ANIMATRONIC HAND

Dnyaneshwari S. Ganorkar [1], Shravani M. Wankhade[2], Mrs. Rachana M. Patil[3]

[1]Student of Department of Electronics and Telecommunication Engineering ,Mauli College of Engineering and Technology ,Shegaon-444203(Maharashtra) India
[2]Student of Department of Electronics and Telecommunication Engineering ,Mauli College of Engineering and Technology ,Shegaon-444203(Maharashtra) India
[3]Assistant Professor at Department of Electronics and Telecommunication Engineering ,Mauli College of Engineering and Technology ,Shegaon-444203(Maharashtra) India

---***---

Abstract - The field of robotics have been witnessed remarkable advancements till now, with the aim of creating intelligent and versatile machines that can mimic human capabilities. The primary objective of this project is to design and construct a hand that achieves natural and fluid movements, enabling it to perform intricate tasks with precision. The design of the animatronic hand will prioritize durability, safety, and power efficiency. These key considerations will ensure that the hand can withstand prolonged usage, operate safely in various environments, and optimize power consumption for extended battery life. The project will culminate in the delivery of a fully functional prototype, accompanied by comprehensive documentation and rigorous testing to showcase its capabilities. Additionally, a user-friendly interface will be developed for both manual control and programming of customized gestures, making the hand adaptable for various applications.

Key words: - Advancements, Animatronic hand, Dexterity, Flexibility, Sensors, Power efficiency, Prototype

1. INTRODUCTION

The development of animatronic hands represents a groundbreaking advancement in robotics, offering innovative solutions to mitigate risks associated with human involvement in hazardous environments. Industries such as nuclear and chemical sectors face significant challenges in ensuring worker safety while handling potentially harmful substances. Similarly, the medical field seeks innovative technologies to enable remote surgical procedures and enhance patient care. In response to these challenges, the concept of animatronic hands emerges as a promising solution.

This research paper aims to explore the design, implementation, and applications of animatronic hands in various industrial and medical settings. By leveraging the capabilities of Arduino Uno microcontrollers, flex sensors, and servo motors, these robotic devices can replicate human hand movements with precision and efficiency. Moreover, the integration of wireless control mechanisms enables remote operation, thereby reducing the need for direct human intervention in hazardous environments. The significance of this research lies in its potential to revolutionize workplace safety and accessibility across diverse industries. By replacing human hands with animatronic counterparts, tasks that pose risks to human health can be performed with greater efficiency and reduced exposure to danger. Additionally, the adaptability of animatronic hands makes them invaluable tools for assisting individuals with physical disabilities, fostering greater independence and autonomy.

In the subsequent sections of this paper, we will delve into the technical aspects of animatronic hand design, including sensor integration, control mechanisms, and real-world applications. Through empirical analysis and case studies, we aim to demonstrate the efficacy and practicality of animatronic hands in enhancing workplace safety and productivity. Furthermore, we will explore future research directions and potential advancements in this field, highlighting the transformative impact of animatronic technology on human-machine interaction.

2. MODELING AND ANALYSIS

1. Human Hand-Glove

In the development of animatronic hands, flex sensors play a crucial role by capturing the intricate movements of the human hand. These sensors, affixed to the hand, detect the bending and motion of fingers and the hand itself. Operating as transducers, flex sensors quantify both the degree of bend and angular deflection. Typically constructed with a variable resistive circuit, they undergo changes in resistance as they are bent. In this project, the flex sensors utilized measure 2.2 inches in length, providing adequate coverage for a range of hand movements. With two terminals, flex sensors exhibit variable resistance, increasing as the sensor bends. To interface with the Arduino Uno microcontroller, one terminal connects to the power supply, while the other is grounded to the Arduino uno. Implementation on the Arduino, facilitated by a computer interface, allows for real-time monitoring and control. The provision of power to the Arduino ensures continuous operation, enabling seamless integration of flex sensor data into the animatronic hand system.

