MODELLING AND CONSTRUCTION OF SMART SOLAR EV CAR

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Abstract

Android mobile phone plays a vital role in everyday life. This research work is planned to model and construct smart solar EV car that runs with solar energy, which helps reduce pollution and reliance on fossil fuels, making transportation cleaner and more sustainable. The constructed car has the following features, such as solar panel on its roof that convert sunlight into electricity, and storing it in a lithium battery. It includes navigation tools for monitoring energy usages in real-time. The main components used in this research work are Arduino Uno, Bluetooth (HC-06), ultrasonic sensor (HC-SRO4), Infrared obstacle avoidance sensor (KY023), solar PV, lithium batteries, L298 motors Driver, 2 DC and servo motor. The performance of the smart solar car could be control with mobile phone and it makes an eco-friendly vehicle that relies on renewable energy. This system accepts to response its movement control through the Bluetooth protocol which is used latest technologies version likes as IOT (internet of things), WiFi and others.

Keywords: Solar PV, Lithium Battery, DC motor, Ultrasonic sensor, KY-023 sensor, Android.

Introduction

The Arduino Uno development board is used to interface Bluetooth module for controlling the car. The car has two main functions. They are obstacle avoidance function and wireless control function. To detect obstacles, it used Ultrasonic and KY-023 IR sensors. A mobile phone is used to wirelessly control the car, sending commands for it to go forward, backward, left, right, and stop. The ultrasonic sensors help the car to avoid obstacles and make decisions. To enable wireless communication, Bluetooth and Wi-Fi technology are typically used. In this solar car, a Bluetooth module is used. The hardware includes a controller with a Bluetooth module connected to the solar car motors and other components. When the Android application is activated and connected to the system via Bluetooth, the car can be controlled by sending wireless commands from the mobile phone using pre-programmed functions. The vehicle can move in all four directions: left, right, forward, backward, and stop. The vehicle can also switch between automatic and manual modes. When moving forward, both motors travel in the same direction, while for reverse movement, the motors move in opposite directions. For left and right movements, either of the two motors rotate in each direction.

The Solar Renewable Energy

Humans have been using solar energy since the beginning of the century. Renewable energy comes from sustainable sources like solar energy, wind energy, bioenergy, and geo-energy. Solar energy is particularly popular because it's environmentally friendly. Solar panels made up of interconnected solar cells, capture and convert solar energy into usable electrical energy through the photovoltaic (PV) effect. These panels can be connected in series to increase the output voltage, and the energy can be stored in a lithium battery. Different types of photovoltaic panels, including monocrystalline silicon, polycrystalline silicon, and thin-film panels, are used in various applications such as solar lighting, residential units, telecommunication stations, calculators, clocks, radios, and photovoltaic power plants.

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Components of the Obstacle Avoidance of Smart Solar EV Car

IR Sensor (KY-023) Module

The IR sensor (KY-023) module consists of an infrared LED (transmitter) and a photodiode (receiver). The LED emits an infrared pulse, and if there is an obstacle in the path of radiation, the pulse is reflected and hits the photodiode. This sensor detects obstacles by changing the sensitivity (detection range) by adjusting the brightness of the LED and the threshold of the photodiode. The left (contact side) trimmer adjusts the obstacle sensing distance. The right trimming resistor adjusts the frequency of the emitted IR pulse. Figure 1 shows the infrared obstacle avoidance sensor (KY -023) module. The technical parameters of IR sensor (KY-023) module is listed in Table 1.

Table 1. Technical parameters

Operating voltage	3.3V-5V
Operating current	≥ 20mA
Operating temperature	-10℃ -50℃
Detection distance	2 cm ~ 40cm
IR Pulse Rate	38 kHz
Effective angle	35°

Figure 1. Infrared obstacle avoidance sensor (KY-023) module.

Ultrasonic HC-SRO4 Sensor Module

The HC-SRO4 module determines the distance to the object by sending an ultrasonic pulse and receiving a delayed reflection. Based on this delay, the device determines the presence of objects and the distance to them. The ultrasonic emitter sends 8 signals at the frequency of 40 kHz, which will be reflected by objects and recorded with a microphone in this sensor module. It can measure from 3 cm to 350 cm with an accuracy of 2 mm. It is an ideal ultrasonic module for distance measurement, proximity sensors and ultrasonic detector. The technical parameters of HC-SRO4 module is given in Table 2.

