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Voice Controlled Robot with Obstacle Detection

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ABSTRACT: Robot is a multifunctional, reprogrammable device. It is designed to work like humans such as loading unloading, health care, pick and place, industries and surveillance. The voice-controlled obstacle detection robot described in this project is designed to perform various tasks. It is built using an Arduino UNO microcontroller, L293D motor driver, ultrasonic sensor, HC-05 Bluetooth module, servo motor, gear motors, and Li-ion batteries. The robot is controlled through voice commands, which is transmitted wirelessly from an Android app to the Arduino UNO through the Bluetooth module. The microcontroller processes the voice commands and controls the direction of the robot accordingly. The ultrasonic sensor detects obstacles in front of the robot and sends the signal to the Arduino UNO. The Arduino UNO then compares the received signal and determines the appropriate action to be taken. The software used to write the code is Arduino Integrated Development Environment (IDE), which provides a text editor, message area, text console, and menus for writing and compiling the code in Embedded C. An Android app called Arduino blue control is used to provide commands to the robot. The android app has voice command configuration. We configure each voice command with its respective symbols. Experimental results show that the robot can move in different directions such as forward, backward, left, and right based on the user's voice commands. The servo motor allows the ultrasonic sensor to rotate 180 degrees, enabling obstacle detection in different directions. The applications of this robot include low-range mobile surveillance devices, home automation, and assistive devices for people with disabilities. It can be used for tasks that require continuous work without rest, and in environments that may be dangerous for humans to access.

KEYWORDS Voice controlled, Obstacle detection, Bluetooth module, Ultrasonic sensor, Mobile robot.

I. INTRODUCTION

In voice controlled robots Arduino UNO, Bluetooth module is used to control the Robot. An Android app is used to control a robot via Bluetooth, and the robot is equipped with sensor to detect nearby obstacles. The app allows the user to control the speed and direction of the robot using voice commands. To achieve this, the app uses speech recognition technology to interpret the user's voice commands and send them to the robot via Bluetooth. The robot is equipped with a microcontroller to receive the commands and control the motor driver to control the wheels. To detect obstacles, ultrasonic sensor is used. The sensor allows the robot to measure the distance of the nearest obstacle and adjusts its course accordingly. Overall, this project combines a number of technologies, including speech recognition, Bluetooth communication, microcontroller programming, and sensor integration.

An android application called Arduino Bluetooth control and a Bluetooth communication is made with robot which interfaces with microcontroller to control its speed and direction. Aim of this work is to design and control the robot through voice commands using Bluetooth. Android phones are most popular gadgets these days. You will find various apps on the Internet that exploit inbuilt hardware in these mobile phones, such as Bluetooth and Wi-Fi, to control other devices. Presented here is a Voice controlled Robot with Obstacle detection that can be controlled via an app on the mobile phone. The control commands are sent via Bluetooth and the robot has such features as:
(1) It can be controlled through an app on an android phone by voice commands.
(2) The speed of the robot can be controlled.

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(3) The robot will sense the distance of the nearest obstacle.

II. LITERATURE REVIEW

This section provides an overview of previous research papers and projects related to the topic Voice controlled Robot with Obstacle detection. Srivastava and others developed a Voice Controlled Robot Car using Arduino, where they used the HC-05 Bluetooth module for wireless communication and voice commands given through a mobile application [1]. Bhikuleand others developed an Obstacle Avoidance and Voice Control Unit for an Autonomous Car, they used an RF transmitter for signal transmission and a Bluetooth module for establishing communication between the robot and voice commands. They used an Arduino UNO for reading voice commands and controlling the robot [2]. P. Narendra Ilaya Pallavan and others developed a Voice Control Robot with Real-time Barrier Detection and Averting, based on sound wave transmission and reflection from a sensor. The robot stops upon detecting an obstacle and waits for further instructions [3]. Rahul A. Narhare and others developed a Smart Voice Controlled Vehicle with Obstacle Detection using IOT, they took inputs from an Android app for basic movements and established connection via a Bluetooth module. They used an ultrasonic sensor to prevent collisions [4]. Ritika Dhabliya and others developed a project for Obstacle Detection and Text Recognition for Visually Impaired Persons based on Raspberry Pi. They used a camera to capture objects, compared them with predefined images, and provided voice output for object recognition by blind individuals [5]. Lv and others have developed "Robot control based on voice command" In this paper, they have used a robot which has the ability to apply speech recognition techniques to the control application. The robot can understand control commands and execute the corresponding action [6]. Basyal and others have developed "Voice recognition robot with real time surveillance and automation "This paper enhances the concept of real-time surveillance and automation where an obstacle detection and avoidance mechanism along with lighting and horn operates through predefined voice command [7]. Rashid and others have developed “Design and implementation of a voice controlled robot with human interaction ability” The paper presents the development of a voice controlled talking robot using mobile phone based on Arduino Uno microcontroller. The proposed system is designed based on microcontroller which is connected to smart android phone through Bluetooth module for receiving voice command. The voice command is converted to text by an app of the android phone and sends data to the microcontroller for controlling robot movement. After getting each command the robot will perform according to the instruction and will be able to speak different sentences [8]. Shim and others have developed "An intelligent control of mobile robot based on voice command." This paper, describes a voice recognition control system for robot system which can recognize voice in noisy environments. To suppress interference and noise and to attenuate reverberation, they implemented a multi-channel system consisting of a generalized side-lobe canceller technique and a feature-space noise suppression using MMSE criteria [9]. Sachdev and others have developed "Voice-controlled autonomous vehicle using IOT." In this paper, they have presented the idea of a low-cost autonomous vehicle, which will be controlled by voice commands, given by the user [10].
These research papers provide insights for the development of the Voice controlled Robot with Obstacle detection, including the Bluetooth communication, obstacle detection sensors, and voice commands for controlling the robot's movements.

