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HAND GESTURE CONTROLLED ELECTRIC CAR WITH OBSTACLE DETECTION BASED ON IOT

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ABSTRACT

Technology bestowed different approaches that are used nowadays for subtle control and guidance of the automobiles. Gestures are one such modern ingenious approach to move the wheels. This project proposes the design of an electric car which is controlled by human hand gesture. Gesture is a most powerful natural tool that expresses the non-verbal communication in real life system. These gestures are used for coordination of human expressions with the virtual environment. Likewise, the hand gesture is a significant mode of command for human beings. The system is designed to recognize the hand gestures and act subsequently. Raspberry Pi -an open source platform- acts as the heart of the system and controls all other components. The accelerometer recognises the hand gesture and generates output signals. These output signal is accessed by Raspberry Pi and drives the hub motors that runs the wheel. The system is interfaced with obstacle sensor at the front and back so as to stop the car to avoid any collision against a wall or other vehicles. The car is charged up using electric power which serves as an eco-friendly approach. The complete system provides a user-friendly outlook so that it is easily accessible to all.

Keywords: - *Accelerometer, Hand gesture, Hybrid Electric Car, Obstacle Sensor, Raspberry Pi*

I. INTRODUCTION

Transportation sector is considered to be one among the backbone of country's economy. Presently, developments are moving at a brisk rate as a result of the tremendous involvement of this sector. Perhaps, still the world always asks for highly improved and extremely sophisticated transportation system. This has given rise to a new era of Electric, hybrid and automated vehicles. The modernization always made things better by giving break-throughs to the society by creative innovations. New modern concepts in the control system has

outdated the traditional ones due to their easiness in handling providing lesser effort to the humans. The technology has proved that even gestures can be one such mode for controlling an automobile.

Gesture control has been evolved as a modern concept in the field of controlling a system. Especially hand gestures are used to large extents which are highly flexible and remarkably facile. This hand gestures are mostly used nowadays in robotic arms. So, a similar approach has been adopted to facilitate the controlling of an automobile using this hand gesture technology. It enables anyone to have greater command over the effective control of the vehicle. This mode of controlling remotely any robotic vehicle is likely to have free movements of hands in any direction or change the hand gesture in any axis plane which follows the commands accordingly and smoothly like invisible link between the hand and the moving vehicle. This type of control has been most often seen in virtual world computer games that gives natural feel to the players and adds excitement. These controls make switching system more realistic and capacitate better freedom to the user [1].

The Logistics Performance Index (LPI) report of 2016 has showed that India made a big leap of 19 places from 54th position in 2014 to 35th position in 2016. Even though India had made a bigger improvement in the transportation sector yet it has to reach its higher peak. Surveys reported that transportation has been a problem in most of the bigger organization and bigger firms. The employees have found it difficult to travel continuously to their respective areas. Even in many of the universities and colleges where conventional vehicles are banned, students face problems in reaching their destination on time.

This paper proposes an intelligent dynamic and automated vehicle that runs based on hand gesture which can be a solution to the aforementioned problems. We suggest that the installment of these hand gesture controlled electric vehicles can bring a change in many aspects of the society, these electric vehicles can be a great helping hand for physically challenged people. In most of the times we have found them using mechanical power to drive their vehicles. So, this hand gesture vehicle can reduce their efforts allowing them to drive without a hitch.

The obstacle detection technology will be useful to reduce the day to day accidents happening over the roads. The system has command over its own control at the times where the system detects that it can go and hit on any obstacle. At that times, vehicle will decide by itself that it need to stop by itself for the safety of the passenger as well as vehicle. The system is also interfaced with depth sensor which also takes intelligent decisions to stop the vehicle when steps or depths are detected.

In a mission for promoting greener technologies, this vehicle could prove to be of greater importance. The use of sophisticated hand gesture control makes the system user-friendly. The eco-friendly approach that we have adopted would also be supportive for the slogan: “Go Green”. This system can make-way for significant advancement in the transportation sector for the upcoming generations.

1.1. Objectives

The main objective of our project is to make this vehicle simple and user-friendly. Apart from that the other major objectives of this project are: -

- Versatile and compact control of vehicle
- Wireless communication system
- Comfortable usage for disabled people
- Energy Efficient Vehicle

- Effortless steering and control of wheels

1.2. Applications

The system has various applications across various fields and areas in the society.

- This electric car can be of great help to physically challenged peoples as they can drive it effortlessly.
- It can be even used as a military robot where the wireless controlling of the vehicle enables it to control from a hideout across distances.
- Employees and students can use it for short distance travel within the organization which may act as time saving factor.
- Chances of accidents can be reduced as the intelligent vehicle can take its own decision to stop by itself when obstacles are detected.
- The vehicle stops by itself preventing from slipping off the edges at the times of depth providing more safety to passenger.

