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CYBERNETIC E-VEHICLE FOR CAMPUS TRANSPORTATION

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Abstract

This paper provides the solution for smart mobility to the people who are unfamiliar with the routes on campus. The proposed automated e-vehicle contains four wheels - one wheel at the front end and three wheels at the rear end to get a proper balance. It also contains a keyboard Switch with which the user keys their destination point as an input to the system. It is programmed to take the travelers automatically to the destination based on the input provided by the travelers. This is done by automating the main controls like accelerator, brakes and hand bar. Each control is handled by an individual motor. The Servomotor is used to control acceleration whereas the braking and steering of hand bar are controlled by 12V and 24V geared DC motor. Brushless DC motor (BLDC) of rating 48V is used as a main drive. It is responsible for the movement of vehicles. To accomplish zero chance of accident occurrence, ultrasonic sensors are employed. Three numbers of ultrasonic sensors are placed at the front of the vehicle. These sensors help us to detect the obstacle along its way. It gives out a signal when any obstacle is sensed. Global Positioning System (GPS) module helps up to identify the vehicle location on the Earth by coordinates in the form of latitude and longitude. Through this module, the coordinate that the vehicle has to travel is identified and fed into the Arduino microcontroller. At every instance, the present location of the vehicle is compared with the pre-loaded coordinates. Finally, the Arduino microcontroller works with the data from these components and generates the control signals to drive the vehicle in a programmed route. The developed simple Cybernetic E Vehicle is tested in real time.

Keywords:

Cybernetic E Vehicle, Ultrasonic Sensor, Servo Motor, DC Motor

1. INTRODUCTION

In colleges, IT parks, and industries in India have transit vehicle and go by foot method for transportation within the campus. Initially they have only gone by foot has the only mode of transport within the campus. Since the campuses are being quite large the peoples find it difficult to travel from one place to another place within the campus. In order to eliminate this difficulty transit vehicles were introduced, these vehicles may have a battery or fuel which is used as a source [1]-[4].

It is also not possible to have this type of vehicles in every institutes and industries since they are quite costly. Therefore, every institute cannot afford this type of special vehicle for transportation. In the United States, such bicycles can be fully powered by a motor. In other countries such as Japan, electric-motor-powered bicycles are required to operate with 50% human pedal power for up to 12mi/h, and an even higher percentage of human power is required above that speed [1] [6] [7]

Kumar and Oman [1] presented the proposal for Electric bicycles powered by nickel-metal hydride batteries offer a 100-km range between recharges, and have a potential of 300 km when polymer batteries. Lomonova et al. [2] discussed the comprehensive mechanical, electromechanical, electromagnetic, control design and test approaches leading to the system integration, design solutions and physical implementation of the electrically assisted bicycle. Muetze et al. [3] developed an electric bicycle with a new drive with very good performance and low cost. Recent advances in materials research have produced soft magnetic composites that can be considered for use in electrical machines. Muetze et al. [4] presented different concepts of BLDC using soft magnetic composites are investigated and best choices Zhou et al. [5] briefly discussed the impact of the charging of the distribution system, the factors of causing the influence, the charging control methods that reduce the impacts on the distribution network and V2G techniques. Based on the current development status and problems, discuss the trend of Electric Vehicles.

Employees use their Smartphone to schedule the automated vehicle. This vehicle leaves the parking yard in driverless mode and arrives at pickup spot. Then it drives to the destination. This vehicle makes the passenger to finish off his ride without driving by owner. The Collision avoidance system automatically averts cars, pedestrians and cyclists from any kind of accident. This vehicle drops the passenger at the destination and automatically makes next pick up or returns to parking area. An automated shuttle is a vehicle that travels with low speed over a short distance in a fully automated mode. These small and lightweight vehicles are more suitable for closed campus like a University campus, medical centers or other areas where high speed automobile traffic is off limits.

Nowadays, every college, industries and IT parks are larger in size. Hence, people find it difficult to move from one part of the campus to another part in the campus. In some high standard industries they use their own transport vehicle to help the passengers within their campus. These vehicles may be battery powered or fuel powered. But mostly they are fuel powered. The fuel cost and vehicle cost will be high and labor must be appointed to operate these vehicles [4]-[8]. In some campus, they provide bicycle to the peoples who want to move from one place to another. The major drawback is that not every industries, colleges and IT parks can afford their employees with these transport vehicles. The main contribution of this paper is to explore the initiative of the driverless smart vehicle. In the literature, this proposal is not explored. This proposed method is used to guide the people automatically, in the specified routes. This is the unique advantage of this method when compared with other methods. The proposed Cybernetic E Vehicle is used to achieve following objectives:

- To automate the transportation within a campus
- To save the time duration of transportation to different blocks in a campus
- To reduce the fuel cost and pollution

The proposed model can also help them to traverse different blocks within the campus by saving their most valuable time, especially by adapting shorter routes.