III. METHODOLOGY

Voice commands are sent through the Android app, Bluetooth module establishes a wireless communication between the app and the robot. The block diagram of Voice controlled Robot with Obstacle detection is shown in Fig1. The system operates as follows:

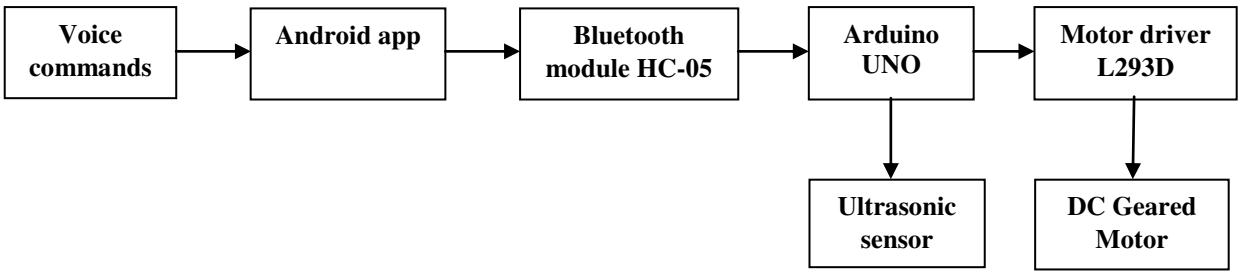

Fig 1: The block diagram of Voice Controlled Robot with Obstacle Detection

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The Bluetooth module receives the signals and sends them to the Arduino microcontroller for processing. The Arduino microcontroller processes the received signals and sends corresponding commands to the motor driver. The motor driver, which is mounted on the Arduino UNO, controls the gear motors of the robot based on the commands received from the Arduino. The ultrasonic sensor, which is connected to the Arduino, detects obstacles in front of the robot and sends signals to the Arduino. The Arduino compares the received obstacle detection signals with the program and determines what action to be taken. The motor driver shield controls the gear motors.

The TX and RX pins of the Arduino are connected to the RX and TX pins of the Bluetooth module to establish communication. The Bluetooth module is powered by 5V, and the GND of the ultrasonic sensor is connected to the GND of the Arduino. The ECHO pin of the ultrasonic sensor is connected to A0, the TRIG pin is connected to A1, and VCC is connected to 5V of the Arduino. Voice commands are processed by the mobile phone and sent to the robot via Bluetooth. The received message via Bluetooth is forwarded to the Arduino using UART serial communication protocol. The Arduino code checks the received message, and when it matches with a predefined string, it controls the movements of the robot accordingly, including forward, backward, turning right, turning left, and stop actions. Overall, the Voice controlled Robot with Obstacle detection uses an Android app, Bluetooth module, Arduino microcontroller, motor driver shield, gear motors, and ultrasonic sensor to enable voice commands for controlling the robot movements and obstacle detection capabilities.

IV. HARDWARE DESCRIPTION

The main hardware components used in this work are Arduino UNO, Bluetooth module HC-05, Motor driver L293D, Ultrasonic sensor.

4.1 Bluetooth HC-05

The Bluetooth module, specifically the HC-05 module, is a crucial component in the Voice controlled Robot with Obstacle detection system. It is responsible for establishing wireless communication between the user (transmitter) and the robot (receiver).

The HC-05 module uses serial communication to connect with the microcontroller, allowing for data transmission and reception. The HC-05 module operates in both master and slave modes, which mean it can either transmit or receive data. It can be connected to various devices, such as mobile phones, handheld computers, and laptops, via the built-in UART (Universal Asynchronous Receiver/Transmitter) interface. This allows for communication with other Bluetooth-enabled devices. The HC-05 module requires a supply voltage of 3.6V to 6V to operate effectively. It is an essential component that enables wireless communication and interaction between the user and the robot in the Voice controlled Robot with Obstacle detection system.