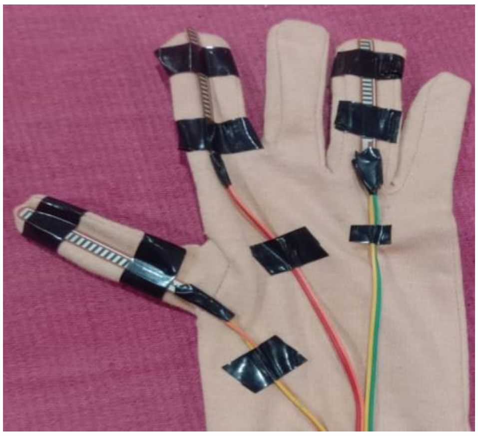

Fig 2.1: Human Hand-Glove connection

2. Artificial hand

Fig 2.2: Artificial Hand

The Receiver module interfaces directly with the Arduino, where essential components ensure smooth operation. Within this module, a voltage regulator with a fixed output voltage of 5V provides stable power supply, vital for consistent performance. A 10k ohm resistor serves to filter the output of the voltage regulator, enhancing signal integrity. The connection between the servo motor and the Arduino Uno is established, with the servo motor featuring three pins: Ground, positive terminal supply, and control signal. Once connected, the servo motor becomes an integral part of the animatronic hand system, linking directly to the artificial hand. Programming tasks are executed within the Arduino environment, where commands are generated and relayed to the servo motor. As the servo motor receives these commands, it initiates corresponding movements in the artificial hand, thereby orchestrating precise and responsive actions dictated by the Arduino program. This seamless integration and control mechanism ensure the effective execution of tasks by the animatronic hand, enhancing its utility and versatility in various applications.

3. The Flex sensor

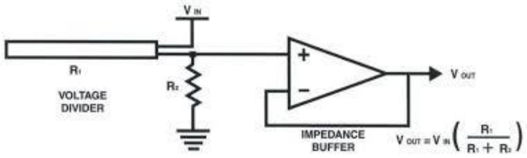

Fig 2.3: Circuit diagram of flex senso**r**

A pivotal component mounted on the human hand, operates as a variable resistance device, undergoing changes in resistance when bent. This resistance alteration is directly linked to the degree of bending, with a higher bend angle resulting in increased resistance. Functionally, flex sensors, also known as analog resistors, function as variable analog dividers within their structure. They contain carbon resistance elements embedded within a flexible substrate, where a higher concentration of carbon leads to reduced resistance. When the substrate is subjected to bending, the flex sensor generates a resistance output proportional to the bend radius. In essence, the flex sensor's resistance dynamically adjusts in response to the hand's movements, providing valuable input for controlling the animatronic hand system.

Fig2. 4: Flex Sensor

4. The servo motor

It is crucial for manipulating finger movements within the hand, comprises three output wires: Red, Orange, and Brown. These wires serve distinct functions in facilitating the motor's operation. The Red wire connects to the power supply, providing the necessary voltage for motor activation. Meanwhile, the Brown wire serves as the grounding connection, completing the electrical circuit. The Orange wire, designated as the signal wire, carries the pulse-width modulation (PWM) signal from the Arduino. This signal, generated by the Arduino, determines the precise angle of movement for the servo motor. Through programmed instructions, the Arduino dictates the magnitude of the PWM signal, thereby regulating the angle at which the servo motor rotates. Consequently, the movement of the servo motor is intricately controlled by the Arduino's programming, allowing for precise and coordinated finger movements within the animatronic hand system.

Fig 2.5 : Servo Motor

5. The Arduino Uno

A versatile microcontroller board, serves as the central control unit in numerous electronic projects and prototypes. Featuring an Atmega328P microcontroller, clocked at 16 MHz, it offers a wide array of digital and analog input/output pins for interfacing with sensors, actuators, and other peripheral devices. Equipped with flash memory of 32 KB, of which 0.5 KB is reserved for the bootloader, and SRAM of 2 KB, the Arduino Uno provides sufficient memory and processing power for executing complex tasks. Its onboard USB interface facilitates easy programming and communication with external devices, while the integrated voltage regulator ensures stable operation across varying power sources. Additionally, the Arduino Uno is supported by a vast community of enthusiasts and developers, offering extensive documentation, libraries, and online resources. With its user-friendly development environment and robust hardware capabilities, the Arduino Uno continues to be a cornerstone in the realm of embedded systems and DIY electronics, empowering users to bring their creative ideas to life.

