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Robot Controlling Using Arduino Uno

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ABSTRACT
In recent years, robotics engineering field is an emerging field that is in great demand as it includes design and construction with various applications like vehicle assembly, packing food items, electronic industries, appliance building etc. This paper describes controlling of a robot using gestures. Making a gesture involves manoeuvre of the face, hand or any other body parts. Making a gesture changes from non-verbal physical communication that do not convey with particular messages, like proxemics, indicative displays, or joint attention displays. It allows human beings to pass on a diversity of affection and thinking, from conflicts and combat to agreement and endearment, along with kinesics towards their speech. The end user needs to put on a making device of gesture that involves a sensor. The sensing element will record the hand variation in a particular path that results in robot movement in the appropriate direction. Making the gesture device along with robot are interconnected wirelessly through radio waves. The wireless transmission qualifies the end user to enact the robot in favorable way. A transferring instrument is used in the hand that consists of accelerometer and RF transmitter using Arduino Uno. It will pass on commands to robot such that it can perform the essential tasks like turning left, right, forward, reverse and stop. All these jobs will be executed by using hand gestures.
Keywords – Arduino, Decoder, Encoder, IC, RF, Robot

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I. INTRODUCTION

A short time ago, consistent efforts are being carried out for developing brilliant and existing communicating and working together among the computers and end users depending on mankind actions. Body language allow an inherent environment to both user and computer. So interfaces depending up on such gestures are used to replace the general devices of interface, also utilized to enlarge the functionalities [1]. Robots are taking prime role across all the zones like medical, manufacturing, military, construction etc. The main framework is build this gadget to make it simple and cheap such that it can be collectively manufactured and can be utilized for various causes [2] like:

- With making a gesture, different devices can be remotely controlled with the wave of a hand.
- This is extremely needful for physically disabled people specifically handicapped persons to accomplish few works, like vehicle driving etc. [2].
- Making a gestures can also be used for entertainment and interactions like gaming that makes the game player's event more attractive [2].
- Conventional interfaces like keyboards and mouse represent a narrow section in applications that depends on massive interactions of the user with the machine due to the strangeness of the interaction.

1.1. Proposed Work

The current work demonstrates RF Communication with the help of Arduino UNO boards. The aim is to transfer the data successfully between the RF transmitter and RF receiver modules making use of two Arduino UNO microcontroller boards. The transmitter device encompasses a Comparator IC for allocating appropriate input voltages levels from an Encoder IC and accelerometer that is utilized for encoding four data bit and that will be send via RF transmitter. At the accepting end the RF receiver does accept the encrypted data and then decrypt the same with the help of decoder IC. These details are then dealt by a microcontroller and given to a driver motor that rotates the motor in a distinct arrangement that makes the robot move in similar direction like a human hand.

1.2. Parts of Gesture controlled ROBOT

The gesticulation robot runs on the concept of accelerometer that documents hands movement and passes the same information to the comparator that later asserts correct

levels of voltage to the documented hand movements. The same data is again sent to an encoder that gets ready for RF transmissions. On the accepting end, the data is accepted wirelessly through RF that is decrypted and again transferred to the microcontroller that initiates variety of conclusions depending on the accepted data. These conclusions are transmitted to the motor driver IC that operates the motors in variety of arrangements and makes the robot go in a specific path [3]. The structure of robot controlled by gestures is shown in figure1. It aids to undergo the functioning of the robot:

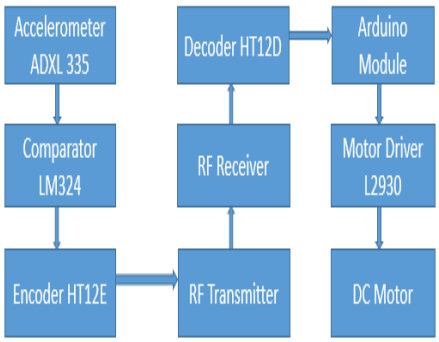

Fig.1.Parts of Gesture Controlled ROBOT

The work is classified into two portions to make it uncomplicated, straight forward and to keep away from complication and error less. The transmitter section is the initial portion with the below mentioned units:

- Accelerometer (ADXL335)
- Comparator (IC LM324)
- Encoder (IC HT12E)
- RF-transmitter

The next portion is the accepting section with the succeeding parts:

- RF-receiver
- Decoder (IC HT12D)
- Arduino module
- Motor driver (IC L293D)
- DC motor

II. REQUIREMENT ANAYSIS

The hardware and software requirements essential to carry out the work is as follows:

Hardware Components: The required hardware components are listed below with respect to the block diagram as shown above in figure. They are:

- Accelerometer (ADXL335)
- Comparator (IC LM324)
- Encoder (IC PT2262)
- RF module (Rx/Tx)
- Decoder (IC PT2272)
- Micro-controller (AT89C51)
- Motor Driver (L293D)
- DC – Motor

The Accelerometer (ADXL335) is a low power, thin and tiny with 3-axis direction accelerometer along with voltage outputs that are signal conditioned. A full-size range of ±3 g is the measurement of acceleration. The steady speed up of gravity can be measured in tilt- sensing applications, and also in energetic acceleration resulting from vibration, shock or motion. The end user chooses the bandwidth of the accelerometer with CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidth may be chosen that suits the application, with a span of 0.5 Hz to 1600 Hz for the X and Y axis, and a span of 0.5 Hz to 550 Hz for the Z- axis. The ADXL335 is present in a tiny, profile (4 mm × 4 mm × 1.45 mm), 16 lead, plastic lead mount chip scale package (LFCSP_LQ).

The Comparator IC differentiates the analog voltages accepted from the accelerometer and differentiates that with a mention of voltages and provides a specific higher or lower voltage. The accepted signal is little noisy and has different voltage levels. The IC differentiates these levels, produces the output in terms of 0 or 1 voltage levels. This procedure is known as signal conditioning.

HT12E is actually an encrypted integrated circuit of 212 encoder series. These are matched with 212 sequence of decrypts and are used in system applications that controls remotely. HT12E is importantly utilized in connecting RF and infra-red circuits. This set of encoder decoder must have exact address and data format. HT12E transforms the aligned input into sequential output. This encrypts the 12 bit aligned data into sequential data for transmitting via an RF transmitter. Hence 12 bits are classified as 8 address-bits and 4 data-bits.

Radio frequency (RF) indicates the oscillation span of 3 Kilohertz to 300 Gigahertz which agree with the radio wave frequencies, also the fluctuating currents that carry radio signals. HT12D transforms the sequential inputs into aligned outputs. This decrypts the sequential address and data accepted by an RF receiver, into aligned information and transfers these to output the data pins. Arduino Uno is actually a microcontroller board formed on the ATmega328P. This is composed of 14 digital input or output pins (6 pins as PWM outputs), a power jack, 6 pins as analog inputs, a 16 MHz quartz crystal, a USB cable connection, ICSP header and a reset button. It consists of all that is essential to aid the microcontroller. It just connects the computer with a connector USB cable or power the same with an AC-DC adapter or a battery to get started.

A DC motor is the one that transforms DC input power into rotational mechanical power. A geared DC Motor encompasses assembly of gear dedicated to the motor. The motor speed is added up with respect to shaft Rotations per Minute (RPM). Assembly of gear assists in growing the torque and releasing the speed. Making use of the exact positioning of gears in gear motor, the speed could be lowered to any desired RPM. This idea of lowering the speed with the aid of gears and also increasing the torque is called as gear depletion.

Software Components: Programming Language: C language using KEIL MICROVERSION.

III. SYSTEM ANALYSIS

Various gestures of hand movement in specific directions for the robot are shown below in figure2:

The robot proceeds in a particular way only when the accelerometer is moved. The convincing movements are shown in figure 2. The movement of hand in the X direction and Y direction are recorded by the accelerometer only and produce persistent analog voltages. These voltage levels are given to comparator IC that differentiates with the reference voltages and are placed through variable resistors embedded onto the IC.

Fig 2. Hand Gestures

The actual levels are set as 1.7V and 1.4V. Each voltage caused by the accelerometer is differentiates them and analog signal 0 or 1 is handed over to comparator shown in figure 3.

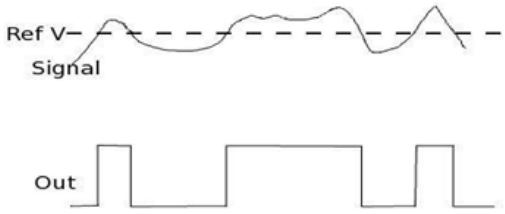

Fig 3. Comparator IC's Input and Output

Five different conditions are used for gesture controlled robot as shown in table 1. The different hand movements are tilting the hand towards right, left, back and front. Inputs taken by Arduino pins are 0001 for tilting towards right direction, 0010 when tilted towards left, 1000 when tilted backward and 0100 towards front. When all pins are zero, it will be in stable state. That means when Arduino senses any obstacle in front of it, it sops movement resetting all pins to zero.

The Encoder IC's input is the analog signal. The inputs to the encoder is equivalent to the outputs that is serially coded waveform appropriate for RF transmission. This IC contains a push button that is implanted to pin 14, called the Transmission Enable (TE) pin. The encoded data are transferred to the RF module as when the button is depressed. The button ensures that data is not broadcasted until required.