This paper is organized as follows, section 1 presents the introduction and literature survey. Section 2 describes our proposed methodology to design the Cybernetic E Vehicle. Section 3 explains the components used to design Cybernetic E Vehicle. Section 4 deals with the Arduino microcontrollers. Section 5 analyses about results and discussion of the proposed system. Finally, section 6 concludes the paper.

2. PROPOSED CYBERNETIC E-VEHICLE

The overall block diagram of cybernetic E Vehicle is shown in the Fig.1. The voltage rating of 48V is required to drive the BLDC motor. The 48V are obtained by connecting four numbers of 12V batteries in series. Each battery is capable of supplying 20A continuously for a time period of one hour. After a certain time the current supplied by the battery starts to decrease with a corresponding drop in voltage. Since the current remains the same in series connection, the connection of battery in series does not produce any circulating current. The two terminals of the series connected battery are connected to the BLDC controller. Three different coloured wires are coming out from the hub motor. These three wires are from Hall Effect sensors which got placed inside the motor. These wires are also connected to the same BLDC controller.

The need of 12V is accomplished by taking connection from only one battery. Similarly for 24V two batteries are taken for connection. The components like GPS, Ultrasonic sensors, servomotor and keyboard are supplied from Arduino itself. Each relay circuit contains a set of 5V to 12V and 12V to 12V relays. The 5V to 12V relay is used as a buffer which connects two different voltages rated devices (5V Arduino and 12V relay). The 12V relays are used to run the DC motor in both the direction. This action is done by reversing the polarity at the motor terminals with the use of relays. These relays operate only when it gets the signal from Arduino. The Arduino also controls acceleration of BLDC motor through the accurate control of the servo.

All these processes start after the system gets the input from the user. The input is given by the passenger through the keyboard and the Arduino selects the coding based on the given input. The vehicle traces its path based on the GPS coordinates. The vehicle stops by the operation of braking motor when the ultrasonic sensor detects any obstacle or when any stops corresponding to GPS coordinates arrives. The steering motor operates when the GPS coordinates of the vehicle matches with the turning coordinates or when any obstacle is sensed.

In our proposed model, we have used the BLDC motor for driving the vehicle, Permanent Magnet DC motor is used for steering and braking purposes. A variable resistance pot with servomotor is used for acceleration. An ultrasonic sensor is used to detect the obstacles present in the vehicle path. A GPS module is used to trace the map of the campus. The Arduino ATmega Micro controller is used to control all these components.

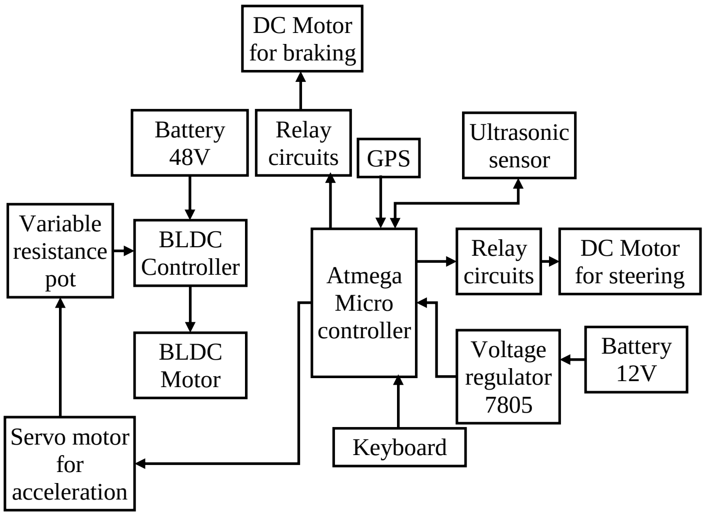

Fig.1. Block diagram of Cybernetic E Vehicle

Initially, the GPS checks the current coordinate with the predefined coordinates that corresponds to the all turning locations. If the GPS current coordinate is not equal to the coordinates that corresponds to the turning location, then the BLDC motor will be turned on. GPS coordinates are checked at every instance of time along with GPS, the ultrasonic sensors also continuously check for any obstacle. If any obstacle is detected, then the braking motor will be energized and brake will be applied and the vehicle waits for the obstacle to clear, else the BLDC motor continues its operation. When any turning or stopping arrive, then the GPS coordinates will be matched with the turning or stopping coordinate respectively given in the controller. If the GPS coordinate matches with the stopping coordinates, then the controller energizes the braking motor and the brake is applied. If the GPS coordinates match with the turning coordinates, then the steering motor is energized and the motor runs clockwise to turn the vehicle right and motor runs anticlockwise for the vehicle to turn left.