II. MATERIALS AND METHODOLOGY

2.1 Hardware Components

2.1.1. Raspberry Pi 3

Raspberry Pi 3 is the brain of the system. It controls the overall working of the vehicle. It makes the vehicle intelligent enough to take its own decision. It processes all the data received from the transmitter part and gives signals for efficient movement of the vehicle. All other components in the system works based on the instructions of the Raspberry Pi.

Fig 01. Raspberry Pi [2]

2.1.2. Lilypad Arduino

The main purpose of Lilypad Arduino is to power up the components at the transmitter part. It runs according to the accelerometer program that is fed in the ATmega 328P processor on Lilypad Arduino. It takes the readings from the accelerometer, ADXL345 and processes it and produces the result in the desired fashion. It is interfaced with Lilypad XBee so as to transmit all the data to Raspberry Pi.

2.1.3. ADXL345 Digital Accelerometer Sensor

ADXL345 accelerometer sensor is the highlight in understanding the hand gestures. The sensor which is mounted on the hand glove will move along with the movements made by the hand. It produces axis readings based on the hand movements which will be processed by Lilypad Arduino.

Table 1. ADXL345 Breakout Board Pin Functions

Mnemonic	Details
GND	Ground
VCC	Positive Power supply, 5V Regulated Power
CS	Chip Select
INT 1	Interrupt 1 Output
INT 2	Interrupt 2 output
SDO	Serial Data Output
SDA	Serial Data Input and Output
SCL	Serial Communication Clock

Fig 02. ADXL345 Accelerometer [3]

2.1.4. HC-SR04 Ultrasonic Distance Sensor

HC-SR04 is the sensor which detects the obstacles that come across in the path of the vehicle. It continuously measures the distance between the vehicle and the obstacles in front of it. When the distance is reduced to less than the braking distance of the vehicle, then Raspberry Pi takes the decision to stop the vehicle soon at a safer distance from the obstacle.

2.1.5. InfraRed Photodiode sensor

IR Photodiode sensor is integrated to the system for the purpose of depth detection. A Pair of these sensors are mounted at both ends of the system at front. It works only if there is an obstacle on the ground at a permitted distance. When an obstacle is not detected on the ground, then the Raspberry Pi stops the vehicle from further going front.

2.1.6. XBee 802.15.4(Series 2C)

XBee S2C is helpful in wireless communication. It has a wired antenna on top of it. It always works in pair or more. XBee S2C are mounted at transmitter part on Lilypad XBee and on the receiver part on XBee Explorer Dongle. It transmits the data generated by ADXL345 from Arduino to Raspberry Pi.

2.1.7. Lilypad XBee

Lilypad XBee acts as an interface between Lilypad Arduino and XBee S2C. It mainly helps in powering up and mounting of XBee S2C.

2.1.8. XBee Explorer Dongle

XBee Explorer Dongle plays the same role of Lilypad XBee but at the receiver part. It makes the interfacing of XBee S2C with Raspberry Pi. Simultaneously, it powers up the XBee S2C.

2.1.9. L293D Motor Driver

L293D Motor Driver is a 16-pin IC that drives the DC motors attached to the wheels of the vehicle based on the data received from Raspberry Pi. We can control two DC motor with Dual H-bridge Motor Driver integrated [4]. In our system we used two L293D which drives four BLDC Motors. It even controls the speed and movement of the vehicle.

2.1.10. BLDC Motors

BLDC Motors makes the wheels rotate according to the direction obtained from L293D Motor Driver. BLDC motor speed and movement are processed through the Motor Driver.

3.1 Software Description

3.1.1. *Putty*

In this system the action of Raspberry Pi is controlled through software called putty. It replicates the LT terminal of Raspberry Pi in the windows OS. It acts as an interface for programming the system in the windows OS itself. Python is used as a programming language.

3.1.2. *Python*

Python is a widely used high-level, general purpose programming language which can work quickly and integrate systems more effectively. It is an open source language which is easy to read the syntaxes so everyone can understand it easily. Also, python supports multiple programming prototypes including object-oriented, imperative and functional programming styles [5].

3.1.3. *X-CTU Software*

X-CTU Software is used for configuring the XBee S2Cs. Using this we will configure one XBee S2C as Coordinator and the other one as Router so as one can send data and the other can receive it. In our project we used point to point communication between the XBee S2Cs.

Hand Gesture Control Car (GCC) is an embedded system integrated with microcontroller project that controls the car motion by gestures made by the hand using hand glove.

