International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org
Volume 6, Issue 4, April 2017 **ISSN 2319 - 4847**

MULTIMEDIA BASED GESTURE CONTROL ROBOT

Rampalli Adithya Sharma[1], Manchella Bharadwaj Sairam[2], Babbur Navya[3], K.Rajavardhan Reddy[4]

[1,2,3]Electronics and communications, Sreenidhi Institute of Science and Technology

[4]Assistant Professor, Department of ECE, Sreenidhi Institute of Science and Technology

ABSTRACT

Nowadays, interaction between humans and machines is moving far away from the pen and mouse and changing into a pervasive and more compatible with the physical world. As days are passing, the gap between the humans and machines is being reduced with the introduction of novel technologies to make ease of living. Robots have played a vital role in achieving the easier life performing tasks which human cannot do. Thus, these robots can be used to perform tasks that may be harmful to humans. This paper describes the gesture controlled robot which can be controlled by normal hand gesture. This project mainly consists of color detection [1], serial communication with Arduino and then wireless communication through radio frequency transmitter and receiver as well. According to the color detected in a region, commands are send to the Arduino by the serial communication from MATLAB. Arduino sends the bit pattern to the transmitter. The transmitter transmits the bit pattern send by the Arduino and the receiver receives the bit pattern and makes the robot move in the direction specified in the program written in the embedded C language in Arduino platform.

Keywords— Arduino, Color detection, Gesture, RF module, Serial Communication**.**

1. INTRODUCTION

In the present days, the interaction between humans and machines has become an important part. This interaction is concerned with many aspects such as design, evaluation and implementation of the interactive systems [2].

Humans are very anxiously working on different new technologies to interact with machines [3]. Gestures made a major breakthrough in interacting with machines. A gesture is generally a form of nonverbal communication in which visible bodily actions communicate different messages. In the present days, many types of robots which communicate wirelessly are being developed and are put to varied applications and uses. Human hand gestures have become more natural and with the help of wireless communication. This type of wireless communication has become easier for the interaction of the robot in a friendly manner. The robot moves depending on the gesture made by the human hand. The project is majorly depending on the color detection using MATLAB. In this project, the red color is being detected. The robot movement depends on the position in which the red color is detected. According to the position in which the color is detected MATLAB sends different commands to the Arduino board. Arduino then generates a bit pattern according to each command and it is given to the radio frequency transmitter. The receiver placed on the robot chassis takes the bit pattern and it gives to the motor driver due to which it controls the robot movement.

The main objectives of using the robot are:

Where man dares not to venture

Robots have been put to use within the environments that are dangerous for man.

To rescue promptly

These robots work under completely different conditions, mainly under precarious conditions such as searching and rescuing after disasters.

We can make the robots go to war

These varieties of robots of varied shapes and sizes were deployed in battle fields to withdraw land mines, rummage around for criminals concealed in caves, rummage around for bombs under cars.

2. PROPOSED MODEL

The block diagram of the proposed model is as follows,

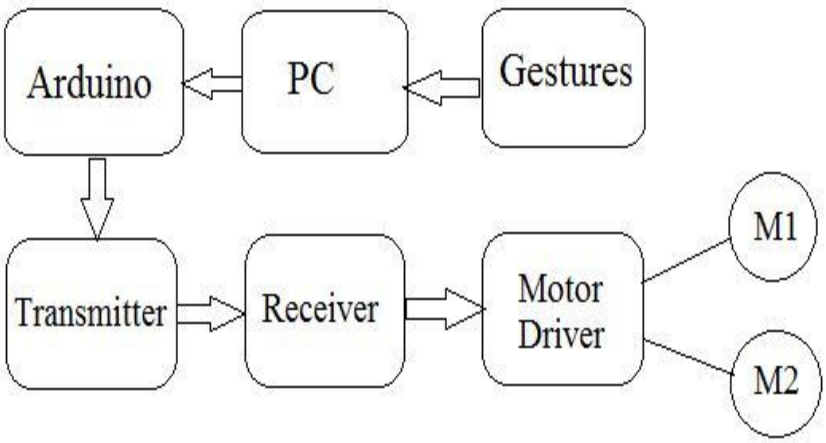

Figure 1. Block diagram

The proposed model consists of majorly four parts

1. Red color detection
2. Finding of the Centroid
3. Serial Communication
4. Radio frequency Communication
5. Red Color Detection

