International Journal of Engineering Applied Sciences and Technology, 2023
Vol. 8, Issue 06, ISSN No. 2455-2143, Pages 100-103
Published Online October 2023 in IJEAST (http://www.ijeast.com)

CONTROL SYSTEM BASED ON HAND GESTURE RECOGNITION USING MEMS ACCELEROMETERS

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Abstract— **This paper aims to propose a methodology to assist individuals with physical disabilities by utilizing MEMS technology. This technology can be used to help non-verbal people communicate without words or assist those with partial paralysis to control their surroundings. The gesture identification is achieved using MEMS accelerometers. When a gesture is made, the accelerometers register the movement, which is then interpreted by a microcontroller. The microcontroller recognizes the gesture by comparing it to pre-programmed signals and assigns it a unique code. Additionally, there is a control module that includes an RF receiver. The RF receiver can detect the unique code from the user module. The ATMEGA microcontroller used in the control module to trigger specific functions based on the user's preferences and requirements. The proposed model is implemented in real time under various testing conditions.**

Keywords—**Hand Gesture Recognition, MEMS, ATMEGA.**

I. INTRODUCTION

Automatic Hand Gesture Recognition (HGR) has become increasingly important as the development of control devices without the need of physical contact are increasing. Gesture recognition is an essential component of modern human-computer interaction systems. Sign language is the main form of communication for people who are deaf, have hearing impairments, or are non-verbal. However, these groups often encounter obstacles when interacting with people who do not know sign language. There exist a need to survey the recent hand gesture recognition systems is presented in terms of the Key issues and challenges of gesture system [1,2]. The system presented in [3] works by using hand gestures as input. It first detects and pre-processes the image of the hand [4-6], and then crops it to the necessary size for analysis. The features of the hand are extracted and classified, and finally, the gesture is converted into speech. The presented work aims to help physically challenged individuals by utilizing advanced technology, including the Arduino Uno microcontroller board, RF transmitters, MEMS ADXL335 sensors, and more. The Arduino Uno serves as the central processing unit with its numerous digital and analog pins, while RF transmitters enable wireless communication. MEMS (Micro-Electro-Mechanical Systems) sensors detect acceleration, providing vital data for control. An optodiac, ensures isolation between control and power circuits. ULN2003 drivers enhance performance. A 2x16 LCD display provides a user-friendly interface for displaying critical information.

In essence, this paper combines modern technology and compassionate engineering to empower physically challenged individuals through innovative, customized control and communication solutions inclusive and affordable.

II. METHODOLOGY

This paper utilizes MEMS technology to assist physically challenged individuals aiming to provide affordable solutions for nonverbal communications and environmental control. The block diagram of the proposed method is depicted in Fig. 1.

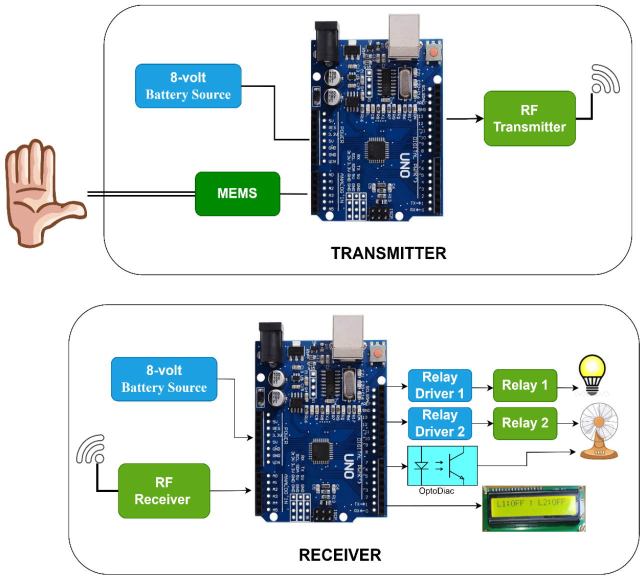

Fig. 1. Block diagram of proposed method

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Table 1: Technical Specifications