2.1 DESIGN METHODOLOGY FOR THE PROPOSED SYSTEM

The GPS coordinates were obtained continuously and given to the Arduino. The Arduino compares the current GPS coordinates of the vehicle to the stoppings or the turning coordinates. The braking and steering were used based on analog input signals on the limit switch. Initially the limit switch will be opened, thus the braking and steering motor do not operate and it operates only when the limit switch is closed. Other inputs were connected to the digital input. The ultrasonic sensor values were used for detecting obstacle the braking operates in the vehicle.

2.1.1 Structure of the Proposed Model:

The Fig.2 shows the flow chart of cybernetic E Vehicle for campus transportation. The GPS module gives the current location of the vehicle.

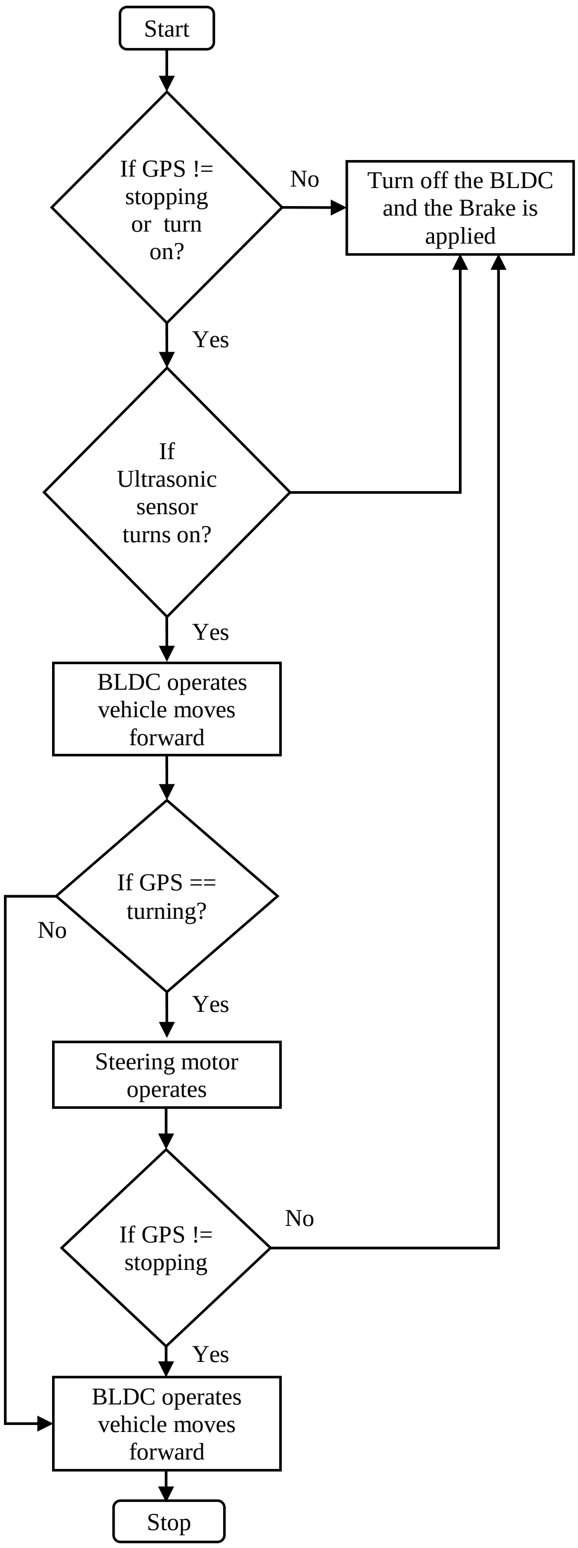

Fig.2. Flowchart of Proposed Cybernetic E-vehicle

If the location coordinates matches with the stoppings or turning coordinates, the brake is applied and BLDC motor stops or when the ultrasonic sensor detects any obstacle the BLDC motor stops. Otherwise the vehicle continues to run. When the GPS location match with the turning coordinates, then the vehicle turns automatically left or right corresponding to the program.

