ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

ACCELEROMETER BASED GESTURE CONTROLLED ROBOT USING ARDUINO

SwarnaPrabha Jena, Sworaj Kumar Nayak, Saroj Kumar Sahoo, Sibu Ranjan Sahoo, Saraswata Dash, Sunil Kumar Sahoo
Electronics and Communication Engineering, Centurion University of Technology and Management, India

ABSTRACT
Generally, robots are programmed to perform specific tasks which humans cannot. To increase the use of robots where conditions are not certain such as fire fighting or rescue operations, robots can be made which follow the instruction of human operator and perform the task. In this way decisions are taken according to the working conditions by the operator and the task is performed by the robots. Thus, we can use these robots to perform those tasks that may be harmful for humans. This paper describes about the gesture control robot which can be controlled by your normal hand gesture. It consists of mainly two parts, one is transmitter part and another is receiver part. The transmitter will transmit the signal according to the position of accelerometer and your hand gesture and the receiver will receive the signal and make the robot move in respective direction. Here, the program is designed by using Arduino IDE.

KEYWORDS:Arduino Uno, Accelerometer, RF Modules

INTRODUCTION
In recent years, robotics is a current emerging technology in the field of science. A number of universities in the world are developing new things in this field. Robotics is the new booming field, which will be of great use to society in the coming years. Though robots can be a replacement to humans, they still need to be controlled by humans itself. Robots can be wired or wireless, both having a controller device. Both have pros and cons associated with them. Beyond controlling the robotic system through physical devices, recent method of gesture control has become very popular. The main purpose of using gestures is that it provides a more natural way of controlling and provides a rich and intuitive form of interaction with the robotic system. These days many types of wireless robots are being developed and are put to varied applications and uses. Human hand gestures are natural and with the help of wireless communication, it is easier to interact with the robot in a friendly way. The robot moves depending on the gesture made by your hand and from a distance. The objective of this paper is to build a wireless gesture control robot using Arduino, accelerometer, RF transmitter and receiver module. The Arduino Uno microcontroller reads the analog output values i.e., x-axis and y-axis values of the accelerometer and converts that analog value to respective digital value. The digital values are processed by the Arduino Uno microcontroller and according to the tilt of the accelerometer sensor mounted on hand, it sends the commands to the RF transmitter which is received by the transmitter and is processed at the receiver end which drives the motor to a particular direction. The robot moves forward, backward, right and left when we tilt our palm to forward, backward, right and left respectively. The robot stops when it is parallel to the ground.

RELATED WORKS
The paper[7][8] focuses on the development of the robotic Arm by using Flex Sensor, ZigBee and 3 Servo motor connected to the Arduino Uno which is controlled by processing software and a computer mouse. These robotic Arm are cheap and easily available which makes it free from unnecessary wire connection, reducing its complexity. But still there is a requirement of adding new ideas and functionality.
The central goal of the paper[6] is to implement a system through which the user can give commands to wireless Robot using gesture. Here, the user control or navigate the robot by using gesture of palm. The command signals are generated from these gesture

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

using image processing and signals are passed to the robot to navigate it in the specified direction.

The paper[4] explain about the implementation and design of gesture controlled robot by using Flex Sensor, Ultra sonic Sensor, Electronic compass and accelerometer connected to Atmega16 Microcontroller.

The research paper[5] describes the Robot, which is controlled by a hand Glove Wirelessly via Bluetooth. The Robot is developed by using the input section consisting of sensor, LCD, Display and a Bluetooth Device and the output section which is consisting of NXT Microcontroller, Motor and Camera. The programming is developed in MATLAB.

PROPOSED WORK

The whole project is divided into two sections one is transmitter section and other is receiver section.

The circuit diagram and the transmitter prototype is shown in figure 2, and figure 3 respectively, and the transmitter section consists of one Arduino Uno, one 3-axis accelerometer and one RF transmitter module.

The circuit diagram of receiver module and the receiver prototype is shown in figure 4 and figure 5 respectively. The receiver section consists of one RF receiver module, one motor driver IC, two PMDC motor, two wheels. Here,two separate 5 volt power supply is applied to both the sections.

Finally, the Arduino Uno reads the analog output values i.e., x-axis and y-axis values from the 3 axis accelerometer and converts the analog value to respective digital value. The digital values are processed by the Arduino Uno and send to the RF transmitter which is received by the Receiver and is processed at the receiver end which drives the motor to a particular direction. The robot moves forward, backward, right and left when there is tilt in the palm of user in forward, backward, right and left respectively directions as shown in figure 1.