There are many different approaches to detect a particular color in each and every single frame captured by the video camera. Here in this project the red color is being detected. One of the popular approaches to detect the red color is the conversion of RGB frame into a corresponding grayscale image followed by the extraction of pixel values related only to the red color [4][5].

However, this type of approach is quite difficult to apply especially in the live video due to the ambient light present in the surroundings. There is a solution where one can detect a particular color in the primary colors such as red, green and blue as well. Although this is not versatile for all colors except the primary colors, but it eliminates the ambient light issue [6].

The flow of process for the detection of red color using MATLAB is as follows [4][7][8],

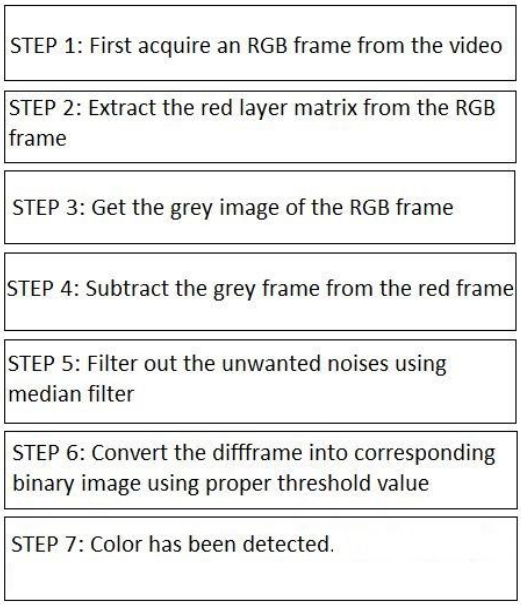

Figure 2. Flow of process for red color detection

Finding of the Centroid

To find the centroid, first all the connected components have to be found. Then the centroid of all the connected components can be calculated. To calculate the centroid, regionprops is an inbuilt command in MATLAB to measure all the set of properties for each of the connected component. The command regionprops computes only the 'area', 'centroid', and 'bounding box' measurements.

Centroid is a 1 x N vector that represents the center of mass of the connected region. The first element of the centroid is the x- coordinate (or horizontal coordinate) of the center of mass, and the second element is the y- coordinate (or vertical coordinate) of the center of mass.

The centroid of all the connected components of the object i.e. the red colored object we check for the biggest component in the captured frame and return the centroid and if our frame has no connected component then the frame itself returns an empty vector [9].

Serial Communication

The interaction of the MATLAB environment with the Arduino development is quite simple and effective when it comes for serial communication. The Arduino and MATLAB both communicate with each other using same language and protocol. This serial communication happens via USB port. The Arduino and MATLAB both have specific commands for the serial communication to be enabled, but the core concept built behind the serial communication is built on the few principles [10].

In order to communicate serially from MATLAB to Arduino, a function need to be created to allow the data to be sent serially through the USB port. Whenever the function is called the serial communication is opened for the PC. After the regions in which the centroid has been found, the variable which has been assigned for each of the region have to be returned to the function created for the serial communication. After the data is sent to the Arduino, the serial communication has to be closed.

