Operation Improvement of Indoor Robot by Gesture Recognition

Savsani Deepkumar Mansukhlal[1], Hansaliya Rishit Nileshbhai[2],
Kantaria Parth Ratilal[3], Patel Unnati Bhupendra[4]

[1,2]M.Tech Student Department Of Electronics & Communication Engineering, Manipal University Jaipur, Rajasthan, India
[3]M.Tech Student Department Of Electronics & Communication Engineering, R.K University, Gujarat, India
[4]M.Tech Student Department Of Electronics & Communication Engineering, GTU PG School, Gandhinagar, Gujarat, India

ABSTRACT: In this Paper, recently the demand for the indoor robots has increased. Therefore, increased opportunities for many people to operate the robots have emerged. However, for many people, it is often difficult to operate a robot using the conventional methods like remote control. To solve this problem, we propose a robot operation system using the hand gesture recognition. Our method pays attention to the direction and movement of the hand. We were able to recognize several gestures in real-time.

Keyword: Matlab, Keil, Microcontroller, Power supply, Voltage Regulators, IC 7805, RS-232, Max-232, ULN2803, RF-PRO Transceiver module.

I. INTRODUCTION

Recently, the demand for the indoor robots, such as auto cleaning and transporter robots has increased. However, the indoor robots have two problems. First, it is usually not easy for many people to operate them because the operations are often difficult and confusing. Second, safety of the robots while operating in the real environment. In order to solve the problem, it is necessary and desirable to construct an easy operation system for everyone. Therefore, a robot operation is designed using hand gestures. This is because hand gestures are easy to understand and intuitive for many people. Here the hand gesture is divided into finger position. Alternate method such as optical flow for hand motion recognition and Harris operator for hand direction recognition can be used.

This work uses camera and to recognize hand gesture. However, this work uses only a camera for easy application and to construction of a simple system. Moreover, in an input interface for the computer by the hand gesture is proposed. This work estimates hand motion by finger position. However, it is necessary to recognize gestures even when a large hand area in an image cannot be extracted. This work proposes a method to recognize gestures at a distance of 1 to 2 meters from the camera.

II. SYSTEM BEHAVIOUR

In constructing an indoor robot, it should meet the following requirements:
- ➢ It should operate in real time.
- ➢ It should be user friendly.
  Therefore, a robot system is developed which is operated by computer image processing results.

A. Gesture:

Gestures are expressive, meaningful body motions involving physical movements of the fingers, hand, head, face, or body with the intent of:

- ➢ Conveying meaningful information or
- ➢ Interacting with the environment.

In gesture recognition technology, a camera reads the movements of the human body and communicates the data to a computer that uses the gestures as input to control devices or applications

B. Classification of Gestures:

Gestures can broadly be of the following types:

➢ Hand and arm gestures: Recognition of hand poses, finger position, sign languages, and entertainment applications.
➢ Head and face gestures: Some examples are: a) nodding or shaking of head; b) direction of eye gaze; c) rising the eyebrows; and d) opening the mouth to speak.
➢ Body gestures: Involvement of full body motion, as in: a) tracking movements of two people interacting outdoors; and b) analyzing movements of a dancer for generating matching music and graphics.

The gesture recognition has to be done in real time by one camera. The sensor device used is an USB webcam. So, this makes it possible for any user to use it in his office or home. The system was developed using MATLAB 7.1 on Windows XP Operating System. The images after being captured through the webcam were saved in the database using .jpg format. One of the main goals of Hand Gesture Recognition is to identify hand gestures   and classify them as accurately as possible.

III. CONSTRUCTION AND WORKING OF ROBOT

Following steps explain about the construction and working of the robot:

The first step is to decide the operation of the robot. In this project, operation decided for the robot are to move forward, backward, left, right, picking up and put down the object which can be controlled by the user wirelessly. The robot can always be modified and made better.