Components	Specification
ATmega328 Microcontroller	14 digital input output pins, 16 MHZ crystal oscillator.
RF transmitter	Frequency 433.92 MHz Transmitting power : < 10mW Receiver sensitivity – 100dBm
RF receiver	433.92MHz Operation Optimal Range 300ft.
Relay	Breakdown Voltage 300 V peak Carry Current 1.0 Amps Switch Speed 1 ms
Opto diac	Output Voltage 400 V Power Dissipation 330 mW Reverse Breakdown Voltage 6 V
Memsadxl335	3-Axis Digital Accelerometer

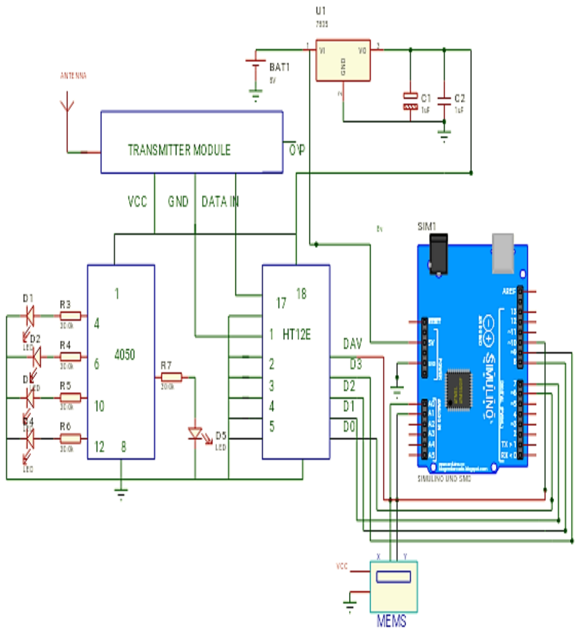

Fig.2. Interaction between RFID tag and RFID scanner

The control module consists of ATmega328 microcontroller to control the relays, RF module, Opto Diac, and LCD display as shown in Fig. 3. The RF transmitter transmits information by means of high-frequency radio waves. The ADXL335 MEMS sensor detects hand accelerations in three perpendicular directions through three accelerometers and transmits the data wirelessly to the user module. The received data from RF module is fed to port RB0 of Arduino UNO in the receiver circuit as shown in Fig. 4 and the data with the pre-stored hand gesture data. If the received data is the same as the pre-stored data then the port becomes 'High' and the corresponding LED is ON through the relay.

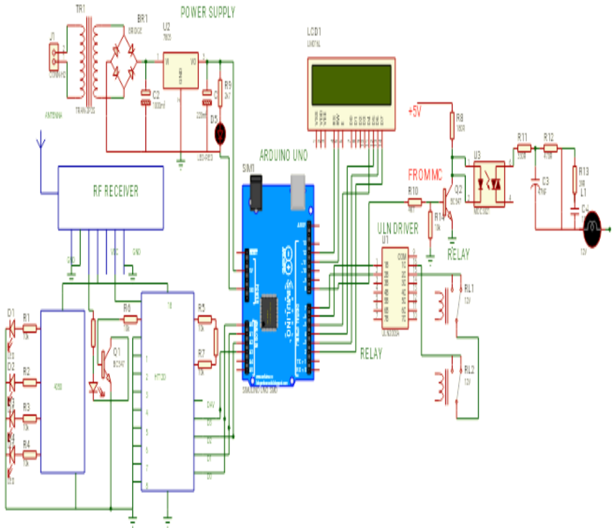

Fig. 1. Receiver circuit diagram

The optodiac MOC 3021 IC shown in Fig. 5 is used to control the speed of the connected fan based on the hand gesture. The speed of the fan proportional to the applied voltage. The SCR firing is varied, there by the voltage applied to the fan is varied, so speed is also varied. Then the current state of the load connected is displayed through 2 X 16 LCD display. The receiver setup is powered using a 9V regulated power supply.