The robot directions with the different variables that are defined for different regions are as follows,

Table 1. Serial data with directions

Serial Data	**Direction**
F	Forward
B	Backward
L	Left
R	Right
S	Stop

Radio Frequency Communication

Arduino generates a 4- bit data output according to the serial data received from the MATLAB. The 4- bit data is given to the encoder HT12E in the transmitter module. The encoder encodes the data and data output is given to the transmitter and the transmitter sends the data wirelessly by using amplitude shift keying modulation technique. When a transmitted data is received at the receiver, it gives this data to the HT12D decoder which decodes the received data and the decoded data is given to the motor driver L293D. Motor driver drives the motors according to the bit pattern. The bit patterns are as follows,

Table 2. Serial data with bit patterns & directions

Serial Data	**Bit Pattern**	**Direction**
F	1010	Forward
B	0101	Backward
R	1000	Right
L	0010	Left
S	0000	Stop

3. HARDWARE AND SOFTWARE REQUIREMENTS

A. MATLAB

MATLAB is a generally termed as matrix laboratory which is a multiprogram numerical computing environment. MATLAB is a proprietary language which is developed by MathWorks. This type of numerical computing environment allows us to do manipulation of matrices, different functions and data plotting, different algorithms implementation, creation of user interfaces and interfacing the programs which are written in different languages such as C, C++, Java, Fortran, Python and C# as well [5].

Primarily MATLAB is intended only for numerical computing. An optional toolbox in MATLAB for numerical computing uses the MuPAD symbolic engine, which allows access to the abilities of symbolic computing. The graphical multi-domain simulation and model based design for dynamic and embedded systems can be achieved by Simulink.

B. Arduino Development Board

Arduino development board consists of an Atmel 8 or 16 or 32- bit AVR microcontroller with complementary elements. This complementary element facilitates the programming and incorporation into different circuits. The most and important aspect in the development board is its customary connectors, that let the users to attach the mother board to the big sorts of interchangeable add-ons that are known as shields. Some of these add-ons communicate with the Arduino development board directly over various pins, but many of these add-ons (or shields) are addressable individually through the serial bus [6].

Most of the Arduino boards include an inbuilt 5V linear regulator and a crystal oscillator of frequency 16 MHz. The micro controller in the Arduino board is pre-programmed with a boot loader. This boot loader simplifies uploading of the programs to the on-chip flash memory. The optiboot bootloader is the default bootloader installed on the Arduino development board.

Figure 3. Arduino development board

C. RFmodule

The RF module operates at radio frequency ranges. In this RF system, the digital data is represented in the carrier wave amplitude. Generally, this type of modulation is called as amplitude shift keying. RF transmission is better because, it supports line of sight propagation and it is more reliable [11] [12].

The RF module consists of a transmitter and receiver. The transmitter and receiver pair operates at 434 MHz frequency. The transmitter take the serial data from laptop and transmits it wirelessly to the robot. The wireless radio frequency transmission occurs at a rate of 1Kbps to 10 Kbps. The transmitted serial data is received by the RF receiver which is operating at the same frequency of 434 MHz. The RF module is shown in Figure 5 [13].

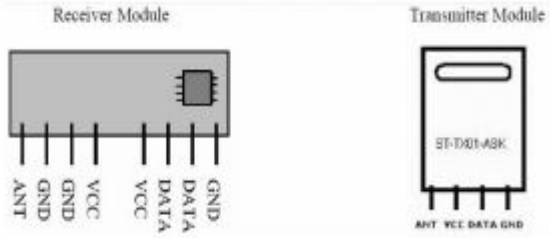

Figure 4. Radio Frequency module

D.HT12E Encoder & HT12D Decoder

HT12E is an integrated circuit which comprises of 2^{12} series of encoders. These 2^{12} series of encoders can be paired with 2^{12} series of decoders for many applications such as remote control transmission applications. It is mainly used in

interfacing the RF and infrared circuits. The pair of encoder and decoder which is chosen should consist of same number of addresses and data format. The encoder is shown in the Figure 6 [12].

HT12D is an integrated circuit which consists of 2^{12} series of decoders. This decoder is generally used to convert serial data which is received by the RF receiver into parallel data. The valid transmission of the data is indicated by the VT pin in the decoder [12]. The decoder is shown in the Figure 7.

