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Handgesture Based Direction Control of Robocar using Arduino Microcontroller

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Abstract: ***In this paper, a different approach to drive a Robocar using hand gesture with the help of software tool is presented. The same design is implemented on hardware using Ardiuno Microcontroller. Gesture is a most natural, expressive way of communication between human and computer in real system. We naturally use various gestures to express our own intension in everyday life. Hand gesture is one of the important methods of non-verbal communications human being. In this paper, a simulation tool, matlab based algorithm is used to recognize hand gesture. Based on hand gesture, output is generated by matlab. This output serves as an input to Microcontroller. This Microcontroller runs the DC motor accordingly. The output of DC motor is used to run the robocar.***

Keywords: Gestures; webcam; Arduino UNO; DC motor; L293D Driver circuit.

I. INTRODUCTION

In present world, we could see a continuous increase in human dependency on electrical application, such as home appliances, application in infrastructure, manufacturing and some more. With increase in users, the need for optimization of designs as also increased. As per observations, we find many electrical applications based on one such electrical equipment DC motor. In a DC motor the power supply directly connects to the field of the motor and causes a precise voltage control which is essential for applications which need control of speed and torque. Because of various advantages such as simplicity, ease of application, reliability and favorable cost, DC drives have long been a backbone of industrial applications. In comparison with AC drive systems DC drives are less and are normally cheaper for low horsepower ratings. Dc motor can be used to drive many applications such as bang-bang control, Robotics, CNC machinery, inline bottle filling and some more. There exists many ways to drive a DC motor, one among them is driving DC motor by using Ardiuno Microcontroller. In this article, a simulation tool, matlab based point pattern matching with SIFT match algorithm is used to recognize hand gesture. Based on hand gesture's output, The Microcontroller runs the DC motor accordingly. The output of DC motor is used to robocar.

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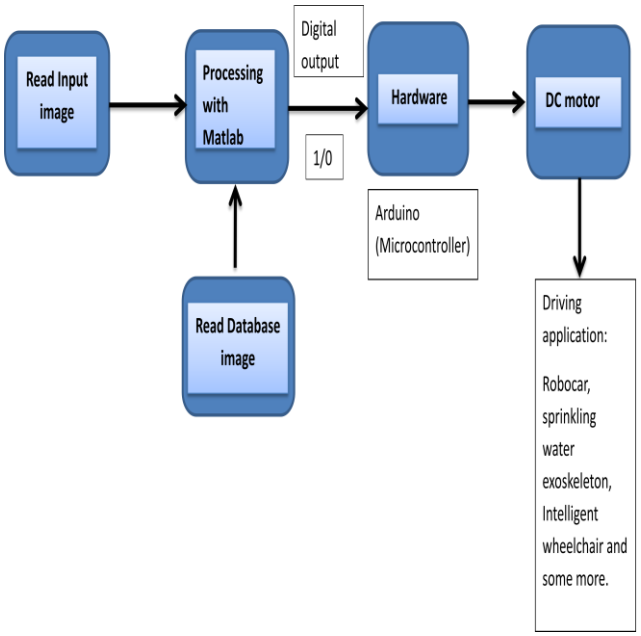

Fig. 1 Design of System

II. TECHNOLOGY USED

A. GESTURE

Gestures are an important aspect of human interaction, both interpersonally and in the context of man-machine interfaces. A gesture is a form of non-verbal communication in which visible bodily actions communicate particular messages, either in place of speech or together and in parallel with words. Gestures include movement of the hands, face, or other parts of the body. Military air marshals use hand and body gestures to direct flight operations aboard aircraft carriers. Hand gesture recognition is one obvious way to create a useful, highly adaptive interface between machines and their users. Hand gesture recognition technology would allow for the operation of complex machines using only a series of finger and hand movements, eliminating the need for physical contact between operator and machine.

B. ArduinoUNO

Arduino is an open source microcontroller board, electronics prototyping platform based on flexible, easy to use hardware and software. It is intended for artists, designers, hobbyists and any more interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators.

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The Microcontroller on the board is programmed using the Arduino projects can be stand-alone or they communicate with software running on a computer.

