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A MEMS Based Single Arm Robotic System

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ABSTRACT: The goal of this research is to develop a wheelchair system which controls its movement by the mere bending of a person's hand. Special type of sensor known as 'MEMS-sensor' is embedded in order to achieve the desired goal. In this research a prototype of an affordable and technologically advanced robot is to be designed and developed. The MEMS sensor can sense the movement and the sensor output is given to the controller. The controller sends the signals and according to the signals the motor is running which changes the robot movements. In proposed system accelerometer sensor is attached to the user hand depending upon the hand gestures or head movements the robot will be controlled. It can also do certain task like pick and place.

The robot operates in 2 modes:

1. Motion mode
2. Pick and place mode

KEYWORDS: MEMS Accelerometer Sensor, RF Technology, Hand movement, RF Transmitter, RF Receiver, AT89S52 Microcontroller, LPC2148 Microcontroller.

I. INTRODUCTION

In recent years, the definition of a robot is used to mean an unmanned system or automation, as often seen in Industrial robots which are designed to do repetitive task and need not have a human like structure. A robot can be remotely controlled by human from a long distance. The automation is playing a significant role to save human efforts in most of the regular works such as industrial work like welding, painting; material handling, assembly, container filling and many more tasks are being carried out by robots. One of the major and most commonly performed tasks are picking and placing objects from source to destination. Pick and place robot is designed for this purpose. Radio Frequency technology is a communication process which ranges from 30Hz to 300Ghz. RF Transmitter and RF Receiver operates at a frequency of 434 MHz. MEMS Accelerometer Sensor and RF Transmitter are interfaced to AT89S52. DC motors are used to picking and placing objects. RF Receiver and DC motors are interfaced to LPC2148. The wireless data transmission from Transmitter Block to Receiver Block is done using RF Transmitter 434 MHz and RF Receiver 434 MHz

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II. HARDWARE IMPLEMENTATION

1. Transmitter Module

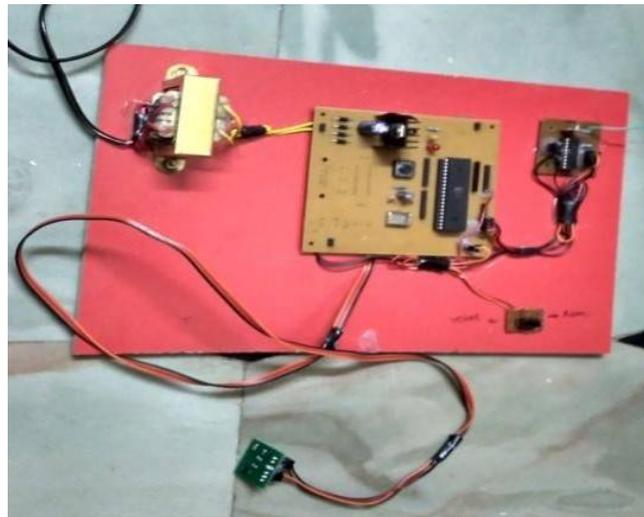


Fig Transmitter Module

Step down transformer is used to Step down 230V AC to 5V DC. 5V DC Regulated output is supplied to all the components on the Transmitter board. AT89S52 Microcontroller, RF Transmitter, RF Encoder, Mode Switch receives 5V power supply. Accelerometer MEMS Sensor takes 5V power supply but a Voltage regulator is inbuilt on the sensor which regulates power supply to 3.3V. There are two different modes that can be selected from the mode switch they are Robot Mode and Robot ARM Mode. According to the hand movement, input is taken from Accelerometer MEMS sensor and sent to microcontroller from there it is transmitted to RF Encoder (HT12E). RF Technology is used to communicate between the Transmitter and Receiver. RF Communication is a serial communication so data from microcontroller is converted to serial data by use of RF Encoder HT12E. RF Encoder will convert 4 bit Parallel data to 4 bit serial data and will be sent to RF Transmitter. RF transmitter receives serial data from RF Encoder and sends the data to RF Receiver. Through the antenna present at the RF Transmitter serial data is sent to the RF Receiver. RF Transmitter of 434 MHz and RF Receiver of 434 MHz is being used in this project. Only if the frequency range of RF Transmitter and RF Receiver is matched then the data is sent from Transmitter module to Receiver module. Operating Range is around 200 meters.