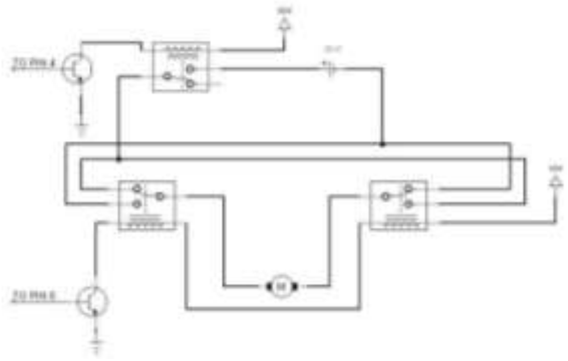

Fig.3. Sectional circuit diagram of steering and braking

The Fig.3 shows the sectional circuit diagram of steering and braking section. The braking and the steering motor are operated by using three relays. The two terminals of the motor are connected to the relays C_2 and C_3. The positive terminal of the battery is connected to the *NO* (Normally Open) of the relay C_1. The negative terminal is connected with *NO* of relay C_3 and *NC* (normally close) of relay C_2. Based on the operation of the relay the braking and steering motor is reversed.

3. HARDWARE COMPENENTS

Various components which are used for designing the Proposed Cybernetic E Vehicle is discussed in this section.

3.1 VARIOUS SENSORS

Different types of sensors which are used in this model are discussed in this section.

3.1.1 Hall Effect Sensor:

Hall sensor provides the information to synchronize stator armature excitation with rotor position. Since the commutation of BLDC motor is controlled electronically, the stator windings should be energized in progression in order to rotate the motor. Before energizing a particular stator winding, acknowledgment of rotor position is necessary. So the Hall Effect sensor embedded in stator senses the rotor position. Most BLDC motors include three Hall sensors which are embedded into the stator. Each sensor generates Low and High signals whenever the rotor poles pass near to it. The exact commutation sequence to the stator winding can be determined based on the combination of these three sensor's response.

3.1.2 Ultrasonic Sensor:

Ultrasound is a technique of measuring distance from objects/obstacles. It contains a transmitter and a receiver. The transmitter transmits a short Ultrasound pulse periodically. If there is an object in front, the pulse hit the object can come back. The receiver then measures the round trip time and can estimate the distance based on the round trip time.

3.2 MOTOR

Our proposed model uses a BLDC motor for driving the vehicle, permanent magnet DC motor is used for steering and braking purposes. The details are discussed in this section.

3.2.1 Overview of DC Motor:

A DC motor converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic to periodically change the direction of current flow in part of the motor. By adjusting the voltage of the DC motor, speed is controlled. In DC motor, voltage is proportional to the speed. As the speed increases, voltage increases.

3.2.2 BLDC Motor:

Unlike conventional brushed type DC motor, wherein the brushes make the mechanical contact with commutator on the rotor so as to form an electric path between a DC electric source and rotor, armature windings, BLDC motor employs electrical commutation with permanent magnet rotor and a stator with a sequence of coils. Due to the absence of brushes BLDC motors are capable to run at high speeds. The efficiency of BLDC motors is typically 85 to 90% [10].

3.2.3 Servo Motor:

Servo motors are available as AC or DC motors. Early servo motors were generally DC motors because the only type of control for large currents was through SCRs for many years. As transistors became capable of controlling larger currents and switching the large currents at higher frequencies, the AC servo motor became used more often.

3.3 GPS MODULE

The campus map is created by getting the coordinates from the GPS with the help of Arduino. At every time GPS senses the co-ordinates and sends the value to the Arduino through the help of TX and RX pins. In addition to these two pins it has V_{cc} and ground. The voltage applied between V_{cc} and ground is around 3.3V.

3.3.1 GPS Working:

Every single location in the entire globe can be specified in terms of geographical coordinates. The geographical coordinate is a system which specifies any given location on the earth's surface as latitude and longitude. There are devices which can read the geographical coordinates of a place with the help of the signals received from a number of satellites orbiting the earth. The system of satellites which helps with the positioning of a place is called GPS. [9]. Latitude and longitude are calculated using the Haversine formula [13].

3.4 ARDUINO

The Arduino UNO is a micro-controller board based on the ATmega328pu. It has 14 digital input/output pins of which 5 can be used as PWM outputs, 6 analog inputs, 4 UART's (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Arduino UNO can be programmed with the Arduino software [14].

