Project for Gesture Based UI Development

Gesture Controlled Robot

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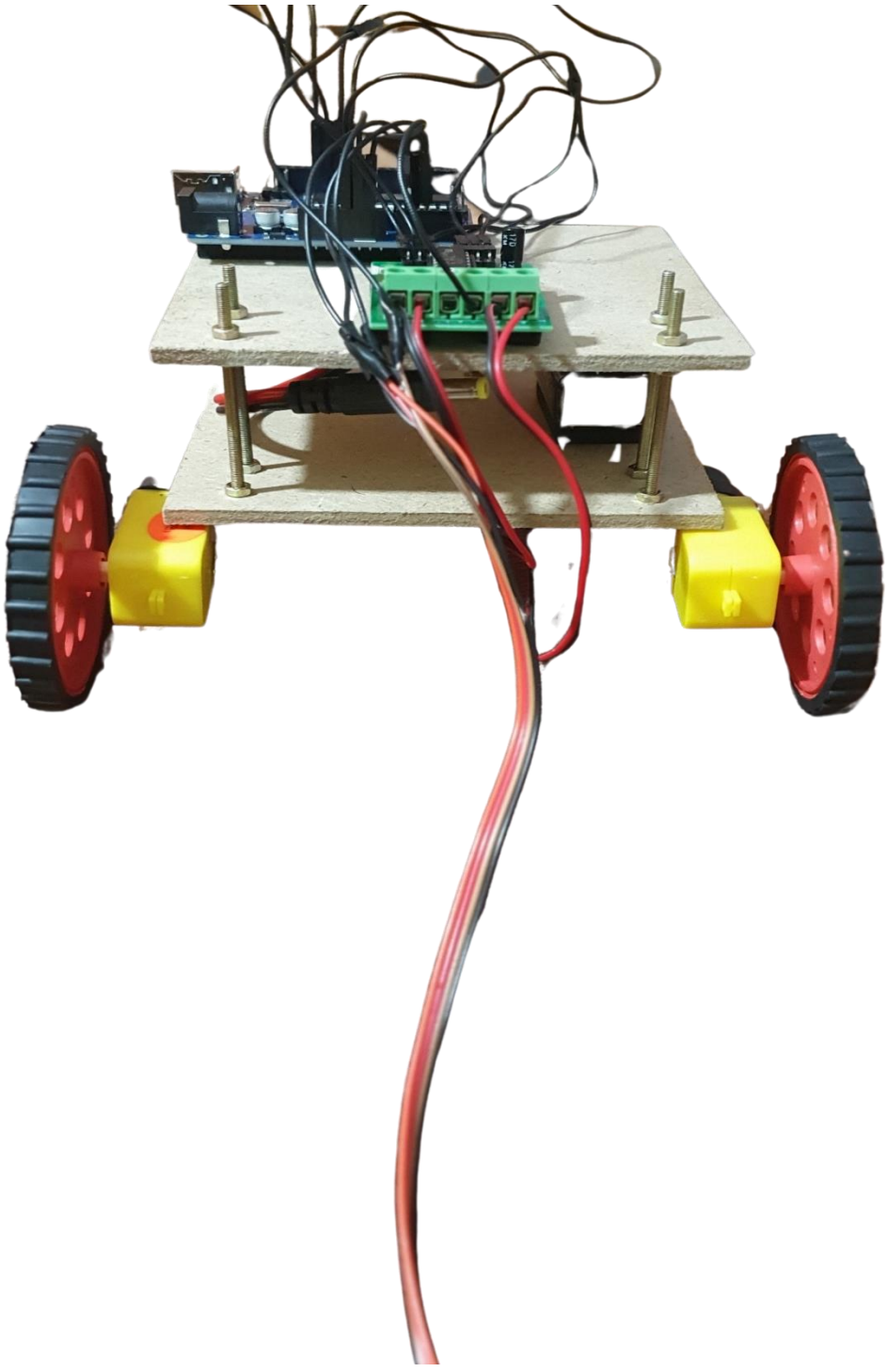
Purpose of the application

The purpose is to build a Gesture based robot which is a robot controlled by hand gestures. The user has a sensor on his hand to detect the motion cause by different hand gestures. Depending on the Gestures detected by the sensor the robot moves accordingly.

Here is the design of the Robot



This is the design of the sensor to be held in hand for controlling Robot.

How it works:

Connect the big round pin wire with the Arduino uno Board. This will power on the Robot and Robot will start moving. Take the accelerometer sensor attached with cardboard in hand. The Arrow Mark on the card points to the forward direction along x-axis. Now if the the sensor is flat i.e at ground level then the robot will stop. To move the Robot, we can tilt the sensor in any direction along x-axis or y-axis to move the robot in that direction. You will find more information about gestures identified below.

Gestures identified as appropriate for this application

Almost everyone has smartphone these days and we have noticed that when we tilt the phone from the portrait view to the landscape view the display on the phone changes accordingly this is because of the accelerometer in the phone which senses its motion.

Similarly, I have accelerometer which will detect the gestures of my hand and make the robot move accordingly

- The Robot will move forward when the accelerometer is tilted forward.
- It should move backward when the sensor is tilted backwards
- It should turn right when the sensor tilts to the right.
- It should turn left when the sensor tilts to the left.
- It should stop when it is not tilted in any direction.

I Picked these gestures because it makes sense to tilt the sensor in the direction we want the robot to move in this way for instance if this robot is given to a new user he wont have to remember any specific type of gestures because these are similar to our daily movements e.g. For the movement of bicycle, bike and car etc we have to move the steering wheel or the handle of the bicycle or cycle to left or right to move it left or right.