The second step is to decide how the operation is done. For moving operation two motors are required, one motor will power one wheel and another for the other. This means to go forward, both motors spin forward; to go backwards, both motors spin backwards; and to turn one motor goes and one motor stays still. To pick up and to put down the object other two motors are required. This project will be using geared DC motors because it's easier. The four basic things for buying geared DC motors are speed, torque, size and weight. Size and weight are very important in this project because there is limited space in the robot to place the motors. Torque is the motors strength. If there are no gears and the torque is low, it probably won't allow the robot to move forward because it doesn't have the strength. Here torque is requiring high, but the higher the torque, generally the lower the speed. For this robot there is good balance of speed and torque.

The third step is to choose a power supply. DC (i.e. batteries) power is not recommended. Hence we use AC (i.e. plug it into the wall) power. The motors being used needs a voltage level of 12V and Microcontroller needs a voltage of 5V. Hence 12V transformer is used. The fourth step is to choose a Transmitter and Receiver. This is going to be the most important, because without it, the robot can't do anything. There are a few frequencies that we can use. The most common are 27 MHz, 72 MHz, 75 MHz, and 2.4 GHz. In this 2.4 GHz frequency is used because it has less interference than any of the other frequencies. For this robot only one channel is require. Since we are transmitting data serially only one channel is sufficient. Hence Zigbee technology can be used.

The fifth step is to choose wheels for the robot. For choosing wheels, the three most important things are diameter, traction and attachment to the wheel of our motors easily. Diameter is the length of the wheel from one side, through the center point, to the other side. The greater the diameter of the wheel, the faster it goes and the more it can climb, but the less torque it will have. Traction is how well the wheels stick to the surface. The sixth step is to do all the electrical and electronic connections to the programmed microcontroller and other devices. Then all the final modifications like placing the camera, battery pack, transmitter and circuit boards etc are need to be done.

Now the robot is ready to be used and can be controlled wirelessly using computer.

A. Introduction of DC motor:

Nowadays DC motors play a vital role in most of the industrial areas, it can be seen in most of the electronic devices. They are mainly used for the mechanical movements of physical applications such as rolling the bundle of sheets or CD drives, lifts etc. Many methods have evolved to control the revolution of a motor. DC motors can be controlled either by software or directly by hardware. Software controlling needs computers which are bulky, common man cannot afford for it, so hardware controls are in use. Even in hardware if it is programmable device then it is preferred because it can be modeled according to the requirements of the user.

B. Working Principle:

It is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left-hand rule and whose magnitude is given by Force

$$F = B \, I \, L \text{ Newton}$$

Where,   B is the magnetic field in Weber/m²
   I is the current in Amperes and
   L is the length of the coil in Meter.

The force, current and the magnetic field are all in different directions. If an Electric current flows through two copper wires that are between the poles of a magnet, an upward force will move one wire up and a downward force will move the other wire down.
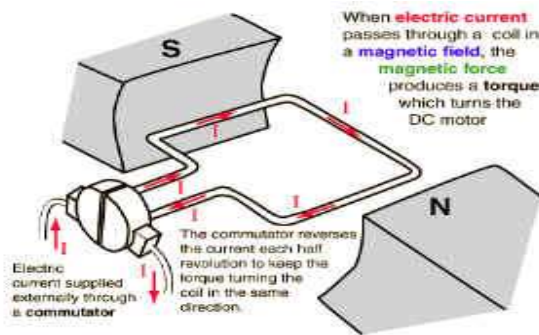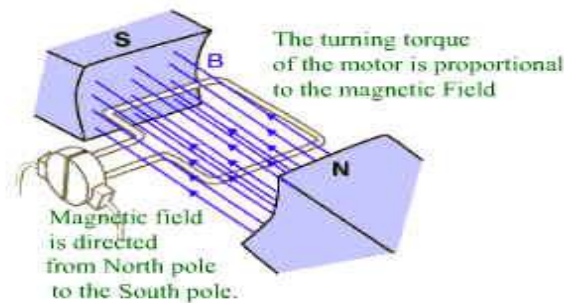