3.4.1 Communication with Arduino:

The GPS module continuously produces a set of data regarding the position of the earth's surface where it is situated which includes the current position with respect to the equator of the earth in terms of Latitude and Longitude. This data can be decoded and printed in the readable format with the help of a microcontroller only. In this proposal, the data regarding the geographical coordinate is extracted from the GPS output with the help of the Arduino. The Arduino can be used as a stand-alone board of which the output or inputs can be taken from the boards or given to the board [14].

3.4.2 Interfacing with Arduino:

The NEO6MV2 GPS module comes with 4 connections: RX, TX, VCC and GND, which is quite easy to incorporate with using Software Serial on an Arduino Uno or a serial interface on an Arduino Mega. But the problem is module uses 3V logic, which is not compatible with the 5V supplied by an Arduino. However, a simple voltage divider can solve this issue. The voltage divider circuit is realized by connecting two resistances 10K and 4.7K between pin RX and GND. Since TX and RX are digital outputs it is connected to any two digital pins of the Arduino.

The Arduino mega can be programmed with the Arduino software (download). The ATmega2560 on the Arduino MEGA comes pre-burned with a boot-loader that allows due to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (ref, C header files). You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP [14].

4. CASE STUDY RESULTS AND DISCUSSION

We have tested our designed simple Cybernetic E Vehicle in a college laboratory. Microcontroller programming code is written to control entire activities of the system. The implementation of our proposed scheme, Cybernetic e vehicle leads to the enhancement of the campus quality where it's installed. The important constraint that is imposed on our proposal, design is that the road surface or platform over which it has to travel. This surface must be plain enough to provide necessary tractive and frictional force to all the three rear wheels.

Performance evaluation is discussed with design calculation of the Cybernetic E Vehicle i.e. calculation of required torque for the vehicle and calculation of speed of the BLDC motor in the forthcoming section in detail.

Computation of Longitude (degrees), Latitude (degrees) is verified with Longitude, Latitude calculator on the particular website. The proposed method is accurate since it uses the Exact Longitude (degrees), Latitude (degrees) calculation [13].

Our proposed model appearance is similar to that of ordinary E-bike structure. In order to provide a safer journey some arrangements are made in the E Vehicle body. The presence of any barrier or obstacle along the path of the vehicle is identified through ultrasonic sensors. So, three numbers of ultrasonic sensors are placed at the front of the vehicle. Linkage mechanism is used to steer the vehicle with the aid of DC geared motor. As the hand bar steers to the any side, its extremes are identified through two numbers of limit switches in each extreme.

The braking is achieved through another DC motor. The main advantage of Permanent Magnet DC motor over conventional shunt wound DC motor is its linear speed torque characteristics. It is due to less interaction of armature, field (back EMF) with the main field. In conventional DC motor, the stator has high permeability (low reactance) due to which the flux produced by the rotor (back EMF) weakens the flux of the stator (poles). As a result the torque is badly affected when the load is increased. Unlike shunt wound DC motors, the permanent magnet DC motor field faces have a high reluctance (low permeability) therefore, the interaction of the rotor flux with main flux is minmized. As a result the main field is constant over a wide range of speed giving linear torque characteristics. For a given armature voltage, the torque increases as the speed decreases.

Electronic controller circuit energizes appropriate motor winding by turning transistor or other solid state switches to rotate the motor continuously. The Fig.3 shows the simple BLDC motor drive circuit which consists of MOSFET Bridge (also called as Inverter Bridge), electronic controller, Hall Effect sensor and BLDC motor. Here, Hall-effect sensors are used for position and speed feedback.

The electronic controller can be a microcontroller unit or microprocessor or DSP processor or Field Programmable Gate Array unit or any other controller. This controller receives these signals, processes them and sends the control signals to the MOSFET driver circuit. In addition to the switching for a rated speed of the motor, additional electronic circuitry changes the motor speed based on the required application. These speed control units are generally implemented with PIC controllers to have precise control. It is also possible to produce four quadrant operation of the motor while maintaining good efficiency throughout the speed variations using modern drives.

The braking method adopted in our proposed system is similar to the action of the anti-braking system. It turns off automatically after three or four rotations. The number of rotations is sensed through limit switch. For each rotation limit switch is pressed once. Acceleration is achieved through servomotor. GPS navigates the vehicle along the preloaded route. Finally, all these processes are Arduino ATmega micro controller. The Table.1 shows the voltage and current rating of 24V DC motor under no load and loaded conditions.