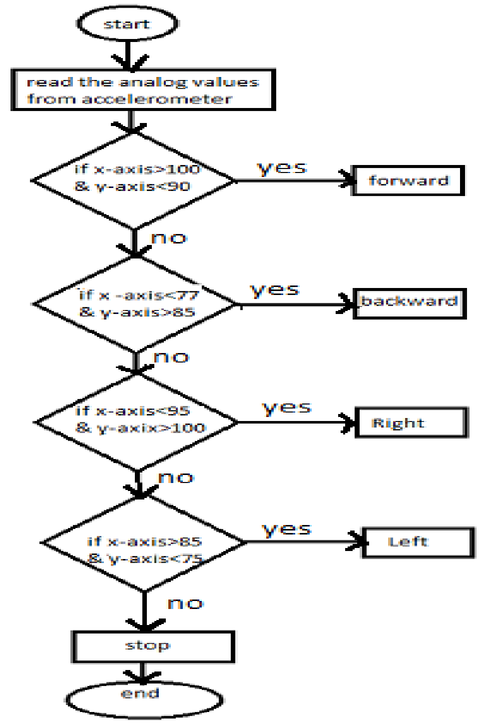

Figure 1: ***Flow Chart For The Proposed System***

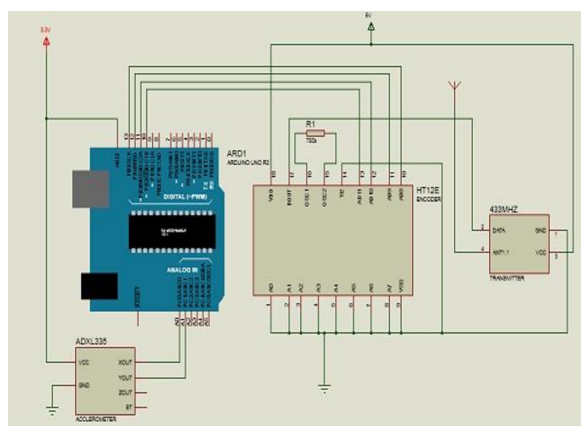

Figure 2: ***Circuit Diagram Of Transmitter Module***

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

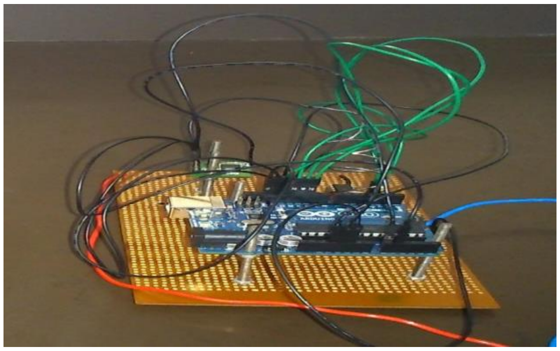

Figure 3: ***Transmitter Prototype***

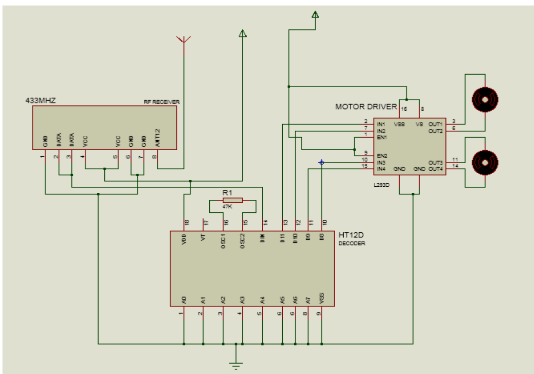

Figure 4: ***Circuit Diagram of Receiver Module***

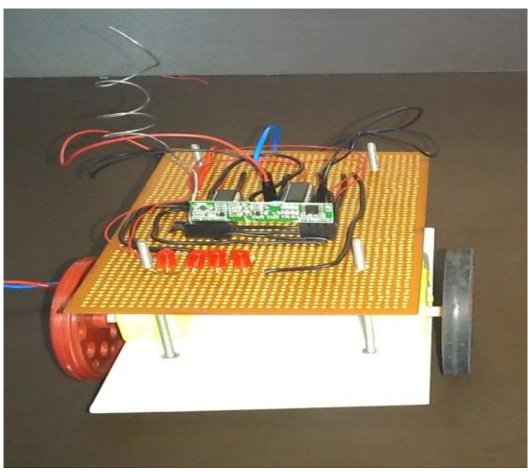

Figure 5: ***Receiver Prototype***

IMPLEMENTATION

Software used

The program is written in Arduino Integrated Development Environment (IDE) as shown in figure 6 . Here, the version used is 1.6.1.It connects to the Arduino hardware to upload programs. But before uploading the program there is a need to select appropriate Microcontroller so, "Arduino Uno" from the Tool menu has been chosen. And for proper communication with computer and Arduino Uno boards there is a need to select COM port fromthe Tool menu.

