Gesture Controlled Rescue and Search Vehicle (GCRSV)

A

Minor Project (IS3270)

Report

Submitted in the partial fulfilment of the requirement for the award of

Bachelor of Technology

in

CSE (IoT and Intelligent Systems)

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STUDENT DECLARATION

We hereby declare that this project, ***Gesture Controlled Rescue and Search Vehicle*** *is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the University or other Institute, except where due acknowledgements have been made in the text.*

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CERTIFICATE FROM GUIDE

*This is to certify that the work entitled "**Gesture Controlled Rescue and Search Vehicle**" submitted by **Radhey Sharma** (219311078) and **Saahil Chaudhary** (219311062) to **Manipal University Jaipur** for the award of the degree of **Bachelor of Technology** in **CSE (IoT and Intelligent Systems)** is a bonafide record of the work carried out by them under my supervision and guidance from Jan 08, 2024 to April 26, 2024.*

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ABSTRACT

The Gesture-Controlled Rescue and Search Vehicle (GCRSV) project introduces an innovative approach to search and rescue robotics by implementing a custom potentiometer model for wrist orientation detection. This technology enables operators to intuitively control the rover's movements and functions by rotating their wrist, offering a natural and ergonomic interface for real-time command execution. The GCRSV system integrates hardware components such as motors, sensors, and a custom potentiometer with software algorithms for gesture recognition and autonomous navigation. Through systematic design and development processes, including hardware prototyping, software implementation, and extensive testing, the GCRSV demonstrates enhanced usability, responsiveness, and effectiveness in supporting emergency response operations. The project's outcomes highlight the potential of gesture-based control systems in improving the efficiency and reliability of search and rescue missions, ultimately contributing to the advancement of robotic technologies in critical scenarios.

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Introduction

In an emergency, search and rescue are of the essence and the circumstances of most searches and rescues can be difficult — remote or otherwise inaccessible and often dangerous. It’s because of these limitations that new solutions are needed for accelerating and making search and rescues more time-efficient. We’ll talk about one such solution: the Gesture Controlled Recovery and Search Vehicle (GCRSV). Here we will discuss the development, operation and implications for new GCRSVs, focusing on their precision and potential in search-and-rescue. Search and rescue are important parts of disaster and accident response and recovery and the use of traditional search and rescue technologies in this process has saved many lives in many ways. However, these traditional methods often have difficulties to overcome including accessibility, difficult terrain conditions and time.

These are hurdles the GCRSV aims to overcome by providing handheld control tools for swift and easy operation in search and rescue missions. Of course, the GCRSV is all concept right now. But, as we'll see below, the ideas can and probably will change -- but in this case, it's not at all hard to imagine the GCRSV being in some way unique in the domain of search and rescue technology.

The work that has already been done in this domain of GCRSV development involved experts, designers, and rescue experts. The first phase involved conceptual thinking and researching the possibility of investigating the deployment of portable technology in search and rescue situations. This led to the piping and testing of new and fixture designs for easier and faster assembly and disassembly of GCRSV, and improving the design, functionality and user interaction among the toolbox for flawless real-world performance. This loop of feedback and continuous improvement is an essential aspect of the build cycle and is responsible for the car’s power and efficiency.

It can run machinery and professional behaviours in rescue control and the vehicle is more powerful because of the absence of human indecision. It has rugged chassis and wheels capable of driving anywhere. It also has advanced altitude sensors for navigation or keeping balance against obstacles. GCRSV is a vehicle driven completely by hand and makes possible all kinds of repetitive actions that effectively save time a salient point not to be ignored in man-machine interface development. Furthermore, where GCRSV has cameras, thermometers and other kinds of sensors which are often used to enhance situational awareness or to conduct precise searches for survivors in difficult settings. More than that, the vehicle's design can be altered according to the task at hand--providing a variety of options and thereby making it adaptable in different environments as well. Unmanned Operations and user control interface design during the operation of the hand gestured GCRSV, brings convenience to all workers in rescues.

Motion gesture control systems convert a series of hand movements into simple and natural commands such as forward, backward, left, right and stop. Since it requires minimal training, first responders with a wide range of technical background can communicate quickly and concentrate on more critical tasks. Visual and auditory cues give immediate feedback to validate command actions and to enhance situational awareness. The interface also allows for remote operation, so that rescuer can control the vehicle from a safe location and navigate through safe zone.