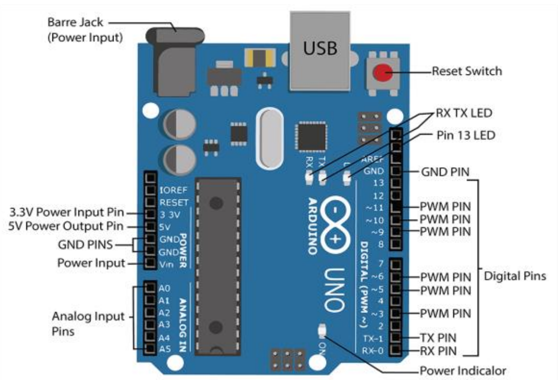

Fig 2.6 : Arduino Uno Description

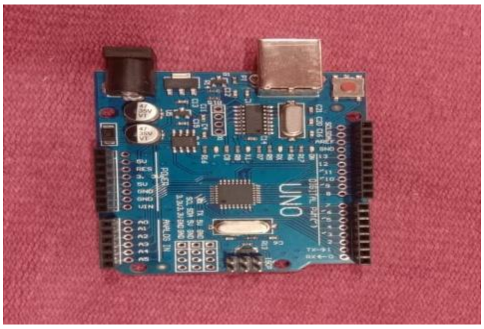

Fig 2.7: Arduino Uno

3. RESULTS

The animatronic hand, a wireless component integrated into a humanoid robot, operates seamlessly in tandem with the human hand through the utilization of flex sensors. Initially tested with a single finger, the flex sensor responds to the bending of the human finger, causing a change in resistance. This change is duly detected at the receiver end, where the corresponding artificial hand finger mimics the movement angle and mannerisms of the human finger. Achieving this coordination is made possible through the precise control exerted by servo motors, which handle the moment of each robotic finger. With all five fingers synchronized to mirror the movements of the human hand, the wireless operation enhances flexibility and versatility. Programming, executed through Arduino software on a PC, forms the backbone of this process, encompassing both transmitter and receiver sides. As the flex sensor detects finger movement, Arduino interprets and transmits this data wirelessly, enabling real-time communication between the human hand and the artificial hand. At the receiver end, Arduino orchestrates servo motor responses to replicate finger movements with utmost accuracy, underscoring the critical role of programming in the seamless operation of the animatronic hand.

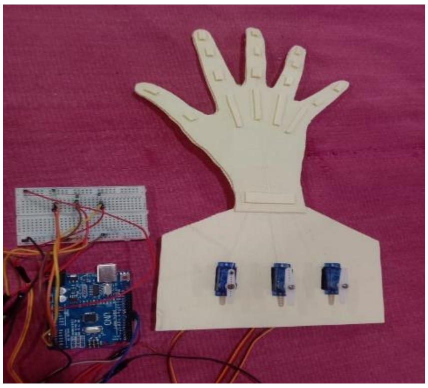

Fig 3.1 : Animatronic hand

Fig 3.2:: Human hand glove with Flex Sensor

4. Conclusion

Undoubtedly, robotic advancements have revolutionized everyday tasks, and the Animatronic hand epitomizes this efficiency by multitasking seamlessly. This technology not hazards or risks to human life. Moreover, the potential of the Animatronic hand can be further amplified by overcoming obstacles and operating in diverse conditions, including air and water. Precision in finger movements is crucial for its broader adoption, prompting ongoing research aimed at refining its capabilities, such as mobility and load-carrying capacity. Cost reduction measures, such as leveraging wireless communication technologies like Bluetooth, hold promise for wider accessibility. Particularly for individuals with physical disabilities, the prospect of a more affordable and efficient Animatronic hand signifies a potential blessing, paving the way for greater independence and empowerment. Only saves time but also enhances productivity by enabling simultaneous completion of multiple tasks. Its applicability expands significantly, particularly in environments fraught with

REFERENCES

[1] Sachin Kumar Gupta. "Arduino-Based Wireless Hand Gesture Controlled Robot" Published in: Jan 2023 IEEE American Institute of Physics (AIP)

[2] Virendra Sangtani, Manish Poswal, Ravi Ram Meena, Saurabhmeena, Vikashyadav, Mohit Vishnani. "Animatronic Hand" Published in: Jun 2022 IEEE International Research Journal of Modernization in Engineering Technology and Science (IRJMETS)

[3] Swarnika Shruti, Savita Kumari Verma, Shrishti Singh, Tanya Gupta. "Arduino Based Hand Gesture Controlled Robot" Published in: May 2021 IEEE International Research Journal of Engineering and Technology (IRJET).

[4] Munir Oudah, Ali Al-Naji, Javaan Chah. "Hand Gesture Recognition Based on Computer Vision: A Review of Techniques" Published in: Jul 2020 IEEE Multidisciplinary Digital Publishing Institute (MDPI).

[5] A. Sai Ramya, R. Madhuri, M. Suryanarayan Murty, Mithiun Bhandari, V. Ramsai. "Robotic ARM Controlled by Human ARM" Published in: Mar 2018 IEEE International Journal of Scientific Engineering and Technology Research (IJSETR)