- In our project, we have put up a car that runs based on the hand gestures. The car wheels are driven using the hand gesture motion readings generated by the accelerometer. The user wears a glove on the hand that is mounted with accelerometer.
- The accelerometer used is ADXL345, which is a small, thin, low power, 3-axis MEMS accelerometer with high resolution (13-bit) measurement at up to +-16 g. Digital output data is formatted as 16-bit twos complement and is accessible through either a SPI (3-wire or 4-wire) or I2C digital interface.
- The ADXL345 is well suited to measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (4 mg/LSB) enables measurement of inclination changes less than 1.0 degrees
- The Arduino microcontroller (Arduino Lilypad) sewn on the hand glove reads the accelerometer readings and it transmits data wirelessly using XBee module to the controller part.
- XBee is a wireless module which is used to make communication between the Arduino Lilypad and the controller (Raspberry Pi) of the system. XBee operates on 2.4GHz band with a data rate of 250kbps. It can transmit the data wirelessly up to 100ft indoor and 300ft outdoor. It helps in wireless transmission of the complete data from the accelerometer to the Raspberry Pi.

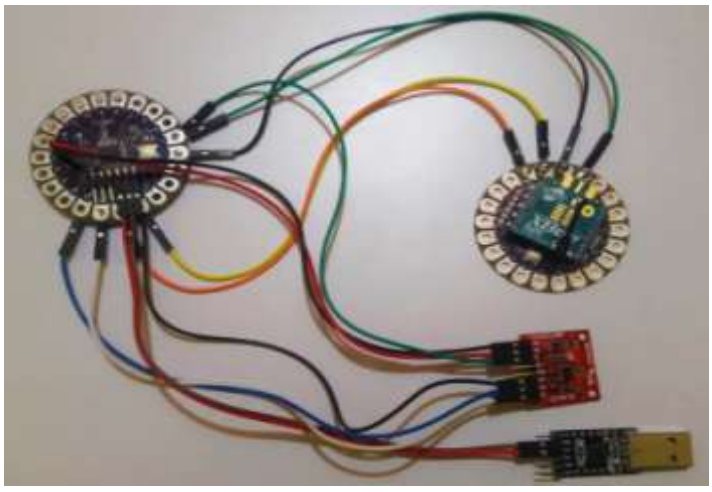

Fig 03. The Transmitter Unit

- Raspberry Pi – an open source platform – is the brain of the system and is the controller of all other operations which processes the received signals and in turn generates the commands to move the wheels.
- The wheels are connected to BLDC motors which are powered up using Lithium-ion batteries. BLDC motors are driven using L293D Motor Driver which is powered up using a 12V, 10Ah Lithium-ion battery.
- The battery can be directly charged by plugging in. It may take up to 6 hours to completely charge the battery.

- The chassis of the vehicle is designed such that the system will be light but will be strong enough to handle the weight of entire unit including the passengers.

Fig 04. The Prototype (Receiver and Processing Unit)

Most of the controllers of existing remote cars require users to interface with joysticks and push buttons. Comparing to these conventional controllers, we built a wireless gesture controller which enables car to mock hand motion in all dimensions.

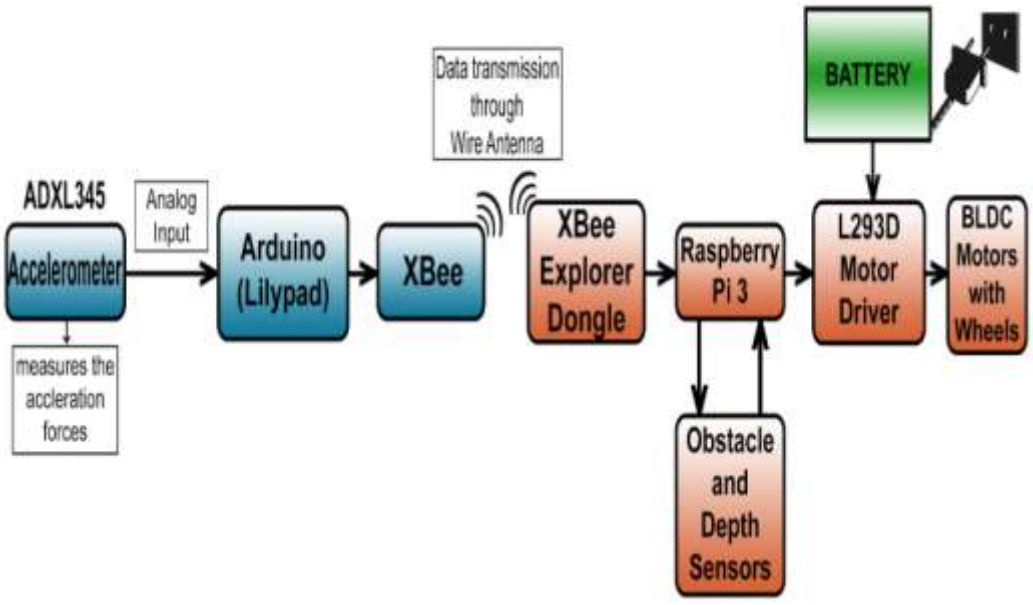

Fig 05. Block Diagram of the system

III. WORKING SEQUENCE

The working sequence or flow of the vehicle is as simple as it is. At first, the data collected from the ADXL345 is transmitted from Lilypad Arduino to the Raspberry Pi using the XBee wireless communication method. All the further processing is carried out by Raspberry Pi itself.