GCRSV’s could enhance the efficiency and effectiveness of search and rescue operations in various scenarios such as natural disasters, forest fires, and urban incidents. By providing rapid response, precision and adaptability to situations where time is of the essence, and where conventional methods won’t suffice.

The GCRSV can scan areas otherwise impossible to access, reducing the time and manpower needed for a successful rescue. The fact that it can handle rough terrain pinpoint survivors and deliver supplies for their survival and/or rescue is just the beginning. GCRSV's reduced impact sensitivity means fewer obstacles impeding rescue and recovery, minimizing the time and effort emergency workers need to deploy and use it.

GCRSV represents a step forward in search and rescue, but it's hardly a complete solution. More work in this field is needed before it becomes relevant. Gesture recognition, sensor fusion and autonomous driving technologies will only take things so far -- the more of these features a vehicle has, the more it can handle all sorts of situations. Moreover, there are more basic issues to solve, such as battery life, extended use and how a vehicle wakes up quickly enough to be effective in its response. The only way the GCRSV will be truly effective for distribution is if charities, government agencies and businesses work together to use it to save lives and get them back on track.

Motivation

The motivation for developing the Gesture-Controlled Rescue Search Vehicle (GCRSV) stemmed from a deep commitment to saving lives in communities around the world and reducing the impact of disasters and emergencies. The fact is, natural disasters or human can happen at any time, and they leave destruction in their wake. It is at this critical time of crisis that the need for innovative solutions becomes most apparent. Consider a natural disaster like earthquake or hurricane situation, where buildings collapse, roads become impassable and communication systems fail. In such chaotic environments every minute reduces the chances survival of those being trapped under the ruins. Traditional search and rescue operations that rely on manual labor and are limited by geographical constraints often struggle to meet the immediate demands of the situation and this is where GCRSV steps in, offering them a lifeline. With its ability to navigate rough terrain, navigate obstacles and locate survivors with precision, the vehicle has been adapted to disaster scenarios with advanced sensors and communications systems embedded in the vehicle, and can rapidly scan the area for signs of life, identify trapped individuals and specifically transmit them to location to rescue teams, as well as intuitive hands-free operation for rescuers is capable of handling the vehicle with ease, even in high-stress situations where every second counts.

However, the benefits of GCRSV extend beyond natural hazards. For investigative missions such as locating missing persons or refugees in remote areas, the vehicle offers distinct advantages in agility and maneuverability. Through dense forests, steep mountains, or cities, GCRSV provides search teams with a way to cover the ground quickly and efficiently

Similarly, after mining accidents or industrial disasters where workers may be trapped underground or in hazardous areas, the GCRSV is an important asset in rescue efforts. Its ability to move through confined spaces, stops critical situation edge, and providing real-time situational awareness allows rescue operations to progress safely and effectively.

Statement of Problem

In search and rescue operations, time is of the essence, and the effectiveness of rescue efforts often hinges on the efficiency of the methods employed. Traditional search and rescue techniques, while effective to some extent, are not without their limitations.

Existing Methods	Pros	Cons
Manual Search and Rescue Teams	- Human intuition and expertise can be leveraged	- Limited by physical endurance and terrain obstacles
	- Familiarity with local terrain and conditions	- Time-consuming and labor-intensive
	- Flexibility to adapt to changing situations	- Risk to rescuers' safety
Canine Search Teams	- Enhanced olfactory capabilities for locating survivors	- Dependent on weather conditions and terrain
	- Ability to cover large areas quickly	- Limited by training and availability of dogs
	- Can detect signs of life in challenging environments	- Requires handler coordination
Aerial Surveillance	- Provides a bird's-eye view of the search area	- Limited visibility in adverse weather or terrain
(Helicopters, Drones)	- Rapid deployment and wide coverage	- Costly to operate and maintain
	- Can identify survivors or hazards from a distance	- Limited endurance for prolonged search operations
Ground-Based Vehicles	- Can navigate rugged terrain and confined spaces	- Require manual operation or pre-programmed routes
(Rovers, Robots)	- Can carry specialized equipment for search and rescue	- Limited autonomy and flexibility
	- Reduced risk to human rescuers	- Vulnerable to mechanical failures or communication loss

Table 1: Pros and Cons of Existing Search and Rescue Methods

While these existing methods have proven effective in many cases, they also have inherent limitations that can hinder rescue efforts, particularly in complex or hazardous environments.