Table.1. No load and onload current Values (Steering Mode)

Voltage (V)	No load current (A)	On load current (A)
24	4.2	6.1

The voltage and current rating of 12V DC motor under no load and loaded conditions are given in Table 2. Here the 12V DC motor is used for braking. The voltage is measured by connecting the multimeter between two terminals of the DC motor. During an on-load the terminal voltage drops slightly. However, this voltage drop is considered as negligible.

Table.2. No load and on load value for current (Braking Mode)

Voltage (V)	No Load Current (A)	Load Current (A)
12	4.2	5.2

In our proposed work, on-load condition of braking DC motor corresponds to the pressure on the brake shoes while the BLDC motor is running. The no-load condition of braking DC motor corresponds to the pressure on the brake shoes while the motor is in the rest or not in motion. As a bottom-line, the motor is always under load condition. But the load value is higher in on-load condition when compared to the no-load condition. Since the value of load current is proportional to the amount of load, the current consumed by the motor under on-load is higher when compared to no-load. Some part of current at no-load as well as on-load is contributed towards the magnetisation of the field winding. But the current that causes copper loss is contributed only from load current. Since copper loss is directly depends on the load current.

In this proposed model, servo motor is used for the controlling of vehicle acceleration with the help of signal from the Arduino. The shaft of a servo is connected to the shaft of 10K variable resistance pot. The variable pot is connected to the three terminals that emerge out from the Brushless DC motor controller. By varying the resistance, the speed of the Brushless DC motor is controlled. Since the servo is coupled with variable pot, the speed is controlled by controlling the position of the servo. Thus, steering control is achieved. Servo motors are available in different shapes and sizes. A servo motor will have mainly three wires, one is for positive voltage another is for ground and the last one is for the position setting. The red wire is connected to power, Black wire is connected to ground and yellow wire is connected to signal.

Servos are controlled by sending them a pulse of variable width. The control wire is used to send this pulse. The parameters for this pulse are that it has a minimum pulse, a maximum pulse, and a repetition rate. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of potential rotation in the clockwise direction as it does in the counter clockwise direction. It is important to note that different servos will have different constraints on their rotation, but they all have a neutral position, and that position is always around 1.5ms.

The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse width Modulation. The servo expects to see a pulse every 20ms. The length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90 degree position (neutral position). When these servos are commanded to move they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is the torque rating of the servo. The Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

When a pulse is sent to a servo that is less than 1.5ms the servo rotates to a position and holds its output shaft some number of degrees counterclockwise from the neutral point. When the pulse is wider than 1.5ms the opposite occurs. The minimal width and the maximum width of pulses that will command the servo to turn to a valid position are functions of each servo. Different brands, and even different servos of the same brand, will have different maximum and minimums. Generally, the minimum pulse will be about 1 ms wide and the maximum pulse will be 2ms wide.

In normal cases, registers of the controller are needed for adjusting the frequency and for getting required duty ratio for accurate position control of a servo motor. Arduino has predefined libraries, which will set the frequencies and duty ratios accordingly once the header file is called or included. In Arduino it simply has to state the position of the servo that needed and the PWM is automatically be adjusted by ATmega2560.

Rather than requiring a physical press of the reset button before an upload, the Arduino Mega2560 is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega2560 via a 100 nano-farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow user to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

4.1 DESIGN CALCULATION FOR CYBERNETIC E VEHICLE

In our opposed Cybernetic E Vehicle, Design Calculation of BLDC motor is done to find speed of the vehicle using Eq.(1).

$$V = 2\pi r\left(\frac{60}{10^3}\right)\times N \tag{1}$$

where, speed of the vehicle (V) = 20km/hr, radius of the wheel (r) = 0.2(m), N is the Speed in rpm: N = 331.18 rpm.

Necessary torque for the vehicle is calculated using Eq.(2)

$$T = \frac{Weight\ to\ be\ carried \times Radius}{Specific\ Gravity\ of\ Earth} \tag{2}$$

Assume weight = 350kg and T = 7.13Nm.

Torque produced by a 250W motor is calculated using Eq.(3)

$$P = \frac{2\pi NT}{60} \tag{3}$$

Assume weight = 350kg and T = 7.24Nm

BLDC motor has several advantages over conventional DC motors and some of these are

- It has no mechanical commutator and associated problems.
- High efficiency due to the use of permanent magnet rotor.
- High speed of operation even in loaded and unloaded conditions due to the absence of brushes that limits the speed.
- Smaller motor geometry and lighter in weight than both brushed type DC and induction AC motors.
- Long life as no inspection and maintenance is required for commutator system.