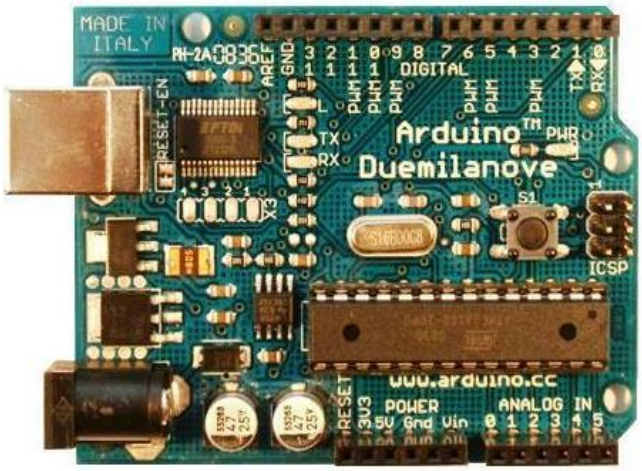

Fig. 4 Adruino UNO

C. L293D Driver Circuit

L293D is a typical Motor driver which allows DC motor to drive on either is a 16-pin IC which can control motors simultaneously in any direction. We can control two DC motor with Dual H-bridge *Motor Driver integrated.* The L293D can drive small and quiet well, check the Voltage Specification. It works on the concept of H-bridge. H-bridge is a circuit which to be worked in either direction. As voltage need to rotate the motor in clockwise or anticlockwise. H-bridge IC is ideal for driving a DC motor. In a single L293D chip there two H-bridge circuit inside the two dc motor independently. Due to its size, it is an application for controlling DC motors. The pin diagram of motor controller is given below. There are two Enable pins on L293D: pin 1 and pin 9. For being motor, the pin 1 and 9 should be high. For driving the motor, enable pin 1 should be high and for right H-Bridge, enable pin 9 should be high. If anyone of the either pin1 or pin9 goes low then corresponding section will suspend working. It's like a switch.

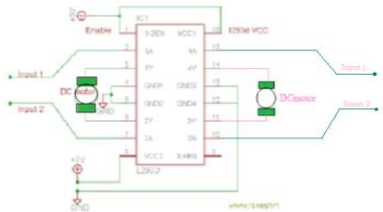

Fig. 3 L293D Driver Circuit

D. PMDC Motor

The permanent magnet DC motor consists of an armature winding as in case of a usual motor, but does not necessarily contain the field windings. The constructions of these types of DC motor are such that radially magnetized permanent magnets 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 given above. The torque equation of dc motor suggests $T_g = K_a \varphi I_a$. Here φ is always constant, as permanent magnets of required flux density are chosen at the time of construction and can't be changed thereafter.

For a permanent magnet dc motor $T_g = K_{a1} I_a$

Where $K_{a1} = K_a.\varphi$ which is another constant. In this case the torque of DC Motor can only be changed by controlling armature supply.

Fig. 2 PMDC Motor

III. DESIGN AND IMPLEMENTATION

Our design primarily focuses on gesture command Recognition. Command is generated at the control station and sent to the PMDC motor. The motor moves in the specified direction according to the specified command. The following section illustrates the steps carried out in the design.

Capturing Hand Gesture

The end result of gesture recognition system is to generate a command and that is given to the PMDC motor. Some of the captured hand gesture is stored in database and compare with captured input hand gesture through webcam. These methods involve recognition of the palm and process it further accordingly.

Image Processing Algorithm

1. Point Pattern Matching Algorithm

Hand gesture recognition system consisting of point pattern matching and SIFT is used to recognize hand gesture, because it is fast and simple approach. Point pattern matching is the assignment of some sort of output value to a given input value, according to some specific algorithm.

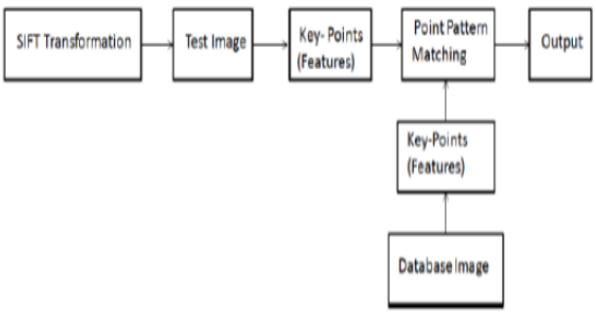

Fig. 5 Block Diagram of Point Pattern Algorithm

As shown in Fig. 5, first we have to take an image from webcam or from database.