In light of these challenges, there is a pressing need for a more efficient and adaptable approach to search and rescue operations. The development of a Gesture-Controlled Rescue and Search Vehicle (GCRSV) aims to address these limitations by offering a versatile, intuitive, and technologically advanced solution that enhances the capabilities of rescue teams and increases the likelihood of successful outcomes in emergencies.

Facilities Required for Proposed Work

HARDWARE REQUIREMENTS-

1. Arduino UNO
2. Breadboard
3. Motor
4. H-Bridge (L298N Motor Driver)
5. Bluetooth Module (HC-05)
6. Jumper Wires (Male to Male, Male to Female)
7. Potentiometer
8. Accelerometer
9. Servo Motor

SOFTWARE REQUIREMENTS-

1. Arduino IDE
2. Tinkercad
3. Serial Bluetooth Terminal
4. Windows 7 or above / Linux any distros / Macintosh

Methodology/ Planning of Work

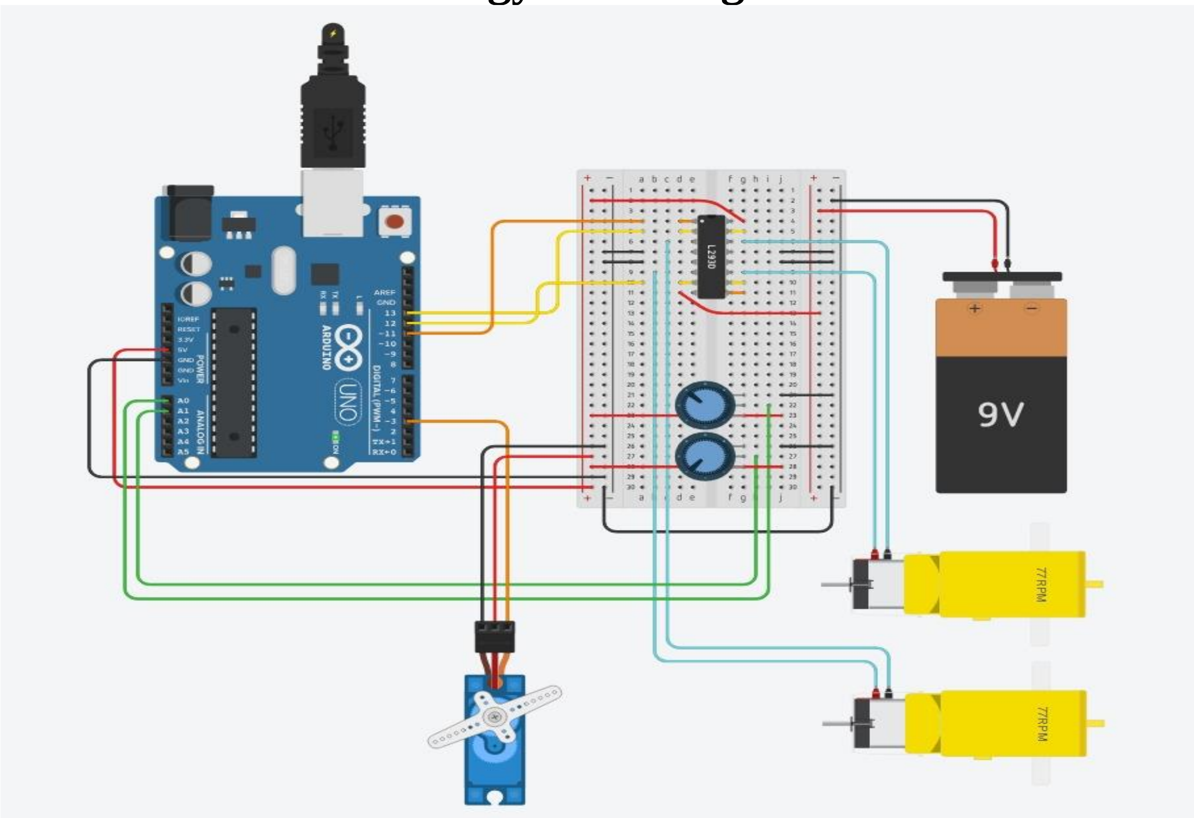

Fig 1: Circuit Diagram [using Tinkercad]