4.2 OBSERVATIONS FROM ULTRASONIC SENSORS AND GPS

The Table.3 shows the time taken by the ultasonic waves in the ultrasonic sensors to get reflect from an object at various distances. The time is measured in milliseconds (ms) whereas distance is measured in centimeter (cm).

Table.3. Distance vs. Time taken for reflection

Distance (cm)	Reflection time (ms)
2.5	0.147
7.5	0.441
12.5	0.735
17.5	1.029
25	1.474

4.3 GPS COORDINATES

In order to test our Cybernetic E Vehicle, we have considered the surrounding of EEE block in SMVEC, Puducherry The latitude and longitude and longitude values that have to be traced by our E Vehicle is tabulated in the Table.4. This value is obtained from the serial monitor window of the Arduino software. The latitudes and longitudes on the Table.4 are verified by plotting these points on the map. These points are shown on the map as a red coloured location symbol in Fig.4. On observing the Fig.4, it is clear that the locations are not in a straight line and they are arranged in a scattered manner within the path.

Table.4. GPS coordinates

Longitude (degrees)	Latitude (degrees)
11.914510	79.635917
11.914623	79.635932
11.914976	79.635932
11.915026	79.635940
11.915034	79.635993
11.915004	79.636075
11.915034	79.636383
11.915000	79.636428
11.914904	79.636428
11.914735	79.636428
11.914480	79.636428
11.914350	79.636512
11.914306	79.636498
11.914281	79.636154
11.914270	79.636016
11.914308	79.635917
11.914453	79.635940

Uploading of these values to the program leads to the zigzag movement of the vehicle. This problem can overcome by taking multiple co-ordinates for the entire path. Then these coordinates are plotted on the map to get the graphical view of the route with locations marked to the corresponding coordinates. Finally, the location symbol which aligned in a straight line is taken for programming the vehicle. By adopting this technique, it can be programmed to move in a straight line without any zigzag movement.

A GPS navigation device is any device that receives GPS signals for the purpose of determining the device's current location on Earth. GPS devices provide latitude and longitude information, and some may also calculate altitude, although this is not considered sufficiently accurate or continuously available enough (due to the possibility of signal blockage and other factors) to rely on exclusively to pilot aircraft. GPS devices are used in military, aviation, marine and consumer product applications.

Fig.4. Mapped co-ordinates of GPS

GPS receivers are composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly stable clock (often a crystal oscillator). They may also include a display for providing location and speed information to the user. A receiver is often described by its number of channels: this signifies how many satellites it can monitor simultaneously.

The distance between two locations whose latitude and longitude are known can be calculated using the Haversine formula [13]. The Fig.5 shows the distance calculation method.

Fig.5. Distance calculation method

The need for the inclusion of two resistances is due to the problem of two different voltages for Arduino. These modules are rated at the operating level of 3V-5V whereas GPS module is rated at the operating level of 3.3V only. Due to this it is not possible to interconnect both these modules. Tx pin of GPS module is directly connected to the digital pin Arduino since the output voltage of 3.3V is more than enough to operate the Arduino module. But the problem arises when come to Rx pin. Rx pin carries data from the Arduino in the form of 5V logic. Hence, in order to establish communication between Arduino and GPS modules it is necessary to convert this 5V logic to 3.3V logic. This conversion is achieved through voltage divider.

Let us consider, V_1 = 5V and V_0 = 3.3V

Let us assume that R_2 = 4.7KΩ and R_2 = 10KΩ

By voltage divider rule R_1 is calculated using Eq.(4)

$$V_0 = V_1\left(\frac{R_1}{R_1 + R_2}\right) \tag{4}$$

The relays are used for the switching process by motors. The switching can be in either direction and used for steering and braking of the vehicle. At the time of obstacle detection, the brakes are needed to be applied. The braking is done by using DC motor. When an obstacle occurs, the ultrasonic sensor sends a signal to trigger the operation of the relay. The DC motor is turned on by closing the appropriate contacts of the relays which is done through the microcontroller. At the same time steering is controlled by another set of relays which paves the way for motor to rotate in either direction. Relays have the exact working of a switch. So, the same concept is also applied. A relay is said to switch one or more poles. Each pole has contacts that can be thrown in mainly three ways.