Table 2. Technical parameters

Supply voltage	5V
Current operating parameter	15mA
Passive current	<2mA
Viewing angle	15°
Touch Resolution	3mm
Angle of measurement	30°

Servo Motor

These are electronic motors that turn a shaft a certain number of degrees in response to control impulse. The step of the angle of rotation depends on the type of servomotor. A simple servo motor like the SG-90 can be powered from the Arduino's 5V power output pin. The servo control pin can be connected to any digital pin on the Arduino board. Usually a servomotor turns 90° in either direction. i.e maximum movement can be 180°. It cannot rotate any further due to a built-in mechanical stop. The servo has three wires.

- Red – connected to the 5V pin or directly to the power supply;
- Brown or black –ground;
- Yellow or white –the signal is connected to any Arduino digital output.

A servo motor is controlled by sending a pulse width modulated (PWM) signal through the control wire. A pulse is sent every 20 milliseconds. Width of the pulses determine the position of the shaft. For example, a pulse of 1 ms move the shaft anticlockwise at -90°, a pulse of 1.5 ms will move the shaft at the neutral positon that 0° and a pulse of 2 ms will move the shaft clockwise at +90°.

Construction and Operation of Smart Solar EV car

The Arduino control system consists of both hardware and software components. The hardware includes the Motor driver IC (L298N), Servo motor (Tower Pro SG90), two Geared Motors, a Robot Car Chassis, and a Lithium battery. The software consists of the Bluetooth module and Android mobile phone. The main body of the car is made up of a chassis, wheels, and two DC motors. Additionally, two DC motors are used for the four wheels that drive the car. Sensors play a crucial role in electronics, particularly in robotics and automation. There are various types of sensors such as fire sensors, humidity sensors, motion sensors, temperature sensors, and Ultrasonic sensors. Ultrasonic sensors in solar cars are used to detect surroundings, avoid obstacles, and navigate towards a target area. A wheeled cart with an Ultrasonic sensor is used to detect large obstacles and measure the distance between the solar vehicle and the obstacle. Mobile control vehicles can move through the environment. Arduino can be connected to various devices used by users. Bluetooth enables short-range wireless data communication between two microcontroller systems. In this setup, it is paired with a master Bluetooth device such as a PC or Mobile Phone, making its operation transparent to the user. All data received through the serial input is immediately transmitted wirelessly. A car equipped with Bluetooth can move and rotate freely without using the Servo Motor and Ultrasonic sensor. The Ultrasonic sensor emits ultrasonic pulses and receives reflections to detect objects in its path. However, Ultrasonic sensors may not work well with small targets against large backgrounds. An ultrasonic sensor measures the distance to an object using sound waves, while a servo motor is designed for precise control of angular or linear position, velocity, and acceleration. The Motor driver IC (L298N) is a dual full-bridge motor driver module used for DC motors in the solar car. It is used to control the direction of two DC motors and contains a dual-channel H-Bridge motor driver IC. There are two methods to control the speed and direction of the DC motor: PWM for speed control and H-Bridge for rotation control, with the direction rule method being used in this work. This module also includes a 78M05 5V regulator. The L298N Module can control up to 4 DC motors, 2 with directional and speed control. Solar vehicles require the solar energy for operation. Therefore, a 12V lithium battery is used to power and connect with Arduino. When the lithium battery is not charged, external (non-USB) power can come from an AC to DC adapter or a lithium battery. The flowchart and block diagram of smart solar EV cars are shown in Figures 2 and 3.