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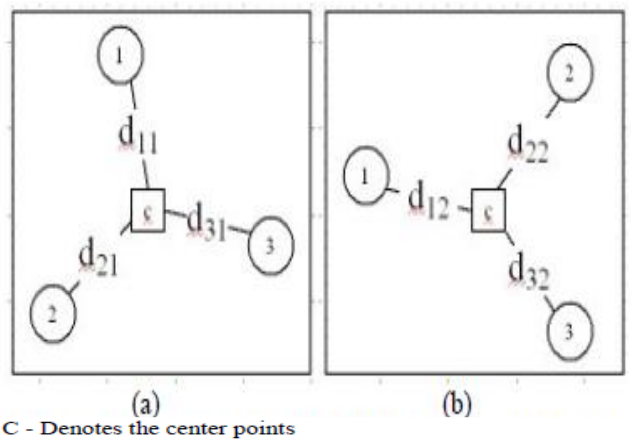
These images will go through a SIFT Transformation. This transformation will find key-points (Features) of that particular image into a feature vector, which will be then compared with other feature vectors of Database images of hand gestures. For comparison we use Point Pattern Matching Algorithm. Hand Gesture Recognition system is developed by using SIFT algorithm with point pattern matching algorithm to perform hand gesture recognition. Point pattern matching algorithm provides a navel approach to achieve a matching of adequate quality in an efficient and robust manner. For hand gesture recognition, we used point pattern matching with SIFT match algorithm. The flowchart of proposed algorithm is as shown in following Fig. 6.

Fig. 6 Flow Chart of Proposed Algorithm

2. MK-RoD Algorithm

For finding the validity ratio MK-RoD algorithm is used. For example, Fig.7 shows the two images for finding the validity ratio.



C - Denotes the center points
D - Denotes the distance mask
T - Denotes the No. of test image to match
M - Denotes the No. of Matched Points 1, 2, 3 are the key points.
The procedure to find the Validity ratio of One Database Image versus Test Input Image is as follows:

(1) $d_{T1} = \sum_{i=1}^{M} d_{i1}$
(2) $d_{T2} = \sum_{i=1}^{M} d_{i2}$
(3) $Ratios\ 1 = \left[\frac{d_{11}}{d_{T1}}\ \frac{d_{21}}{d_{T1}}\ \frac{d_{31}}{d_{T1}}\right]$
(4) $Ratios\ 2 = \left[\frac{d_{12}}{d_{T2}}\ \frac{d_{22}}{d_{T2}}\ \frac{d_{32}}{d_{T2}}\right]$
(5) $Distance\ Mask = abs[Ratios\ 1 - Ratios\ 2] < (Threshold\ Value)$
(6) $Valid\ Points = sum(Distance\ Mask)$
(7) $Validity\ Ratio = \frac{No.of\ Valid\ Points}{No.of\ Matches\ Points}$

Fig. 7 Test Input Image vs Database Image

Once we got the validity ratio, mask the distances by taking the absolute which are below the algorithm's threshold. This operation is done in order to determine the similar pattern of the matched key points from the center of the matched key points. The absolute of the difference of the points which are below the given threshold are treated as valid matched key point.

Arduino UNO

The Arduino family consists of popular, low cost development boards based on various ATMEL AVR Microcontroller. The particular model used in this class is the Duemilanove, which uses an ATmega328P Microcontroller with a simplified USB interface provided by an FT232 bridge. The board incorporates 5v and 3.3v LDD regulators to provide regulated voltage sources using either USB bus power or an external power supply of 7-12v. There are also indicator LED's for power and serial activity, as well as a single user LED on pin13. The Microcontroller pin-modes are made accessible by 0.10" female headers on the sides of the board. Pins are grouped according to enuction and are labeled at the foot of the pins.

Serial Communication between Arduino and MATLAB

Serial means "one after another". Serial communication is when we transfer data one pin at a time, one right after the other. Information is passed back and forth between the computer and Arduino by, essentially, setting a pin high or low. Just like we turn an LED on and off, we can also send data. One side sets the pin and the other reads it. MATLAB can read/send the data from/to the serial port of the computer and process it. We have to connect the Arduino board to the PC. Each serial port on the PC is labeled COM1, COM2 etc. The Arduino will be given a COM port number. Now we are ready for the MATLAB and Arduino serial communication.