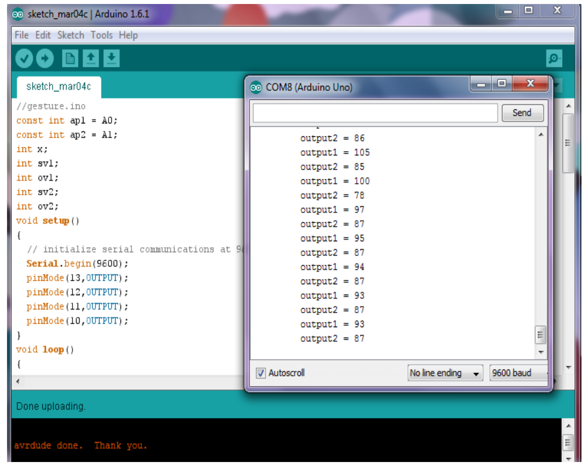

Figure 6:*Arduino IDE*

Hardware used

This paper consists of the following hardwares:

Arduino Uno

It is a microcontroller board based on ATmega328[2][3] which has 14 digital I/O and 6 analog pins. It has everything that is needed to support the microcontroller. Simply connect it to the computer with a USB cable to get started with the Arduino Uno board. It is flexible, easy to use hardware and software. Arduino Uno can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators.

Accelerometer

The ADXL335[9] is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. It has 6 pins. 3 pins is for X,Y,Z axis. First pin for power supply (VCC), second pin for ground (GND) and the last one for self-test (ST). It operates on 3.3V from the Arduino Uno board. X and Y axis pins are connected to A0 and A1 pin of Arduino Uno board respectively. It can measure the static acceleration of gravity from tilt-sensing applications as well as dynamic acceleration resulting from motion, shock or vibration and gives corresponding analog values through X,Y,Z axis pins.The ADXL335 is available in a small, low profile, 4mm x 4mm x 1.45 mm, 16-lead, plastic lead frame chip scale package. The low cost and small sixe of 3-axis accelerometer, are the two factor that makes it effetctive to detect the hand gesture.

Encoder

Here,HT12E[11] is 2^{12} series encoder is used. It is capable of encoding information that consists of N-address bits. It consists of 18 pins. Pin(1-9) and 14 are connected to ground. Pin number 10,11,12,13 of encoder are connected to 13,12,11,10 of Arduino Uno board respectively. A resistor of 750KOhm is connected to 15 and 16 number pin. Pin 17 is connected to Data pin of 433MHz RF transmitter module. It operates on 5V power supply to which 18 number pin is connected.

Decoder

HT12D[10], 2^{12} series decoder is used which is capable of decoding information that consists of N-address bits. It consists of 18 pins. Pin (1-9) connected to ground. Pin number 10,11,12,13 of decoder are connected to 10,15,7,2 of Motor driver respectively. A resistor of 47KOhm is connected to 15 and 16 number pin. Pin 17 is not connected. Pin 14 is connected to Data pin of 433MHz RF receiver module. It operates on 5V power supply to which 18 number pin is connected.

RF Transmitter And Receiver Module

RF stands for radio frequency[1][13]. It is available in different operating frequencies and with different operating range. We have used 433 MHz RF Tx/Rx module. RF module is often used along with a pair of encoder and decoder. It can transmit the signal up to 500 ft of range at rate of 1 Kbps to 10 Kbps.

Figure 7: ***Waveform for RF transmitter***

Transmitter module consists of 4 pins (GROUND, VCC, DATA, ANTENNA). DATA pin is connected to encoder (pin 17). A 17 cm single strand wire antenna is used which is connected to antenna pin of Tx module. Transmitter receives serial data and transmits RF signal wirelessly to the receiver through this antenna.

To test the RF transmitter module just connect the DSO with the data pin of the transmitter module and check that a train of pulses are coming or not which is shown in figure 7, if no pulses will occur then it means that modules are not working.

