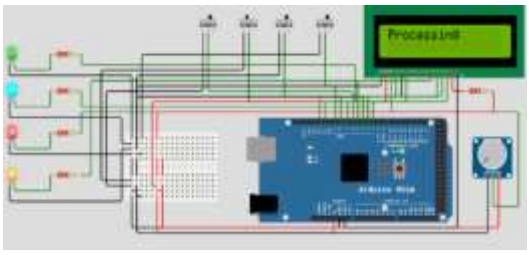

Fig. 6. The system display “Processing”.

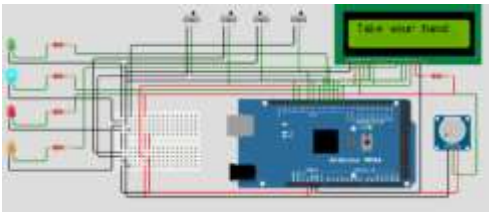

Fig. 7. The system display “Take your hand”.

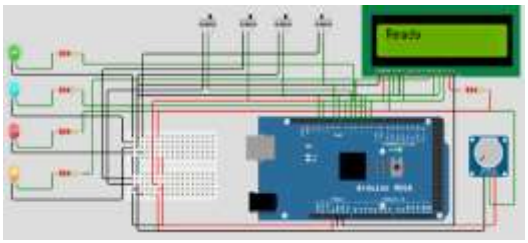

Fig. 8. The system display “Ready”.

3. RESULTS AND DISCUSSION

In this section, we present the implemented circuit and the results of the glove-removing system.

Fig. 2 illustrates the results of opening the door when the hand is positioned two centimetres closer to the machine. Fig. 3 and 4 demonstrate that when the wrist of the hand is within two centimetres of the ultrasonic sensor, the sensor detects the hand and activates the servo motors in forward mode. The motors operate in this mode for three seconds, followed by a three-second pause to allow the vacuum pump to secure the wrist of the glove. Subsequently, the servo motors run in reverse for three seconds, causing the glove's mouth to widen. Fig. 5 shows the "Start" display, which appears when the door is opened. Fig. 6 depicts the "Processing" display, which is shown when the wrist is detected by the sensor on the actuator inside the machine. Fig. 7 illustrates the "Take Your Hand" display, which appears when the glove has been fully removed from the hand. Finally, Fig. 8 shows the "Ready" display, indicating that the system is prepared for the removal of the next glove.

4. CONCLUSIONS

In conclusion, our research aims to develop an automatic glove removal system and currently, it is not available on the market. It helps with the hygienic disposal of used gloves in operating theatres. The simulation model is developed and according to the simulation results, the system is working efficiently. In addition, the progress can be monitored using the display. This innovative system is designed to enhance efficiency and minimize the spread of germs, thereby contributing to a safer and more sterile surgical environment.

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