Effective control is paramount for the successful deployment of the Gesture-Controlled Rescue and Search Vehicle (GCRSV) in real-world disaster scenarios. We delve into the implementation of a custom potentiometer model for gesture recognition. This innovative approach offers a user-friendly interface with the potential for intuitive control. By accentuating the details of the potentiometer's design and integration, we will illuminate how the GCRSV translates user gestures into actionable commands, ultimately guiding the rover during critical search and rescue operations, incorporating the following parts:

1. Arduino UNO: It acts as the central control unit of the Gesture-Controlled Rescue Search Vehicle which helps to manage the sensor inputs, control motor movements and process the input gesture commands. It is programmed to respond environment and take appropriate decisions to traverse adverse terrains.

2. Motor: Used to rotate the wheels of the rover which provides mobility to the rover. It provides driving force for rover’s movements based on control signals from Motor Driver.
3. H-Bridge (L298N Motor Driver): It facilitates bidirectional control and speed control for the motors. It enables independent control of motors through Arduino Uno to conduct precise maneuvering and navigation throughout search environment.
4. Potentiometer: A custom designed potentiometer model is used to take input from users by rotating their wrist so as to vary the angular displacement on the potentiometer which in turn changes resistance and hence detects the orientation of the wrist.

Fig 2: Custom Designed Potentiometer

6. Bluetooth Module (HC-05): It used to communicate wirelessly between the Gesture control module and the rover with the help of Master-Slave configuration. It can be used to remotely send commands to and receive feedback from the rover with greater flexibility.

7. Servo Motor: It is employed to offer precise positioning of the rover by providing the scope for tilting and readjustment of the search vehicle.