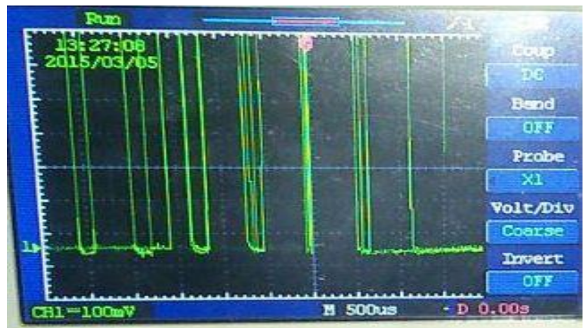

Figure 8: ***Waveform for RF Receiver***

Receiver module consists of 8 pins. 3 ground pins, 2 VCC pins, 2 DATA pins and 1 antenna pin. DATA pins are connected to decoder (pin 14). In this module also, a 17 cm single strand wire antenna is used for receiving RF signal from transmitter.

To test the RF receiver module just connect the DSO with the data pin of the transmitter module and check that a train of pulses are coming or not which is shown in figure 8, if no pulses will occur then it means that modules are not working and not receiving the data from the transmitter module.

The length of the antenna is determined according to the frequency range of RF module.

We know,

Wavelength, λ = speed of light (c) / frequency (f)

$$= 3\times10^8 / 433\times10^6 \text{ m}$$
$$= 0.69284 \text{ m}$$

So, Antenna length = $\lambda/4$

$$= 0.69284/4 \text{ m}$$

$$= 0.1732 \text{ m} \approx 17 \text{ cm}$$

Motor Driver

We have used L293D[12] IC which is 16 pin DIP package motor driver having 4 input pins, 4 output pins, 4 VCC pins and 4 ground pins. All 4 input pins are connected to the output pins of decoder IC. And 4 output pins are connected to the DC motors of robot. We have connected all 4 VCC pins to 5V DC supply.

PMDC Motor

The permanent magnet DC[7] motor consists of an armature winding as used in case of a usual motor, but does not necessarily contain the field windings. The constructions of these types of DC motor are radially magnetized permanent magnets and are mounted on the inner periphery of the stator core to produce the field flux. The rotor on the other hand has a conventional DC armature with commutator segments and brushes. The diagrammatic representation of a permanent magnet dc motor is shown in figure. The torque equation of dc motor suggests Tg= Kaφ Ia. Here φ is always constant, as permanent magnets of required flux density are MOTOR chosen at the time of construction and can't be changed thereafter. For a permanent magnet dc motor Tg = Ka1Ia WhereKa1 = Ka.φ which is another constant. In this case the torque of DC Motor can only be changed by controlling armature supply.

Two DC motor of 100 rpm are used in this paper. One motor is connected to pin 3 and 6 of motor driver and another motor is connected to pin 11 and 14.

DESIGN AND WORKING

The transmitter prototype is kept on the palm and the receiver prototype (i.e robot) moves according to the palm movement. This paper explains about the 5 different gesture position of the hand i.e stop condition, forward movement, backward movement, moves towards right and moves towards left.

Stop Condition

When the accelerometer is parallel to the horizontal plane, all the output pins of decoder (13, 12, 11, 10) are set to high which makes the robot in stop mode. Led are connected to the decoder output pins. Since all the output pins are high, so all the led are glowing as shown in figure 9.

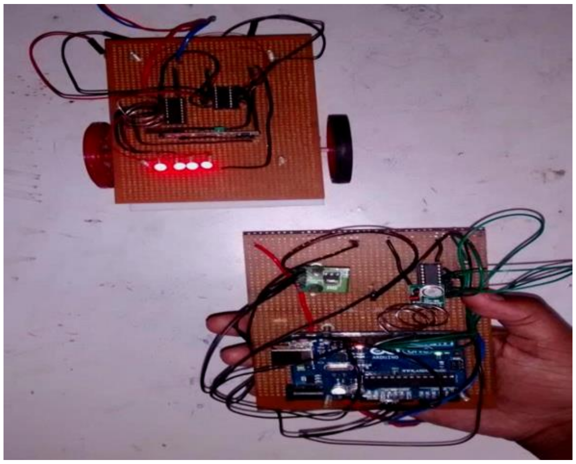

Figure 9: ***Stop Condition***

Forward Movement

When the accelerometer is tilted to forward, two output pin of decoder (13, 11) are set to low and other two output pin of decoder (12, 10) are set to high. This condition commands the robot to move in forward direction. Led connected to pin 13 and 11 are not glowing as it is low and led connected to pin 10 and 12 are glowing since, it is high as shown in figure 10.