DC Motor and Robocar

In very small ratings, use of permanent-magnet excitation results in lower manufacturing cost.In many cases a PMDC motor is smaller in size than a wound-field DC motor of equal power rating.Since field excitation current is not required, the efficiency of these motors is generally higher than that of the wound-field motors.Low-voltage PMDC motors produce less air noise.When designed for low-voltage (12 V or less) these motors produced very little radio and TV interference.Two PMDC motors are connected to two wheels of the Robocar separately. The DC motor is connected to the Driver circuit to drive the Robocar. The Arduino Uno Board is also connected to the DC motor to drive the wheels of the car in forward or backward direction.

L293D Driver Circuit

There are 4 input pins for this L293D, pin 2, 7 on the left and right as shown on the pin diagram. Left input pins will regulate motor connected across left side and right input for motor on. The motors are rotated on the basis of the inputs provided across LOGIC 0 or LOGIC 1.

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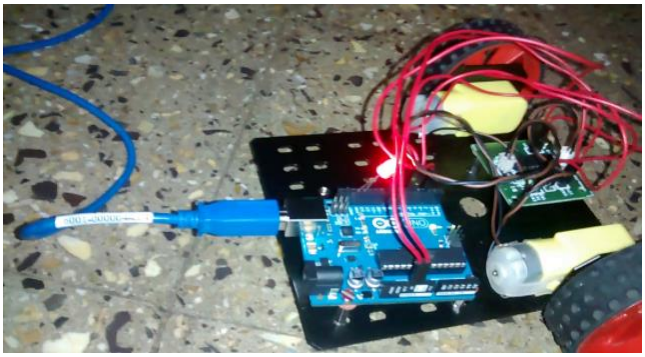
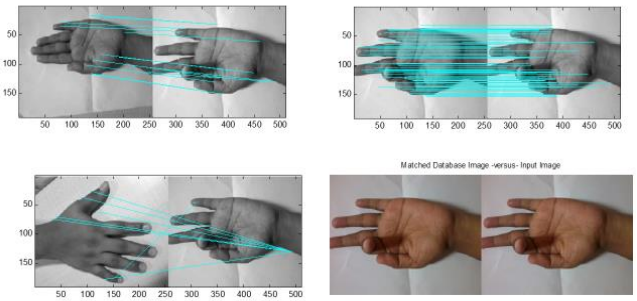
In simple we need to provide Logic 0 or 1 across the input pins of motor.There are 16 pins in which pin 1 and 16 is given to 5v supply. Pin 2,7,10 and 15 are given to inputs. Pin 3 and 6 for motor 1 and pin 11 and 14 for motor 2. Pin 8,Vcc2 is given to 12v supply and pin 4,5,12, and 13 are grounded.

IV. HARDWARE IMPLEMENTATION



The Hardware Implementation is shown in the figure. It consists of PMDC motor, Arduino Uno Board, Driver Circuit and wheels. Wires are used for connections.Dual H-bridge driver circuit is used because it can handle the working of two DC motors simultaneously. Two DC motors are connected to two wheels of the Robocar separately. The DC motor is connected to the Driver circuit to drive the Robocar. The Arduino Uno Board is also connected to the DC motor to drive the wheels of the car in forward or backward direction by the output generated in matlab and Arduino program which is dumped into the microcontroller with the help USB connection.

V. RESULT



The arduino program is uploaded into the microcontroller. The algorithms of the matlab are executed.The sequence of matlab output is shown above.If the input image is matched with the Database images the matlab gives the output as match found and thus the microcontroller controls the driver circuit and the robocar moves forward direction and if the input image is not matched with the database image the matlab gives the output as match not found and thus the microcontroller controls the driver circuit and the robocar moves reverse direction.

VI. CONCLUSION

The importance of gesture recognition lies in building efficient human–machine interaction. Its applications range from sign language recognition through medical rehabilitation to virtual reality. Almost all consumer electronic equipment today uses remote controls for user interfaces. The features of the input image are processed by comparing with features of data base images. If the hand gesture is similar then Arduino is programmed such that the robotic car moves forward, if it is different robotic car moves backward.This system used for security purpose.The same device control system design can be used to implement other DC motor applications such as Ro, sprinkling water exoskeleton, intelligent wheelchair. Artificial neural network can be used to make the system faster and with the implementation of neural network system becomes more versatile and easy. Training the system with the artificial algorithm makes the system to reduce the complexity in network. It reduces the time for process with fast algorithm of the network.

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