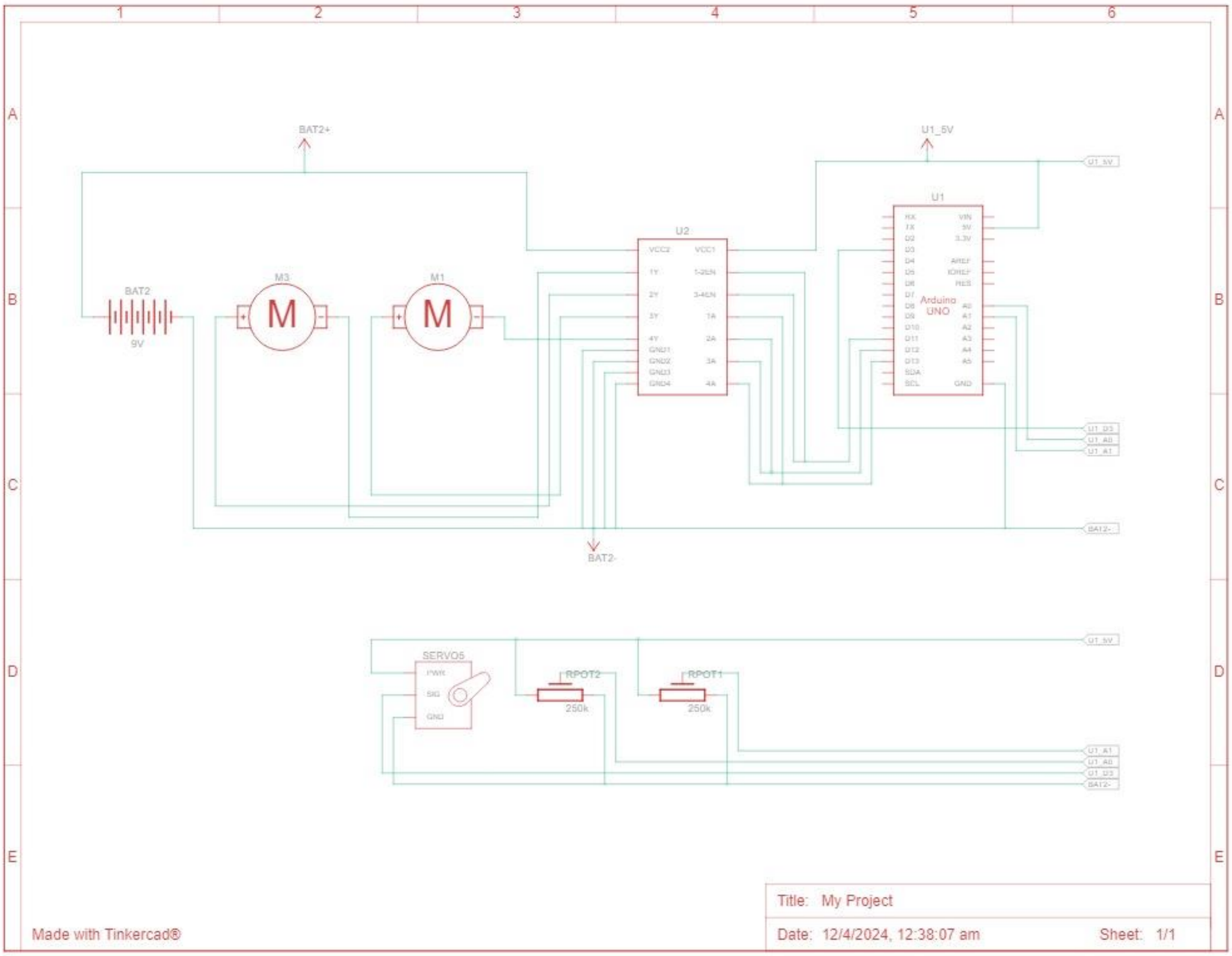

Fig 3: Schematic Diagram of proposed model

Results

Here we dive into the key findings and outcomes of our approach such as the effectiveness of the potentiometer model in translating the range of gestures recognized by the system into actionable commands for the rover. This will provide valuable insights into the user experience and the overall feasibility of utilizing a custom potentiometer for gesture control in the GCRSV project, its response time, and any limitations encountered during testing.

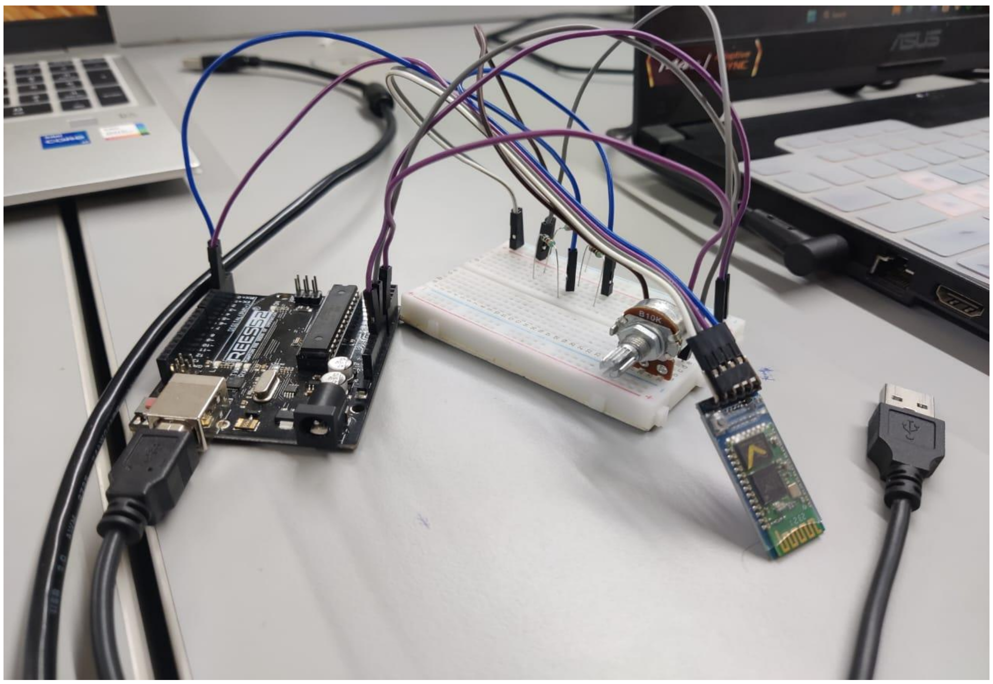

Fig 4: Direction and Speed Controller with Master Bluetooth Configuration

Fig 5: Serial Monitor Output

1. Controller: In figure 4, the controller is fitted with potentiometer which provides control for direction as well as speed. It sends these signals through its Master HC 05 Bluetooth module to the Slave HC 05 Bluetooth installed on the rover which are read by the microcontroller to control the speed and direction of the motors.
2. Serial Monitor: The instructions from the Controller are displayed on the serial monitor as shown in figure 5, to understand how the rover is supposed to move according to the input from the potentiometer. It also helps in debugging and ease of comprehension of the user.