Initially, after receiving the signals from transmitter, Raspberry Pi checks for any obstacle in front of the vehicle using HC-SR04 Ultrasonic Distance sensor. If the path is clear then next it checks for any higher depths in front of the vehicle using IR sensor. If both of this test is cleared then only the motion of the vehicle starts.

All the further movements after clearing obstacle and depth tests are purely based on the hand movements. The vehicle moves forward, backward, right and left when there is tilt in the palm of user in forward, backward, right and left directions respectively [6].

If the accelerometer readings are in positive x-axis direction, then the vehicle moves completely forward in a linear path. Similarly, if the readings come in negative y-axis direction, then vehicle takes reverse motion. If the readings are a combination of positive x and y then it takes a forward left path and in case of combination of negative x and y, then vehicle moves right backwards. In case of positive x and negative y vehicle takes right turn towards front and in case of negative x and positive y vehicle moves left towards reverse direction. The flow chart describes the working flow in a better fashion [6].

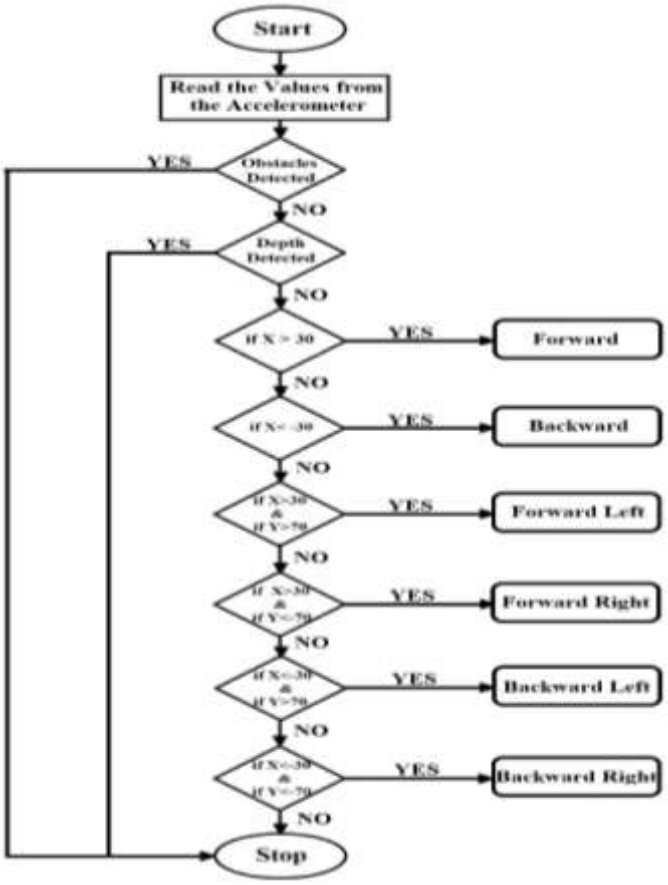

Fig 06. Flow chart of the system

IV. CONCLUSION

1. The complete motion of the system is controlled by the Hand Gestures.

The Hand Gesture is used for complete control of the vehicle. All the movements and directions are made only through Hand Gesture. No need to have any pre-requisites for driving the vehicle.

2. The vehicle is solar powered as the form of energy can be tapped easily and can be stored.

For the movement of the vehicle a non-conventional energy i.e. solar energy is used, to avoid refilling of fuel like other Vehicles. So, the refilling job is ruled out and as a result the fuel expenditure is saved. This makes an additional advantage to the physically handicapped people.

In case in the absence of solar power, the batteries can be plugged in and charged. So, at any point of time, there won't be any shortage of fuel.

3. The system is completely user-friendly and eco-friendly.

The whole system is made in such a way that any person should be able to understand it's working very easily and can operate it without having any prior knowledge about the working of the system.

As it works on solar, the energy usage will be more efficient. The whole system will be eco-friendly as it doesn't cause any pollution.

V. FUTURE PROSPECTS OF THE SYSTEM

The system can be further integrated with GPS tracking system which will be especially a great benefit for the military uses where they can track the position and movement of the vehicle from their hideouts or camps. Developing an android app and interfacing it with GPS will help to control and guide the vehicles through it for larger distances where Hand Gesture control may have limitations. As Raspberry Pi supports HTML based web controlling, developing a small web page for the vehicle may prove to be effective as the controls can be easily managed through it. As India is a country where solar power is available throughout the year, this will be the best option for charging up the batteries during their run time which can avoid charging time of batteries by plugging in.

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