Fig 1 : Force in DC Motor

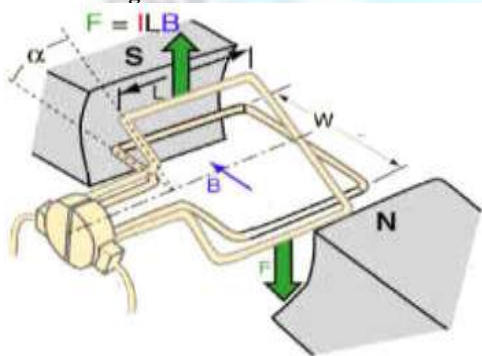**Fig 2 : Magnetic Field in DC Motor**
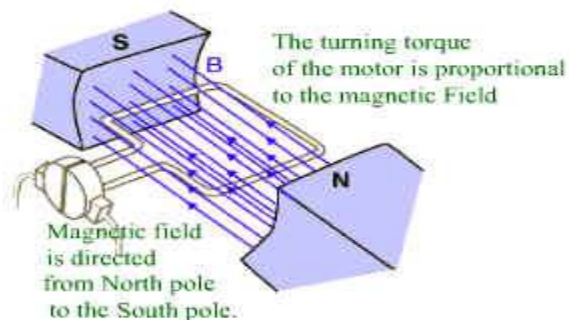

Fig 3 : Torque in DC Motor

Fig 4 : Current Flow in DC Motor

The loop can be made to spin by fixing a half circle of copper which is known as commutator, to each end of the loop. Current is passed into and out of the loop by brushes that press onto the strips. The brushes do not go round so the wires do not get twisted.This arrangement also makes sure that the current always passes down on the right and   back on the left so that the rotation continues.

C. DC Motor Drive Circuit:

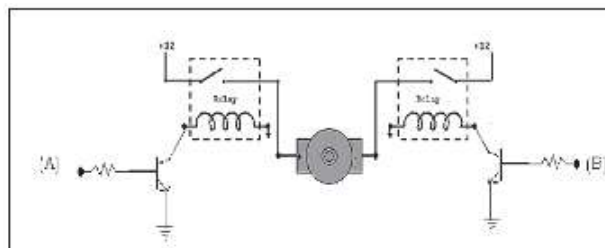The H-bridge as shown in Fig 5, is use to drive the DC-motor forward and backward.

Fig 5 : H-bridge circuit

The +12V DC power is applied from the battery to the H-bridge circuit, and controlled through the controller by applying logics.

Table 1 : H-bridge circuit Boolean Logic

A	B	FUNCTION
1	0	Forward
0	1	Reverse
1	1	Stop
0	0	Stop

In Table 1, when logic 1, 0 is applied to terminal A and B, the motor moves in forward direction and when logic 0, 1 is applied it moves in reverse direction respectively. The motor will be in rest state when logic 0, 0 or 1, 1 is applied.

IV. IMPLEMENTATION OF HAND GESTURE

A.   System Overview:

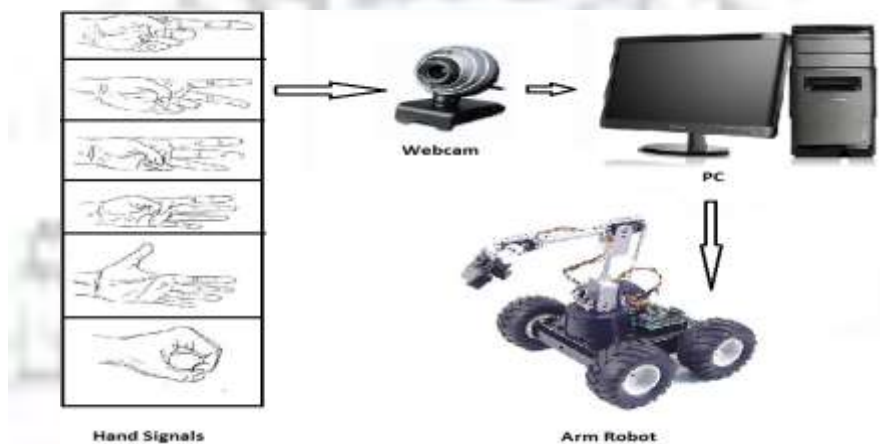The basic representation of the system is shown below as a Fig.6.