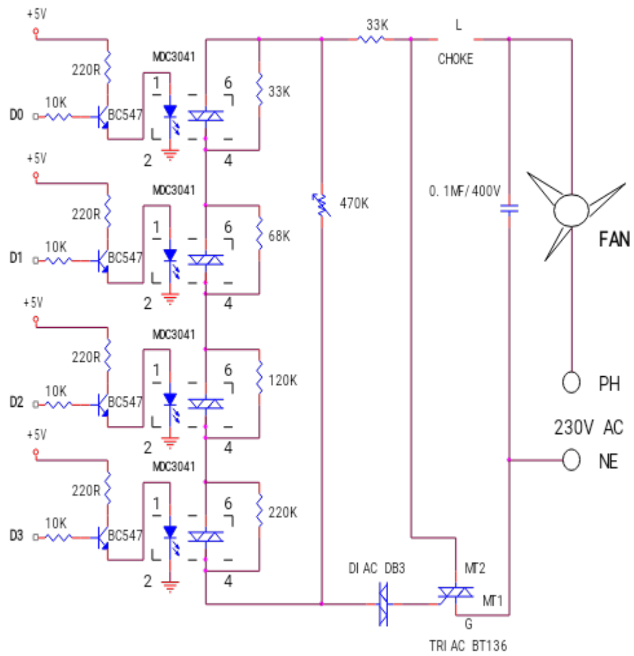

Fig. 4. Opto Diac Speed Control

III. RESULTS AND DISCUSSION

In this work, we aimed to develop a system that helps individuals with partial paralysis perform basic tasks by recognizing their hand gestures. We have implemented MEMS (Micro-Electro-Mechanical Systems) technology for HGR as shown in Fig.5.

Fig. 5. MEMS control in hand

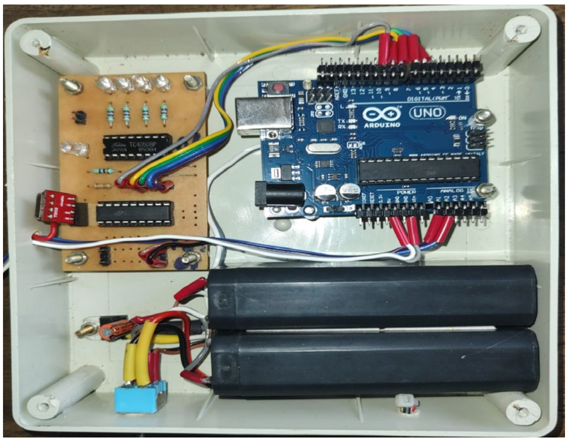

Fig. 6. Transmitter

The circuit shown in the Fig. 7 includes an RF receiver, a 17A/250V relay, UPTODIAC, ULN DRIVE, an LCD display and Arduino Uno (ADXL335) . The analog pins A0, A1, A2, and A3 are used for transmitting RF data. A4 is used for Data Available (DAV) and is connected to a recovery board. The digital pins D2, D3, D4, D5, D11, and D12 are connected to the LCD display. The Digital pin D6 controls Load 1, and D7 controls Load 2, while D8, D9, D10, and D11 are used to control fan speed in a Binary Coded Decimal (BCD) fashion.

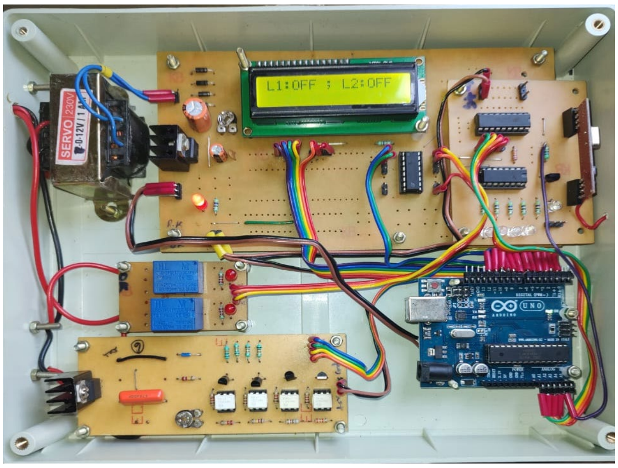

Fig. 7. Receiver in neutral mode

The system is initially in off state, in order to start the system the neutral hand gesture is shown for 500 ms In the neutral position, all data pins (D0, D1, D2, and D3) are set to "low," indicating no action. The hand gesture is considered to be at a zero-degree angle in the X-axis. The X-axis controls the states of Load 1 and Load 2. The Y-axis controls fan speed.
The program defines four data states, all starting at the "low" position. When the hand gesture moves in the X-axis from 0° to 90°, Load 1 is turned "on," and data pin 1 is set to "high" for a delay of 100ms.The LCD display for the load 1 ON condition is shown in Fig.8.