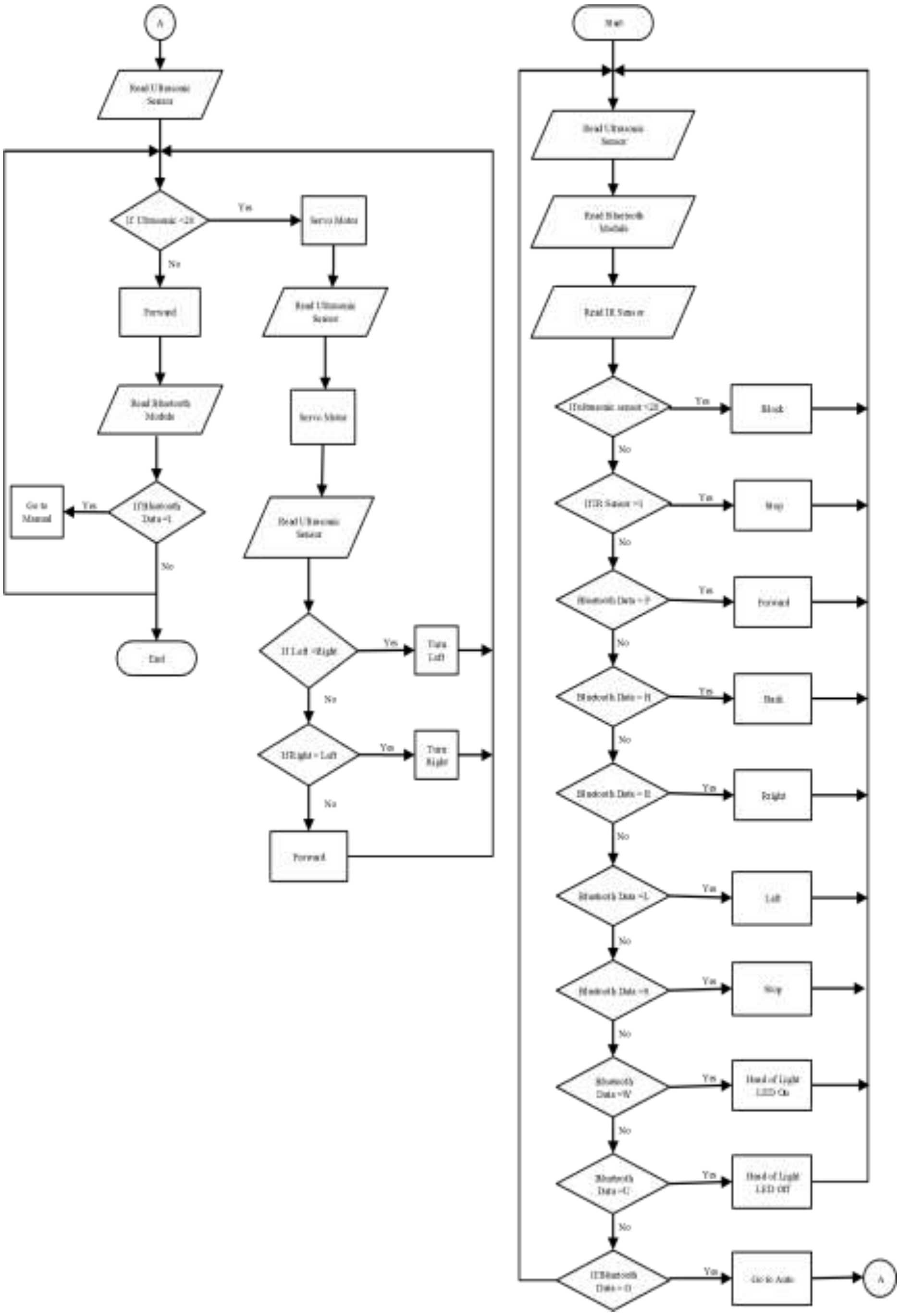

Figure 2. Flowchart of construction of smart solar EV car.