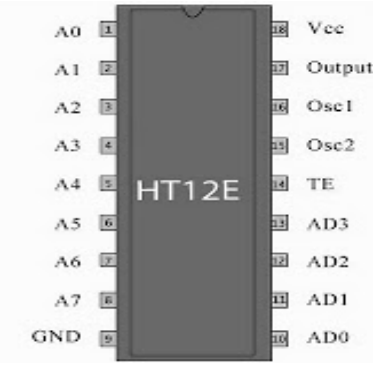

Figure 5. Encoder

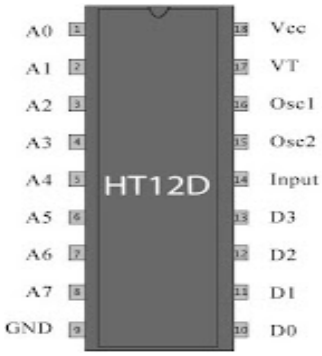

Figure 6. Decoder

E. L293D motor driver

L293D is the dual H-bridge motor driver integrated circuit. The H- bridges in the motor driver act as current amplifiers since they take low current control signal and provide high current signal. This higher current is used to drive the motors. Two dc motors can be driven simultaneously by using a single motor driver in both forward and reverse direction [14]. The L293D motor driver is shown in the figure 8.

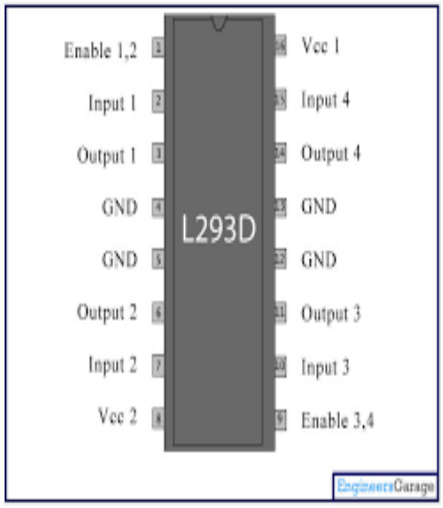

Figure 7. Motor driver

4. RESULTS

In this project, the color detection and the centroid calculation in MATLAB have been achieved. Thereby the serial communication from PC to Arduino have been done successfully.

If the red color strip mounted on the finger is moved towards the region for which the forward direction is assigned, the robot moves forward. If the finger is moved towards the region for which the backward direction is assigned, the robot moves backward. In the same manner, the robot moves in all directions with respect to their assigned regions.