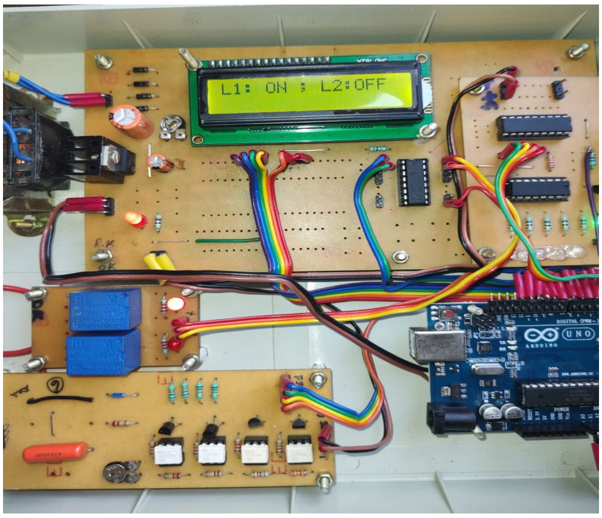

Fig.8. Load-1 in ON mode

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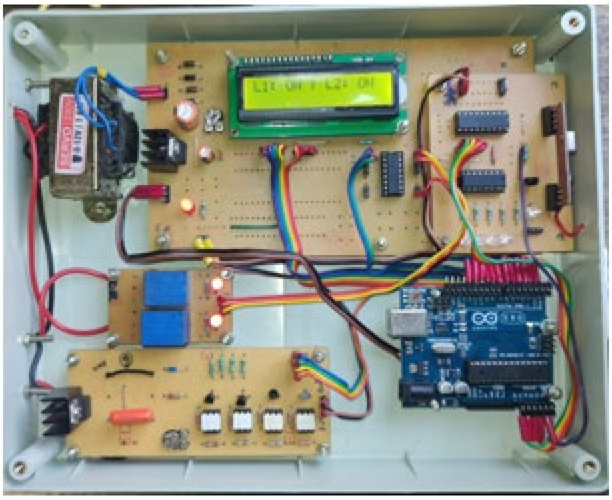

Fig. 9. Load1 and Load-2 in ON mode

When the hand gesture moves from 180° to 90° in the X-axis, Load 2 is turned "on," as shown in Fig. 9 and data pin 2 is set to "high" Load 2 is controlled in a similar manner using data pin 2. When Load 2 is "on," moving the hand gesture in the Y-axis from 0° to 90° increases fan speed. Fan speed increases continuously for 1000ms.Data pin 3 is set to "high" during this process. When the hand gesture moves from 360° to 270° in the Y-axis, fan speed decreases continuously for 1000ms.Data pin 4 is set to "high" during this process. The program allows fan speed control and sets the fan to run at the selected speed as shown in Fig. 10.

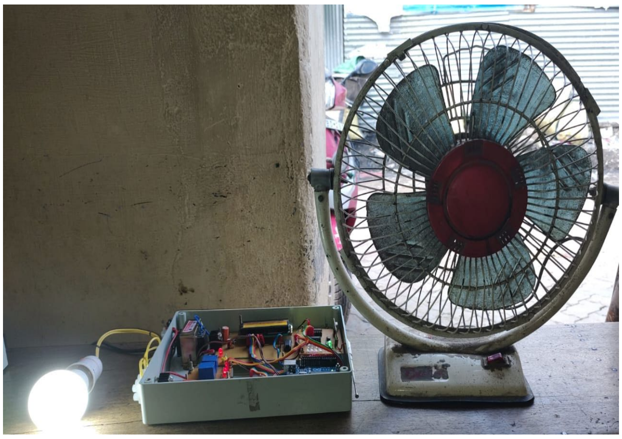

Fig. 10. Load in speed control mode

IV. CONCLUSION

In conclusion, this paper demonstrates the potential of MEMS-based hand gesture recognition technology to empower individuals with partial paralysis by enabling them to control essential household functions. Further research and refinement can improve the accuracy and range of gesture recognition, making such systems even more effective for people with disabilities.

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