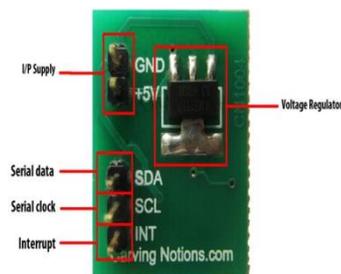


Fig. CN1004 MEMS Accelerometer Sensor

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CN1004 MEMS Accelerometer Sensor is a three axis accelerometer which can measure acceleration in three directions. The three directions are x, y and z. It needs low operating voltage such as 2.4V-3.6V for analog and 1.71V-3.6V for digital. The accelerometer consists of five pins, where the function of each pin is discussed below

- GND: GND pin is connected to the ground for the purpose of biasing
- +5V : VDD pin is used to give +5V supply to this pin
- SDA: Serial Data
- SCL: Serial Clock
- INT: Interrupt

2. Receiver Module



The Receiver Module consists of UART (Universal asynchronous Receiver/Transmitter) and ISP (In system programming) used during software process. UART0 is used to dump the program. RS232 Connector is used to download Hex File into CPU. UART1 is not used for dumping it's only used for extension in project if project requires modules such as GSM, GPS we can interface by UART1. ISP (In system programming) Press ISP LOAD Switch (S1) and RESET Switch (S2) on Board "ARM7 LPC2148 Development Board" to reset MCU. Power Supply is obtained from 12V battery. Components on Receiver board require only 5V so a 7805 regulator is used to regulate 5V DC. RF Receiver receives the serial 4 bit data from RF Transmitter and sends the data to RF Decoder. RF Decoder converts the 4 bit serial data to parallel data because digital communication uses only parallel data. 4 bit parallel data is sent to LPC2148 Microcontroller. A code has already been loaded in the microcontroller so the 4 bit data is compared with the code. If both the data's are matched then microcontroller gives input data to the

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H-Bridge. H-Bridge uses L293D IC which drives the 2 DC motors. Two H- Bridges are used in the project one for the Robot movement and another H-bridge for the Robot ARM movement.

Table Robot Values

S3	S2	S1	S0	RESULT
0	1	1	1	Robot moves right
1	0	1	1	Robot moves left
1	1	1	1	Robot stops
1	1	1	0	Forward direction
1	1	0	1	Reverse direction

Table Robot ARM Value

S3	S2	S1	S0	RESULT
1	0	1	0	Robot ARM moves downward
0	1	0	1	Robot ARM moves upward
0	1	1	0	Robot ARM jaw closes
1	0	0	1	Robot ARM jaw opens

III. EXPERIMENTAL RESULTS

Transmitter and Receiver module are Switched On. The desired mode i.e. Robot Mode or Robot Arm mode must be selected by using the Mode switch. Transmitter module has Accelerometer MEMS Sensor which will be placed on the hand and according to the hand movements the Robot will move if it is in Robot Mode. The same way the Robot ARM will move if the Robot Arm Mode is selected.

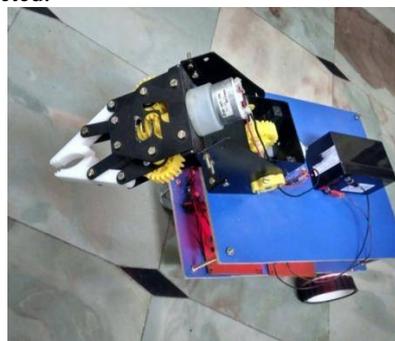


Fig Receiver (Robot)

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Robot Movements

MEMS Accelerometer Sensor placed on hand, according to the hand movement Robot moves in four directions.



Fig MEMS used to move Robot in Forward direction

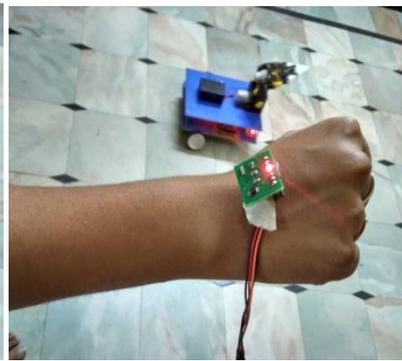


Fig MEMS used to move Robot in Backward Direction

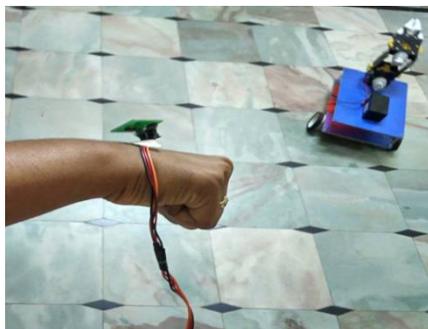


Fig MEMS used to move Robot in Left Direction

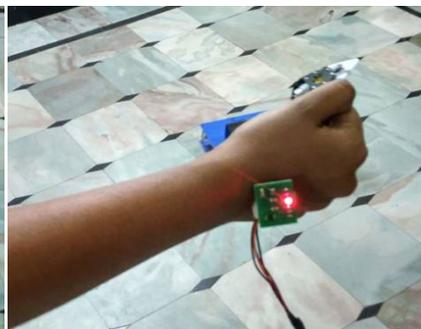


Fig MEMS used to move Robot in Right direction

Robot ARM Movements

MEMS Accelerometer Sensor placed on hand, according to the hand movement Robot ARM moves in two directions and ARM Jaws opens and closes.