The screenshots of the project are as follows,

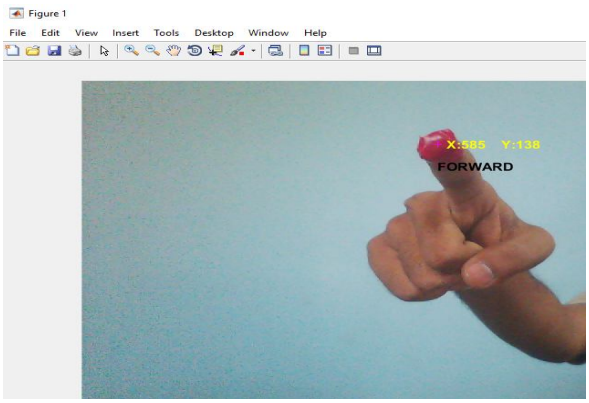

Figure 8. Forward direction

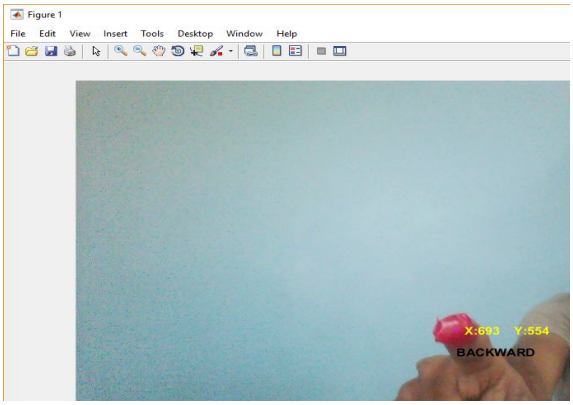

Figure 9. Backward direction

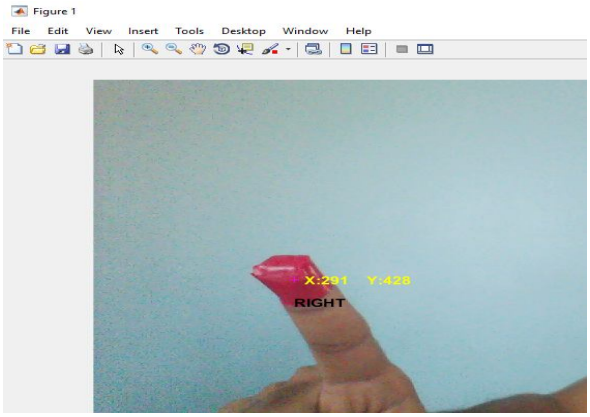

Figure 10. Right direction

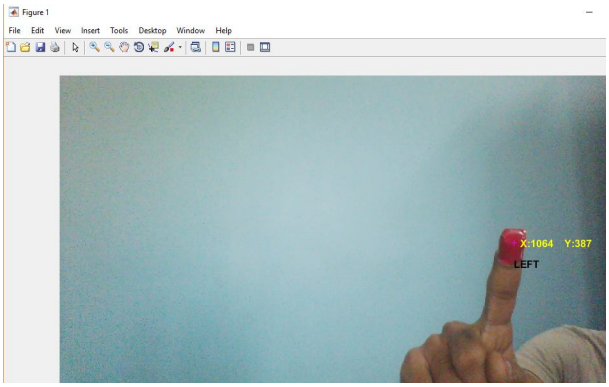

Figure 11. Left direction

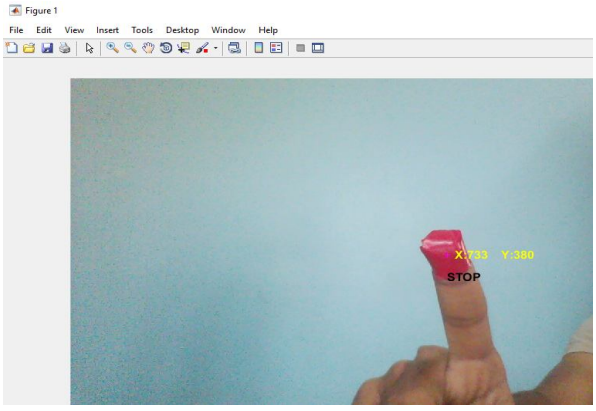

Figure 12. Stop

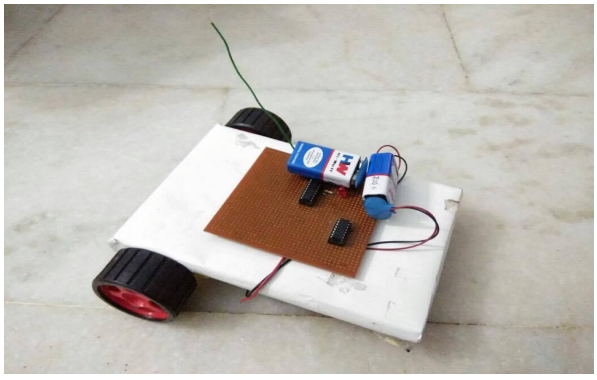

Figure 13. Robot

5. CONCLUSION

Color based image processing plays a vital role in the artificial intelligence. More often it boosts the accuracy of algorithms. The color detection is even helpful in the system automation and it can have numerous applications in near future.

In this project, the gesture controlled robot has been developed which works according to the color detected in different regions. The robot moves wirelessly with the help of RF communication. GPS system can be added to the robot by the help of which its location can be tracked.

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AUTHOR

K. Rajavardhan Reddy received the M. Tech degree in VLSI system design from JNTU Hyderabad in 2011 and 2013, respectively. Currently he is working as an assistant professor in Electronics and communication stream in Sreenidhi Institute of Science and Technology. He has an experience of 3 years in teaching field. The areas in which he is interested are VLSI in both analog and digital domains and Wireless communication networks.