They are Normally Open Contact (NO)-NO contact is also called a make contact. It closes the circuit when the relay is activated. It disconnects the circuit when the relay is inactive. Normally Closed Contact (NC)-NC contact is also known as break contact. This is opposite to the NO contact. When the relay is activated, the circuit disconnects. When the relay is deactivated, the circuit connects. Changeover (CO) or Double-throw (DT) Contacts - This type of contacts is used to control two types of circuits. They are used to control a NO contact and also a NC contact with a common terminal. According to their type they are called by the names break before make and make before break contacts.

The Fig.6 shows the snapshot of the simple developed Cybernetic E Vehicle. Our proposed simple model is an automatic driverless vehicle used for transportation within a campus. This vehicle works from a battery as a power source. This vehicle increases the standard of the campus. This vehicle is smoke free and does not pollute the environment.

Fig.6. Proposed Cybernetic E Vehicle Model

It is helpful for senior citizens who find it difficult to walk more distance. Travelling in this vehicle increases the comfort for the passenger. This vehicle is safe and will not cause any accidents. It will also be helpful to differently abled people.

This vehicle can be used in any pre mapped campus like Educational Institutes, Universities, Colleges, IT parks and Industries, etc. It is enough to give the current position and target destination of the passengers in the vehicle by using the corresponding buttons of the vehicle. This vehicle will be very helpful for a new person who does not familiar about where a corresponding building is located.

Advantages of Electric Vehicles are focused in [12]. When discussing environmental impact, it is important to take into account the full life cycle of a vehicle. This allows looking beyond emissions from the vehicle itself to the environmental impact of batteries, the production of electricity, and so forth. In a full life cycle, electric vehicles emit two times less carbon dioxide (CO_2) in comparison to diesel engines if we take the European electricity mix. This can be even four times less is we take, for example, the Belgian electricity mix. If cars were driving on sustainable electricity, carbon dioxide emissions could be further reduced by more than 10 times [12].

If we look at vehicles from a "well-to-wheel" perspective, electric vehicles produce four times less particulates and 20 times less nitrogen oxides (NOx) compared to conventional vehicles. However, we need to stress that the exploitation and mining of raw materials in South America, Africa, and China leaves much room for improvement. Recycling can further reduce the environmental impact Research indicates that the electrification of our transport system would generate one million additional jobs in Europe in 2030 and double in 2050. These jobs relate to the production of components for electric vehicles, but they also relate to new services, such as charging infrastructure. Electrification will also reduce our oil dependency. The import of oil costs the European economy, one billion Euros per day. Investing this in our own economies could mean a vast improvement in employment rates. Families could increase their purchasing power when they no longer need to depend on imported oil products. It is suggested, however, that loss of income from duties and taxes on diesel and petrol will negatively impact government budgets. However, this does not take into account improved air quality. Improved air quality will have a positive effect on the health budget, resulting in less expense for health care and the cleaning of monuments [12].

Some of the limitations of Electric Vehicles are described in [11]. The greatest challenges facing widespread adoption of Electric Vehicles are relate to the limitations of current battery technology and consumers negative or uninformed perceptions. The restrictions of current batteries include the high upfront cost of the battery packs, the lower energy densities of these batteries, and the longest amount of time required to charge those [11].

Charging infrastructure is another concern. As mentioned earlier, most drivers, for a majority of driving trips, would be able to satisfy range requirements by charging the Electric Vehicles at home. If the driver needed to charge the EV while on the go, options are continually increasing as the infrastructure continues to develop furthermore. Chargers are frequently being installed both by electric vehicles manufactures and third-party companies entering the infrastructure market.

One of the challenges EVs is currently facing is their higher retail price compared to equivalent gasoline powered vehicles. Vehicle battery packs are expensive. Additionally, the time required to charge the massive battery packs is another engineering challenge. Currently, to charge a dead Leafs battery on a standard 120V wall outlet would require up to 20hrs, or 8hrs on a 240V circuit. However, an 80% charge could be achieved in about 30 minutes with a fast charger [11]

5. CONCLUSIONS

Implementation of this proposed simple model in a campus will predominantly increase the infrastructure standard of the campus. It will save travelling time for the transportation between different blocks in a campus. This proposed model contributes a lot towards the development of the campus and various features such as smart mobility for an unfamiliar person for transportation. Other biggest advantages of this proposed model are very low noise and zero pollution from the vehicle. The major requirement for any educational institution is the low polluted environment. In future, this proposal can be advanced by adding following features. Solar panels can be used to charge the battery. Reversing of BLDC motor can be done to achieve reverse operation of the vehicle whenever it is necessary. Voice recognizes system can be adopted to get the input from the user without the use of keyboards. The vehicle can be expanded so that it can accommodate more people.

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