Table 1. Hand Movement Directions

Hand Movement	Arduino inputs				Directions
	D_3	D_2	D_1	D_0	
Stable	0	0	0	0	Stop
Right tilt	0	0	0	1	Right turn
Left tilt	0	0	1	0	Left turn
Back tilt	1	0	0	0	Backward turn
Front tilt	0	1	0	0	Forward turn

The RF transmitter will modulate the input signal with the help of Amplitude Shift Keying (ASK) modulation as shown in figure 4. It is the modulation structure which constitutes binary data as dissimilarity in the carrier wave amplitude. Figure 4 displays the output modulation of RF module:

Fig 4. Amplitude Shift Keying (ASK) Modulation

The RF modules tasks on the frequency of 315MHz. Means that carrier frequency of the RF module is 315MHz. The RF module authorize the end user to command the robot easily and wirelessly.

IV. SYSTEM DESIGN

Making a gesture robot means that a robot can be commanded by actions of hand and not by the using buttons (old fashion). The user is necessitate to have on a little broadcasting instrument on his hand along with a sensor (accelerometer). Hand movement in a proper orientation will instruct the robot that moves next in a proper path. The broadcasting device encompasses a Comparator IC used for allocating appropriate level to the voltage input from the accelerometer. Also an Encoder IC that is used to encrypt the four data bit and later that will be send by an RF transmitter module. Towards

the accepting end an RF receiver module will accept the encrypted data and decrypt it with the help of a decoder IC. Later the information is activated via microcontroller and transmitted onto a driver motor to rotate the motors in a distinct shape, making the robot forgo in that direction like that of hand.

The overall system design is shown in figure 5. In the beginning Arduino UNO is to be initialized. The microcontroller board Arduino UNO can be programmed (C and C++) and connected to the system. Program can be uploaded by USB cable. Also input values are given to Arduino through accelerometer. Accelerometer accounts movements of hand and transfers that data to comparator that assigns correct levels of voltage to the accounted movements. Later these details is then shifted to the encoder that keeps it ready for RF transmissions.

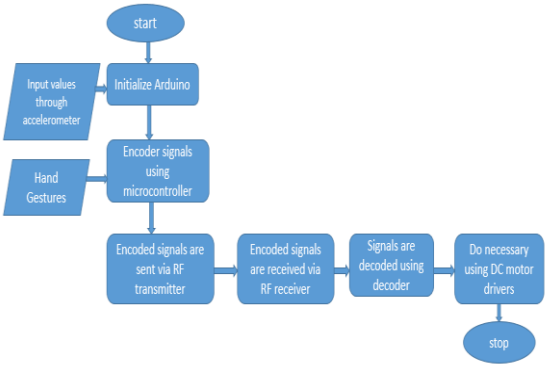

Fig 5 System Design

At the accepting end, the details are accepted through RF wireless receiver in which signals are decoded and then transferred on to microcontroller that takes different decisions depending on the accepted details. These conclusions are transferred to the IC of DC motor driver that activates motors in various arrangements to achieve the robot moves in a particular path.

V. IMPLEMENTATION

C code is written for the microcontroller for the DC motors to run with the help of IC H-Bridge (L293D). In this modulation the corresponding information to the microcontroller (AT89C51) is sent via switches as shown in code. The Microcontroller processes the information and sends the data to IC of Actuator (L293D). The IC of Actuator collects data in return by driving the DC motors. Arduino programs are classified into three main parts: structures, variables and functions. Two control structures are used namely setup and loop functions. Setup function is used to indicate the initial values of the system on starting. Loop ( ) function contains the statements that will run whenever the system is powered after the setup. Variables used are HIGH, LOW, INPUT and OUTPUT. Functions used are digital I/O functions: pin Mode ( ) and digital Write ( ). The transmitter and receiver codes for setup ( ) is as shown below:

```
Void Setup ( )      //transmitter code setup function
{
Serial. Begin (9600);
MySerial.Begin (9600);
Pin mode (out1, OUTPUT);
Pin mode (out2, OUTPUT);
Pin mode (out3, OUTPUT);
Pin mode (out4, OUTPUT);
Pin mode (ire, INPUT);
Pin mode (2, OUTPUT);
Digital Write (2, HIGH);
}
Void Setup (void) //receiver code setup function
{
  Serial. Begin (9600);
  Wire. Begin ();
  MPU.Initialize ();
  MySerial.Begin (9600);
}.
```

VI. TESTING

The robotic actions are tested and validated and summarized as shown in table 2. The Arduino pins of D3 D2 D1 D0 are set from transmitter. The receiver is MPU control accelerator acts as receiver by controlling motion range in X and Y axis. X-axis range is 300-400, whereas Y-axis range is 100-200. Based on this the accelerometer orientation is either forward mode (+y), backward mode (-y), right mode (+x), left mode (-x) and stop (reset). The robot moves as per the hand movements as the transmitter will be in our hand. Inclining our hand front-side, the robot starts proceeding ahead and continues the movement till next command is provided.