Fig 6: Basic Representation of Arm Robot using Hand Gesture

B. Web Camera

Web camera which we are using has following features:

➢ Lens high Quality 3P lens
➢ Interface: USB 2.0 High-Speed (UVC)
➢ Snapshot Button
➢ Built In Microphone
➢ Suitable for both laptop and desktop
➢ Zoom function with four choices for the zoom (1x, 2x, 3x & 4x)
➢ Focus Rate: with VGA (640x480) format rate up to 30fps
➢ Automatic exposure control, Auto White balance
➢ Color: RGB 24 (true color 24 bit)

C. Personal computer (PC):

The PC should have following features to install the MATLAB software. Below Table 2 shows the requirement to install MATLAB.

Table 2: Operating System Specification

Operating System	Processor	Disk Space	Ram
Windows XP (Service Pack 1 or 2) Windows2000 (Service Pack 3 or 4) Windows Server 2003 (Service Pack 1 or 2) Windows Vista	Intel Pentium (Pentium IV and above)Intel Celeron Intel Xeon Intel Core AMD Athlon AMD Opteron	510 MB (MATLAB only)	512 MB (1024 recommended)

V. SYSTEM IMPLEMENTATION
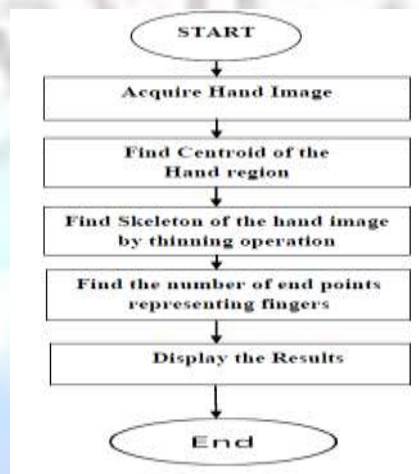
A. SOFTWARE IMPLEMENTATION

Fig 7 : Flowchart for steps of program executed in MATLAB

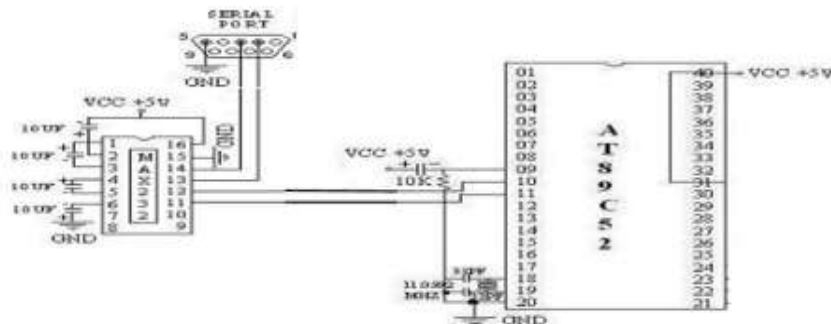### B. HARDWARE IMPLEMANTATION
(i) MICROCONTROLLER AND MAX232

Fig. 8 : Interfacing between Microcontroller and Max232

The RS232 is not TTL compatible; therefore it requires a line driver such as MAX232 chip to convert RS232 voltage level to TTL level, vice versa.