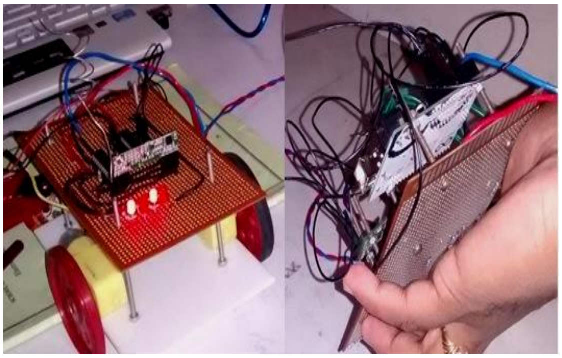

Figure 10: ***Forward Movement Of Robot***

Backward Movement

When the accelerometer is tilted towards backward direction, two output pin of decoder (12, 10) are set to low and other two output pin of decoder (13, 11) are set to high. This condition commands the robot to move in backward direction. Led connected to pin 13 and 11 are glowing as it is high and led connected to pin 10 and 12 are not glowing since, it is low as shown in figure 11.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

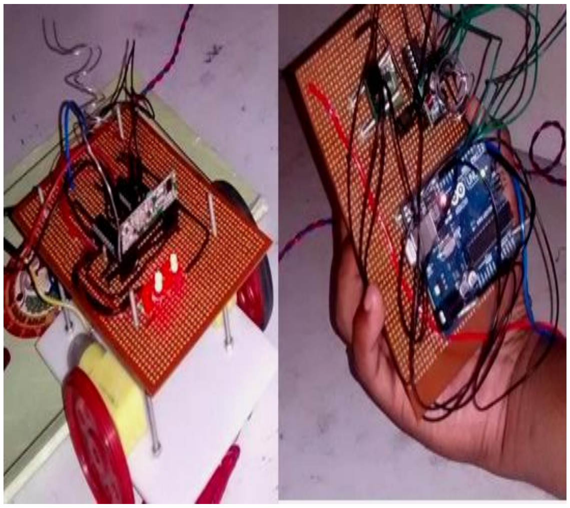

Figure 11: ***Backward Movement Of Robot***

Moves Towards Right

When the accelerometer is tilted towards right, two output pin of decoder (12, 11) are set to low and other two output pin of decoder (13, 10) are set to high. This condition commands the robot to move towards right. The output can be seen in the above picture. Led connected to pin 13 and 10 are glowing as it is high and led connected to pin 11 and 12 are not glowing since, it is low as shown in figure 12.

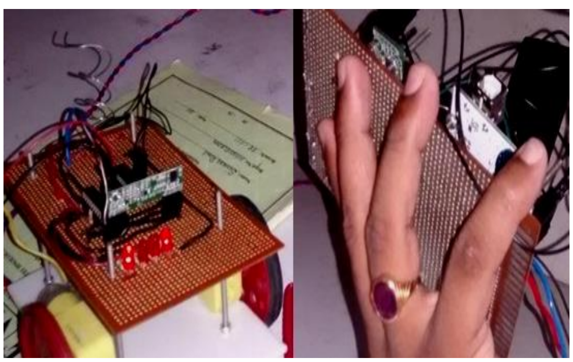

Figure 12: ***Robot Moves Towards Right***

Moves Towards Left

When the accelerometer is tilted towards left, two output pin of decoder (12, 11) are set to high and other two output pin of decoder (13, 10) are set to low. This condition commands the robot to move towards left. Led connected to pin 13 and 10 are not glowing as it is low and led connected to pin 11 and 12 are glowing since, it is high as shown in figure 13.

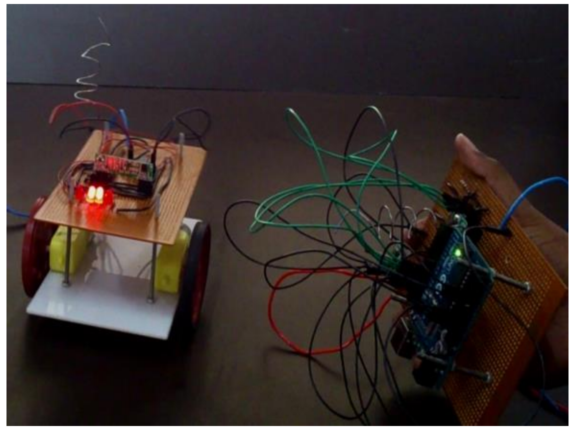

Figure 13: ***Robot Moves Towards Left***

COMPARISONS WITH EXISTING SYSTEM

The major advantage of this system over other systems is that it provides real time palm gesture recognition, leading to an effective and natural way of controlling robots. Additional advantage-- many existing system have used Bluetooth wireless control which is replaced by RF modules in this paper, and due to which the range has been enhanced.