Similarly, when we are moving down the hill then we are moving forward, and it seems as we are tilted forward, and the reverse of forward is backward.

similarly, a hoverboard has these all same gestures for its movement

Hardware used and its Purpose

4 core cable

For Connecting Accelerometer ADXL335 Sensor to Arduino Uno.

Arduino Uno

For Programming the Robot and for power distribution. There are many other microcontrollers that can be used as an alternative to Arduino Uno, but this is the simplest and most used and available.

Arduino Uno USB Cable

For connecting Arduino Uno to Computer.

Accelerometer ADXL335 Sensor

For detecting X-axis and Y-axis values. ADXL345, 356 etc could also be used but ADXL335 is the cheapest and good for small range with precise readings.

L293D Motor Driver Circuit

To drive Two DC motors in any direction with the same IC as microcontroller cannot provide enough power required for the motors its an interface between the Microcontroller and Motor

DC motors

For Rotating the wheels so that robot can be moved. Other option is to use stepper Motor but that's slow as compared to Dc and Dc is fast and Continuous rotation motor and specially used in robotics and embedded systems.

Other Small Components

- 2 Wheels for Motors
- 1 Castor Wheels
- Connecting Wires
- Pin connectors wire
- Barrel connector wire
- 1 board for Chassis
- 2 U Clamps
- Screws and nuts
- Tapes insulation and double sided
- 9-volt battery
- 9-volt battery connectors

Below are the pictures of the main components

Arduino Uno

ADXL-335 Accelerometer Sensor

L293D Motor Driver Circuit

Wheel

Dc Motor

Architecture for the solution

This Gesture Based Robot have an Accelerometer Sensor that provides the necessary inputs based on the detection of gestures. I have used ADXL335 Accelerometer Sensor in this Project. These inputs from the sensor are send to the brain of the robot which is the Arduino uno in my case. The Arduino uno is programmed using graphical programming language called scratch Arduino. I have programmed Arduino to detect inputs and make necessary actions to make the robot move and finally the Robot which have a board chassis with 2 wheels with 2 Dc Motors and 1 Castor wheel at the front is actuated by the Arduino Uno. The Dc Motors are driven by the motor driver which provide the necessary voltages to both motors to move the robot in accordance to the sensor input.

One 9 Volt battery is connected to the Motor Driver to power the Dc motors and other 9 volt battery is connected to the Arduino uno to power the Arduino uno.

Connections Table for Dc Motor to Motor Driver

Motor Driver	DC Motor
MB 1	**Positive of left motor**
MB 2	**Negative of left motor**
MA 1	**Negative of right motor**
MA 2	**Positive of right motor**

Connections Table for Motor Driver to Arduino Uno

Motor Driver	Arduino Uno
A 1	**Digital Output 10**
A 2	**Digital Output 11**
B 1	**Digital Output 12**
B 2	**Digital Output 13**
V -	**Ground**

Connections Table for ADXL-335 to Arduino Uno

ADXL-335	Arduino Uno
VCC	**5 Volt**
Ground	**Ground**
X-Axis	**Analog pin 1 (A1)**
Y-Axis	**Analog pin 2(A2)**

Programming Logic

Checking the ADXL335 Readings

The readings of the Accelerometer sensors as flat state may be different for each model so first I have written a code that checks for the readings and prints out on the monitor console of the scratch IDE so that then we can define our movement logic. This script is available on the GitHub in the Roughwork Folder.

Main Logic

In a loop continuously read and store the values of the Analog pin A1 which is connected to the x-out and Analog pin A2 which is connected to the y-out of the ADXL

Move Forward Logic:

Check if the x axis reading is less than 300 then turn the digital pin 10 and pin 12 output to High, pin 11 and 13 to Low to move both motors clockwise so that robot moves forward.

Move Backward Logic:

Check if the x axis reading is greater than 350 then turn the digital pin 10 and pin 12 output to Low, pin 11 and 13 to High to move both motors anti-clockwise so that robot moves backwards.

Move Right Logic:

Check if the y axis reading is greater than 350 then turn the digital pin 10 and pin 13 output to Low, pin 11 and 12 to High to move Right motor backwards and Left motor forward so that robot moves to the right

Move Left Logic:

Check if the y axis reading is less than 300 then turn the digital pin 10 and pin 13 output to High, pin 11 and 12 to Low to move Left motor backwards and Right motor forward so that robot moves to the Left.

Stop Logic:

Check if the y axis and x axis reading is greater than 300 and less than 350 then turn the digital pin 10,11,12 and 13 to Low to stop the robot.

Programming Logic Table

				Right Motor		Left Motor	
ADXL335	**X-Axis (A1)**	**Y-Axis (A2)**	**Robot Movement**	**INP A1 Pin 10**	**INP A2 Pin 11**	**INP B1 Pin 12**	**INP B2 Pin 13**
Flat	~320	~320	Stop	Off	Off	Off	Off
Tilted Forward	<300	~320	Forward	On	Off	On	Off
Tilted Backward	>350	~320	Reverse	Off	On	Off	On
Tilted Right	~320	>350	Right	Off	On	On	Off
Tilted Left	~320	<300	Left	On	Off	Off	On

Conclusions & Recommendations

This project made me learn embedded programming which I have never done before during the course (BSc Hons in Software Development) through this project I learned about different sensors and their types and learned about the ADLX335 Accelerometer sensor , Microcontrollers, Arduino Uno, Dc Motors and Generally the field of Robotics in depth and apart from software I gained skills in hardware and thoroughly enjoyed it.

If I would undertake this project again, I would make the sensor work wireless so that the user doesn't have to move with the robot and give it a more kind of a finished look rather than the this rugged look.

like for physically challenged individuals this concept can be used to build gesture-controlled wheels chairs and other devices to enable more control in their lives.