- 8051 has two pins that are used specifically for transferring and receiving data serially.
- These two pins are called TxD and RxD are a part of the port3(P3.0 and P3.10).
- These pins TTl compatible.
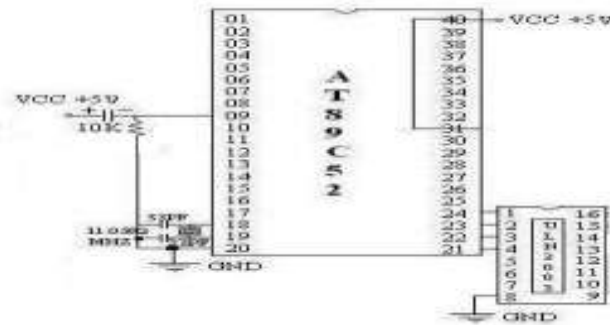
(ii)   MICROCONTROLLER AND ULN2803

Fig 9 : Interfacing between Microcontroller and ULN2803

- Microcontroller pins lack sufficient current to drive the relay.
- While relay coils needs around 10mA to be energized, microcontrollers pin can provide a maximum of 1-2mA . For this purpose we use a driver, such as ULN2003AG to drive the relay. Relay acts as a switch between the microcontroller and the appliances.
- The contacts in the relay can be normally open(NO) or normally closed(NO).In NC type the contacts are closed when coil is not energized.IN no type, contacts are open when coil is unenergized.

(iii) RELAY

- Relays are remote control electricals switches that are controlled by another switch, such as a computer as in a power train control module. Relays allow a small current flow circuit to a control a higher current circuit. Several designs of relays are in use today, 3-pin, 4-pin, 5-pin, 6-pin single switch or dual switches.

VI.   TESTING AND RESULTS

➢ **Power Supply**

Power supply can be tested using a Digital Multi-meter. Firstly, switch on the Multi-meter and turn the dial to V_{dc} setting. Connect the negative probe (Black) of the Multi-meter to the ground wire and positive probe (Red) to the Output wire. The highest voltage is +/- 12V. The obtained Output was 5.03V. The testing confirmed that the power supply can work under a load.

➢ **Relay**

Keep the multimeter in the continuity check mode and Check for continuity between the N/C contacts and pole again check for discontinuity between N/O contacts and the pole. Now energize the relay using the rated voltage. For example use a 9V battery for energizing a 9V relay. The relay will engage with clicking sound. Now check for continuity between N/O contacts and pole. Also check for discontinuity between N/C contacts and pole. As a final test, measure the resistance of the relay coil using a multimeter and check whether it is matching to the value stated by the manufacturer.

➢ **DC Motor**

Find the two small metal terminals on the electric motor. They are near the back and have two colored wires usually red and black, attached to them. Turn on the power unit that supplies electricity to the electric motor. You need to check if electricity is getting to the motor. When proper electricity passes through the motor, the rotor will rotate indicating proper working of the motor.

➢ **2.4Ghz RF module Transceiver**

Testing Communication between Modules: Once the 2 modules have been connected to 2 different PC's and are powered on with the terminal initialized on both of them, the connection may be tested. Any data transmitted from one PC will appear on the other PC, character by character.

VII. CONCLUSION AND FUTURE WORK

➢ CONCLUSION

This paper provides an interface with robot by hand gesture recognition which will be easy to operate. The system can not only be applied in family environment, but also can be applied in public. In public, every user can get information from this system by hand gesture, and the cost will be cheap than touchpad. The system also suitable for the population that is not familiar with computers that only learn how to posture the hand gesture. It will every helpful for the population. Our hand gesture recognition can integrate with other application such as interactive game, smart home, auxiliary equipment and industrial control.

➢ FUTURE WORK

We envision gesture-based control to be of particular value for interacting with teams of robots. Controlling individual robots can still be achieved using a mouse or a joystick there is a one-to-one mapping between the joystick position and the robot velocity. Multi-robot systems require a much richer form of interaction. Instead of providing low-level control for individual robots, the user needs to provide high-level directives for the team as a whole. We will address control of multi-robot systems in our future research. Here we are able to recognize several gestures in real-time, but in future we can also use stored gesture. As well in future we can add more than one gesture types (eg, head gestures, body gestures etc,).

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