CONCLUSION

In this paper, an automated robot has been developed which works according to your hand gesture. The robot moves wirelessly according to palm gesture. The RF module is working on the frequency of 433 MHz and has a range of 50-80 meters. This robot can be upgraded to detect human life in earthquake and landslide by implementing the sensor accordingly. It can also be upgraded to bomb detecting robot as it has robotic arm it can also lift the bomb. GPS system can be added to the robot by the help of which its location can be tracked.

ACKNOWLEDGEMENTS

We would like to thank Mrs Shanaz Aman, Asst. Prof. ,ECE and Miss Arna Prabha Jena for their support and contributing ideas for this paper. We would also like to thank various open sources and related papers that facilitated our work, mainly Arduino.cc.

REFERENCES

[1] RiyazMansuri, SandeshVakale, AshishShinde, Tanveer Patel, “Hand Gesture Control Robot Vechile”, IJECT, Vol-4, Issue SPL-2, PP. 77-80, JAN-MARCH 2013.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

[2] Aswath S, Chinmaya Krishna Tilak, Amal Suresh and GaneshaUdupa, "Human Gesture Recognition for Real-Time Control of Humanoid Robot", International Journal of Advances in Mechanical and Automobile Engineering (IJAMAE), Vol- 1, Issue 1, PP.96-100, (2014).
[3] Shruthi B. N, Shivraj, Sumathi S, "Hand Gesture Based Direction Control of Robocar using Arduino Microcontroller", International Journal of Recent Technology and Engineering(IJRTE), Volume-3, Issue-3,PP.-32-35, July 2014.
[4] Vicky Somkuwar, RoshanGabhane, Sandeepkakde, "Design and Implementation of Gesture Controlled Robot using Flex sensor and Accelerometer".
[5] GauravGautam, AbhijeetAshish, Anil Kumar, Avdesh, "Wirelessly Hand Glove Operated Robot", International Journal of AdvancedResearch in Electronics and Communication Engineering (IJARECE), Volume-3, Issue-11,PP.-1546-1547, November 2014.
[6] Harish Kumar Kaura, VipulHonrao, SayaliPatil, PravishShetty, "Gesture Controlled Robot using Image Processing", International Journal of AdvancedResearch in Artificial Intelligence (IJARECE), PP.-69-77, Vol-2, No.-5[2013].
[7] AdityaPurkayastha, Akhil Devi Prasad, Arunav Bora, Akshaykumar Gupta, Pankaj Singh, "Hand Gestures Controlled Robotic Arm", Journal of International Academic Research For Multidisciplinary, Vol-2, Issue-4, PP.-234-240, May 2014.
[8] Love Aggarwal, Varnika Gaur, PuneetVerma, "Design and Implementation of Wireless Gesture Controlled Robotic Arm with Vision", International Journal of Computer Application, Vol-79, No.-13, PP.-39-43, October 2013.
[9] http://www.analog.com/media/en/technical-documentation/data-sheets/ADXL335.pdf
[10] http://www.eleinmec.com/datasheets/ds_holtek_ht12d.pdf
[11] http://www.holtek.com/pdf/consumer/2_12ev120.pdf
[12] http://www.ti.com/lit/ds/symlink/l293.pdf
[13] http://oap.sourceforge.net/datasheets/rf.pdf

Author Biblography

	**Swarna Prabha Jena** Assistant Professor in the department of ECE and her interest is in the field of Embedded System and VLSI Design
	**Sworaj Kumar Nayak** Scholar in the department of ECE from CUTM and Interested in programming language (c/c++, Arduino).
	**Saroj Kumar Sahoo** Scholar in the department of ECE from CUTM and Interested in Microprocessor, Microcontroller and Digital electronics.
	**Sibu Ranjan Sahoo** Scholar in the department of ECE from CUTM and interested in Embedded System.
	**Saraswata Dash** Scholar in the department of ECE from CUTM and Interested in mobile communication and Embedded System.
	**Sunil Kumar Sahoo** Scholar in the department of ECE from CUTM and Interested in Embedded System.