- Inclining our hand back-side, the robot changes its state and proceeds backward till next command is given.
- Inclining our hand in left-side, makes the robot turns to left till other command is given.
- Inclining our hand in right-side makes the robot turn to right direction.
- Keeping hand in stable, can stop the robot.

Figures 6 and 7 shows the finished product of robotic wheel and robot hand assembly with transmitter circuit.

Table 2. Testing of Robotic actions

Transmitter (Arduino Pins) D3 D2 D1 D0	Receiver (MPU motion range)	Expected Output	Actual Output	Remarks
0 1 0 1	X-axis >380	Moves backwar	Moves backw	Tested OK

		d	ard	
1 0 1 0	X-axis <330	Moves forward	Moves forward	Tested OK
0 1 1 0	Y-axis >170	Moves right	Moves right	Tested OK
1 0 0 1	Y-axis <110	Moves left	Moves left	Tested OK
0 0 0 0	Encounters Infra radiation	Stops	Stops	Tested OK

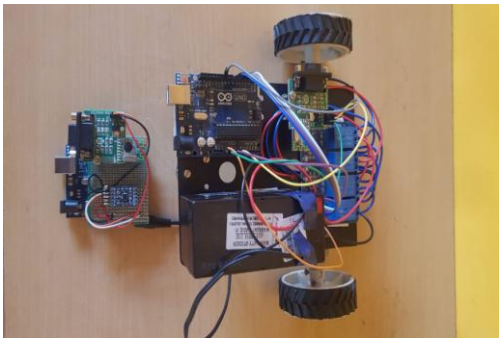

Fig 6. Robotic wheel

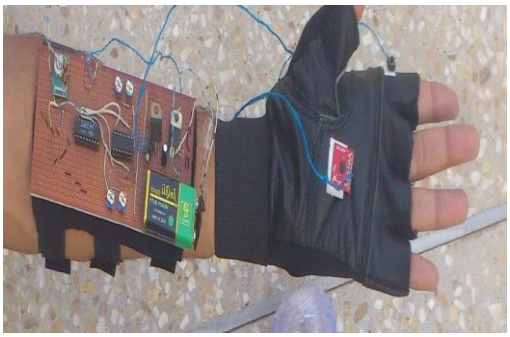

Fig 7. Robot with Hand assembly

VII. CONCLUSION

The robot is shows genuine responses whenever the hand movement is done. For commanding the robot distantly, Holteks' encoder HT12E -decoder HT12D pair are used along with a transmitter/receiver pair of 433MHz. These are ICs of CMOS with voltage that spans: 2.4V to 12V. Encoder (HT12E) consists of eight address lines along with four address or data lines. Overall there are twelve lines, the data set operates on these includes address lines and (address or data lines), and is transferred sequentially, only when TE pin is low. The data output is sequentially visible on DOUT pin. Four times the data is broadcasted in accordance. It comprises of varying terms of positively going pulses for '0' and '1'. Also to be noted that the pulse range for '0' is two times pulse range for '1.' The repetition of the pulses fall between 1.5 kHz to 7 kHz, depends on the values of the resistor OSC1 and OSC2 pins. However there are some drawbacks in this developed robot as summarized below and can be taken forward as limitations and future work.

- Firstly, a lot of space is occupied by on board batteries and are also little heavy. Instead, alternate power sources can be used for batteries or restore the current in DC motor that requires less power.
- Secondly, the range is limited for a RF for wireless transmission approximately 50m to 80m. For wireless transmission (setup all over the world), this issue is solved by using a GSM module. GSM module provides wireless connectivity for little a large range.
- Thirdly, for observing the robot from distant places, on-board camera may be setup. For broadcasting a wireless camera is required and for live streaming, a receiver module is required.

REFERENCES

[1] http://seminarprojects.com/s/hand-gesture-controlled-robot-ppt
[2] http://www.scribd.com/doc/98400320/InTech-Real-Time-Robotic-Hand-Control-Using-Hand-Gestures
[3] http://www.webstatschecker.com/stats/keyword/a_hand_gesture_based_control_interface_for_a_car_robot
[4] http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.37.5427
[5] Raheja, Jagdish Lal, et al., Real-time robotic hand control using hand gestures: A tutorial review, *Proc. 2nd IEEE Int. Conf. on Machine Learning and Computing*, 2010.
[6] http://www.robotplatform.com/howto/L293/motor_driver_1.htm
[7] http://en.wikipedia.org/wiki/Gesture_interface
[8] http://www.wisegeek.com/what-is-a-gear-motor.htm