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Fig MEMS used to move the Robot Arm downward direction

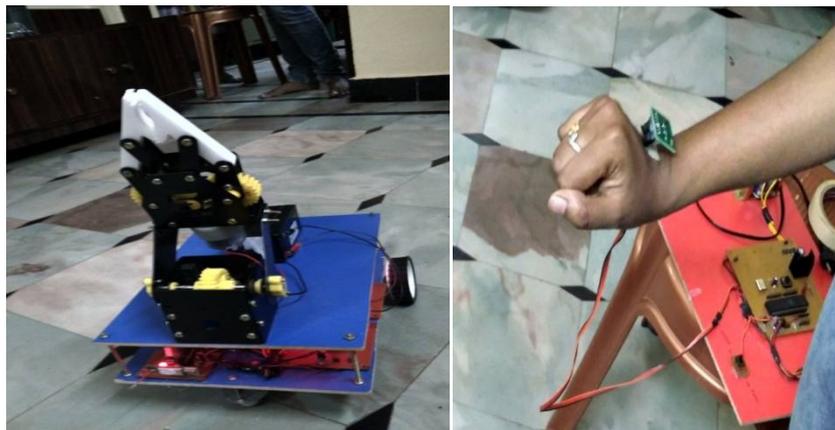


Fig MEMS used to move the Robot Arm upward direction

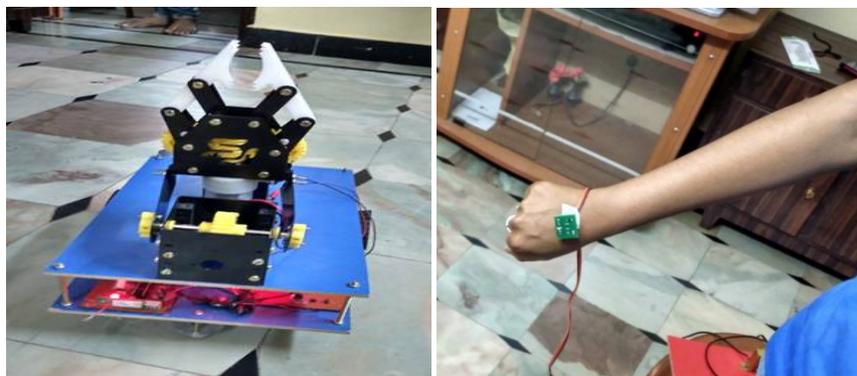


Fig MEMS used to close the Robot Arm Jaw

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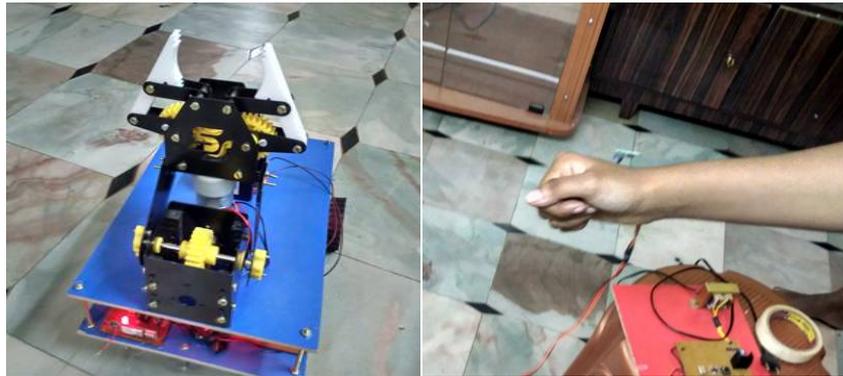


Fig MEMS used to open the Robot Arm Jaw

IV. CONCLUSION

“A MEMS Sensor based single arm Robotic system” is successfully designed and tested. The Robot works according to a person’s hand movements and also does certain pick and place task. A Robotic ARM with Jaws is used for the pick and place purpose. This project if implemented on wheel chair can be helpful for Disabled people and old aged people. It can be useful for moving heavy loads from one place to another. RF Technology is used for longer range communication. This is project is user friendly and gives accurate result.

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