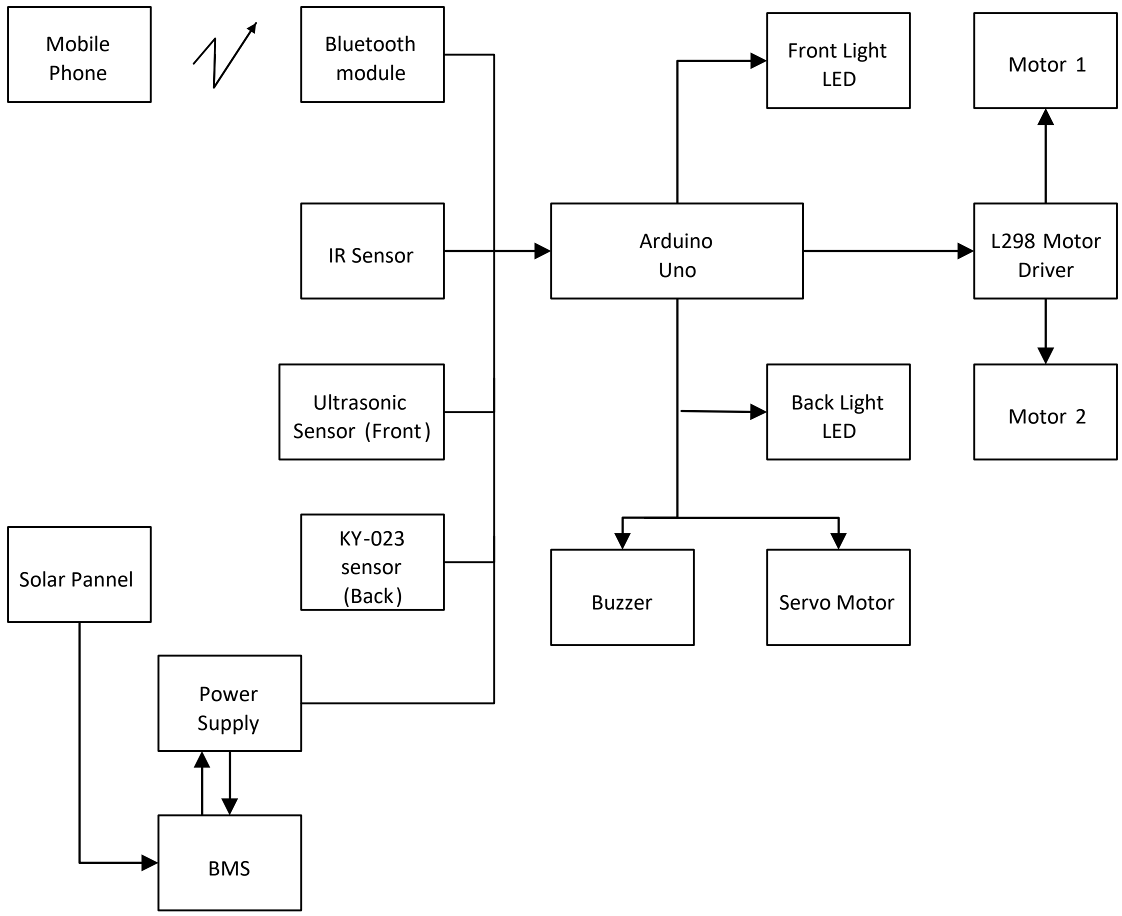

Figure 3. The complete diagram of Block Diagram for smart solar EV car.

The main control system utilizes Arduino and Bluetooth for easy data connection. The Arduino Uno board features 14 available digital I/O pins and 6 analog input pins. In this construction, 12 of these pins are used for building an obstacle-avoidance solar vehicle.

An important aspect of this study is the ability to detect obstacles using an ultrasonic sensor, which has four pins: VCC, Trig, Echo, and GND. Additionally, the KY-023 sensor module, which also has four pins (VCC, GND, EN, and OUT), is connected. The VCC and GND pins of the KY-023 are linked to the VCC of the lithium battery and the GND pin of the Uno, respectively. The button pin connects to pin 11 of the Uno, the Trigger pin connects to pin 7, and the Echo pin connects to pin 6. The Dual Full-Bridge Driver IC operates with two enable input pins and four output pins connected to the DC motor. Pins 2, 3, 4, and 5 are linked to the motor driver.

An Android application can also be utilized in this work. The RX and TX pins in the Bluetooth module connect to pins 9 and 10 on the Uno. Furthermore, pins 12 and 13 on the Uno are connected to the Forward LED and Backward LED, respectively, with the cathode of the LEDs connected to GND. The cathode of the buzzer is also connected to GND, while the anode is connected to VCC. The circuit model was designed using Proteus EDA schematic designer software, as shown in Figure 4.