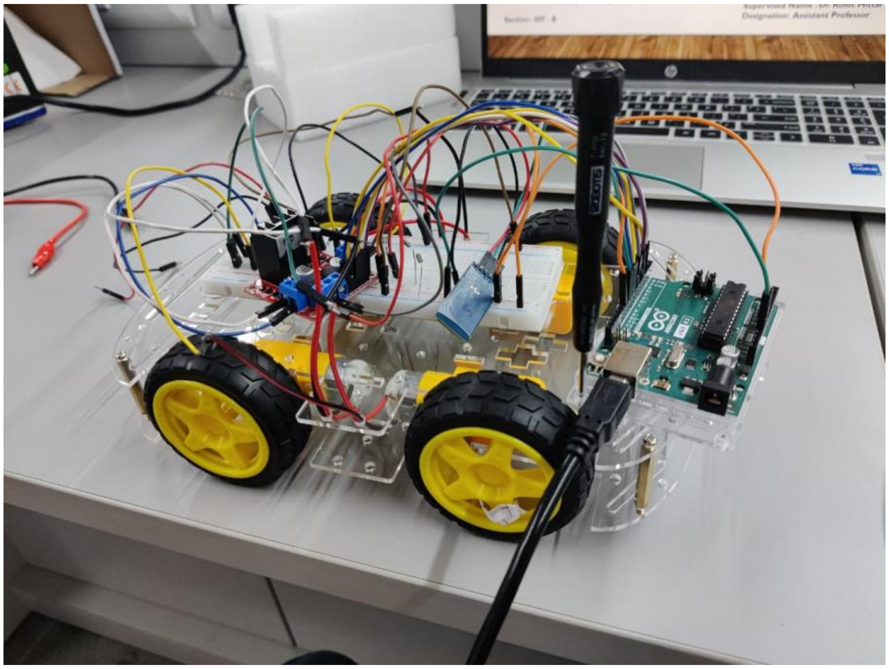

Fig 6: Gesture Controlled Rescue and Search Vehicle (GCRSV)

3. GCRSV: Figure 6 displays the implemented prototype of the GCRSV which receives signals from the Controller through its Slave HC 05 Bluetooth Module and performs the required maneuvering tasks for search and rescue operations. It uses the L298N motor driver to individually control and regulate the power usage at each motor.

Conclusion

The implementation of a custom potentiometer model to detect the orientation of the user's wrist represents an innovative approach to gesture-based control. By utilizing this custom sensor, operators can intuitively control the rover's movements and functions by rotating their wrist.

Advantages:

- Cost-effectiveness: Custom potentiometers can be designed using relatively inexpensive components, making them cost-effective compared to specialized sensors.
- Simpler Design: Potentiometers are less complex and generally require less calibration compared to accelerometers. This can streamline the development process and potentially improve the system's reliability.
- Intuitive Control: Wrist rotation can be an intuitive way to control the rover's movement, especially for users familiar with similar control mechanisms in video games or virtual reality.

Disadvantages:

- Sensitivity to Environment: Dust, dirt, or moisture can affect the performance of a potentiometer. This might be a concern for the GCSRR operating in potentially harsh environments during search and rescue missions.
- Calibration Needs: Regular calibration might be necessary to maintain accuracy, especially as the potentiometer ages or experiences wear.
- Susceptible to Wear and Tear: Being a mechanical component, potentiometers can experience wear and tear over time. This can lead to drift (inaccurate readings) and eventual failure, requiring replacement

Overall, using a custom potentiometer model can be a viable solution for the GCSRR project, particularly in the early stages of development or for prototyping. However, it's crucial to consider the limitations in gesture recognition compared to accelerometers. Future iterations or advanced models might integrate both components to leverage the strengths of each technology.

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