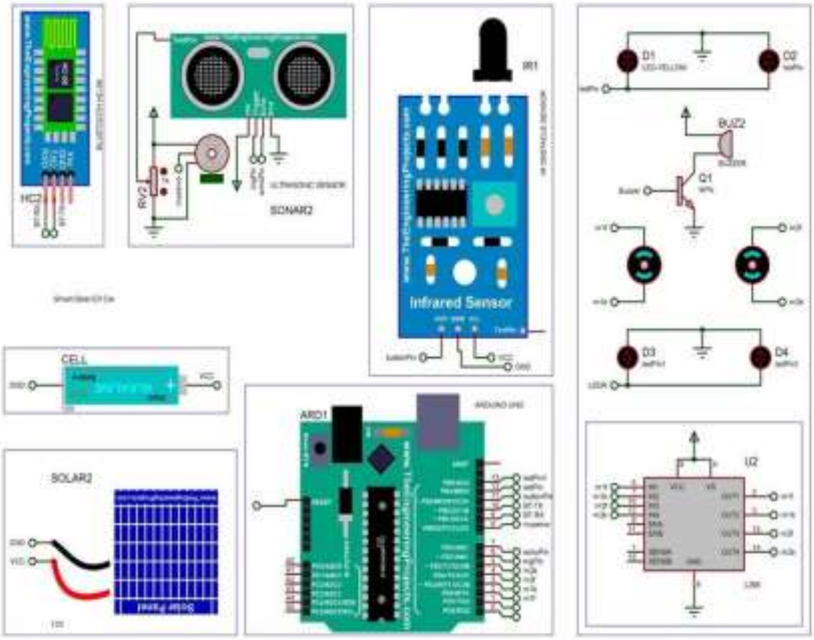

Figure 4. The complete circuit for smart solar EV car.

Results and Discussion

In this study, the Bluetooth Controller program was utilized to control a smart solar EV car using an Android phone. The program must first be installed on the phone. After the Android application is installed, the smart solar EV car can be controlled in four directions. Clicking the "UP ARROW" icon transmits the data "F" to the car to move forward. Pressing the "DOWN ARROW" icon sends the Bluetooth data "B" to the linked Bluetooth Module, causing the car to move backward. Pressing the "LEFT ARROW" icon transmits the data "L" to the linked Bluetooth Module, making the car turn left. Similarly, pressing the "RIGHT ARROW" icon sends the data "R" to the linked Bluetooth Module, causing the car to turn right. Pressing the "HEAD OF LIGHT LED" icon sends the data "W" to the linked Bluetooth Module, turning the car's LED lights on. Pressing the "HEAD OF LIGHT LED" icon again transmits the data "U" to the linked Bluetooth Module, turning the car's LED lights off. Pressing the "FORWARD LEFT" icon sends the data "G" to the linked Bluetooth Module, putting the car into "Auto Mode." Pressing the "FORWARD RIGHT" icon transmits the data "I" to the linked Bluetooth Module, switching the car to "Manual Mode". An Arduino-based Bluetooth module was constructed for the smart solar EV car. It can help overcome obstacles such as animals and other obstructions using an Ultrasonic sensor.

Figure 5. Android mobile application

An android application was developed for controlling the movement of the solar EV car. It has seven icons which perform a different set of operations. The seven keys, placed as shown in the figure of the application, are for the movement in the four directions namely forward, backward, left, and right and the fifth icon is for forward led and the sixth icon is for back led, and the seventh icon is for horn for smart solar EV car. The photograph of Android Mobile Application is described in Figure 5.

Step 1. Turn on the power supply of the circuit.

Step 2. Turn on the Bluetooth module from the phone screen.

Step 3. Open Android Application in the mobile Phone. Select the Bluetooth RC controller.

The Android Application showed in Figure 6 (a) controlled the solar vehicle, and the operation modes of solar vehicle in Figure 6 (b) in day time, or in Figure 6 (c) at night time.

Figure 6. Operation mode of obstacle avoiding of solar car

Conclusion

The smart solar EV car was designed to be controlled and modified using an Android phone. The solar panel can be utilized anywhere in the world as long as there is solar energy available. This solar energy is used to power the car, with stored electricity from the lithium battery being used at night or on cloudy days. By using renewable energy, the car does not rely on fuel, reducing carbon dioxide emissions and promoting technical development. However, in a cloudy or shaded environment, the solar car may not work at full capacity, as it requires sunlight to operate properly.

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