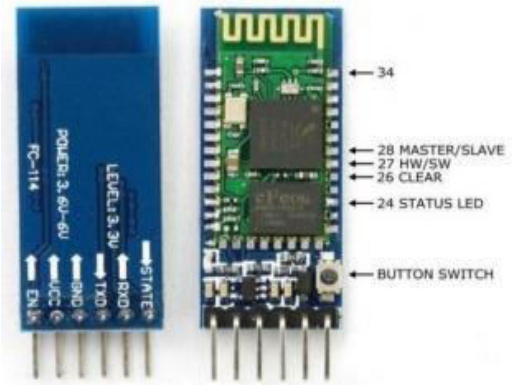

Fig 2: HC-05

4.2 Arduino UNO

The Arduino UNO is a microcontroller board that serves as the brain of the Voice controlled Robot with Obstacle detection system. It has both analog and digital pins, a USB connection for programming the on-board microcontroller, a power jack, an ICSP (In-Circuit Serial Programming) header, and a reset button. The motor driver shield, which controls the motors of the robot, is mounted on top of the Arduino UNO. The program for controlling the robot is uploaded to the Arduino UNO via a data cable, allowing the microcontroller to execute the desired actions for the

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robot. The Arduino UNO is known for its affordability, ease of use, and compact size, making it a popular choice for various projects, including robotics. The Arduino UNO also has several test points (TP0, TP1, TP2, TP3, TP4) on the board for debugging and troubleshooting purposes. These test points provide access to different voltage levels, such as 0V (GND), 5V, 9V, and high pulse corresponding to the distance of the obstacle. These test points can be used to measure and monitor the signals and voltages during operation, aiding in the development and testing of the robot system. The microcontroller on the Arduino UNO is programmed using the Arduino programming language, which is a simplified version of C/C++.

Fig3: Arduino UNO

4.3 Ultrasonic sensor

The Ultrasonic sensor, as shown in Figure 4.4 of the system, is a module that uses sonar technology to determine the distance from an obstacle to the sensor. It is commonly used in robotics and automation projects for proximity sensing and obstacle detection. The HC-05 ultrasonic sensor module is equipped with an ultrasonic transmitter and a receiver module. To measure the distance between the sensor and the obstacle, pin 2 (TRIG) of the module needs to receive a high pulse for at least ten microseconds. This pulse triggers the module to transmit eight cycles of ultrasonic burst at a frequency of 40 kHz, which then travels towards the obstacle and reflects back. When the sensor detects the reflected ultrasonic burst, it sets pin 3 (ECHO) to a high state. The duration of the reflected pulse, measured in microseconds, depends on the distance between the sensor and the obstacle.

Fig 4: Ultrasonic sensor

1.4 Motor driver L293D

The Motor driver L293D is shown in the Fig 5. L293D is a basic motor driver integrated chip that enables us to drive a DC motor in either direction and also control the speed of the motor. The L293D is a 16 pin IC, with 8 pins on each side, allowing us to control the motor. It means that we can use a single L293D to run up to two DC motors. L293D consist of two H-bridge circuit. H-bridge is the simplest circuit for changing polarity across the load connected to it. Since we are using four wheels only two IC is required.

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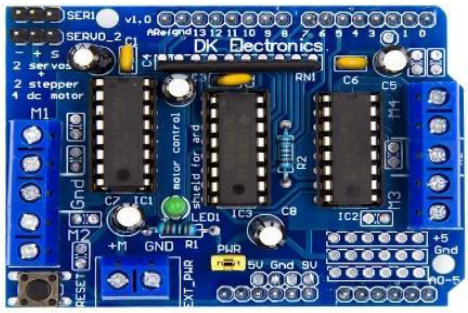

Fig 5: L293D motor driver

V. SOFTWARE REQUIREMENTS

The software requirements for the system include the use of the Arduino Integrated Development Environment (IDE) and Arduino Blue control app.

5.1 Arduino Integrated Development Environment

The software requirements for the system include the use of the Arduino Integrated Development Environment (IDE), also known as Arduino Software, for writing and uploading code to the Arduino UNO microcontroller. The Arduino IDE provides a text editor for writing code, a message area for feedback, a text console for displaying output, a toolbar with buttons for common functions, and menus for various options. The programming language used for writing code for the system is Embedded C, which is a low-level programming language commonly used in embedded systems, including microcontrollers like Arduino UNO. Embedded C allows for writing code to control various functions of the robot, such as forward direction, left turn, right turn, backward direction, and stop. The code is written in the Arduino IDE using the C syntax and libraries specific to Arduino, which provide functions for controlling the Arduino UNO's pins and other peripherals, such as the motor driver and ultrasonic sensor, to achieve the desired robot movements and actions.

5.2 Arduino Blue control App

The Fig 6 shows the overview of the Android app – Arduino blue control. The app has voice command configuration through which the users voice commands can be configured into symbols accordingly. These symbols are communicated to the robot through the bluetooth module which is processed by the microcontroller and appropriate actions are taken. The Google speech service converts audio to text and shares the text with this app. The steps involved in operating the android app are show in Fig 6.

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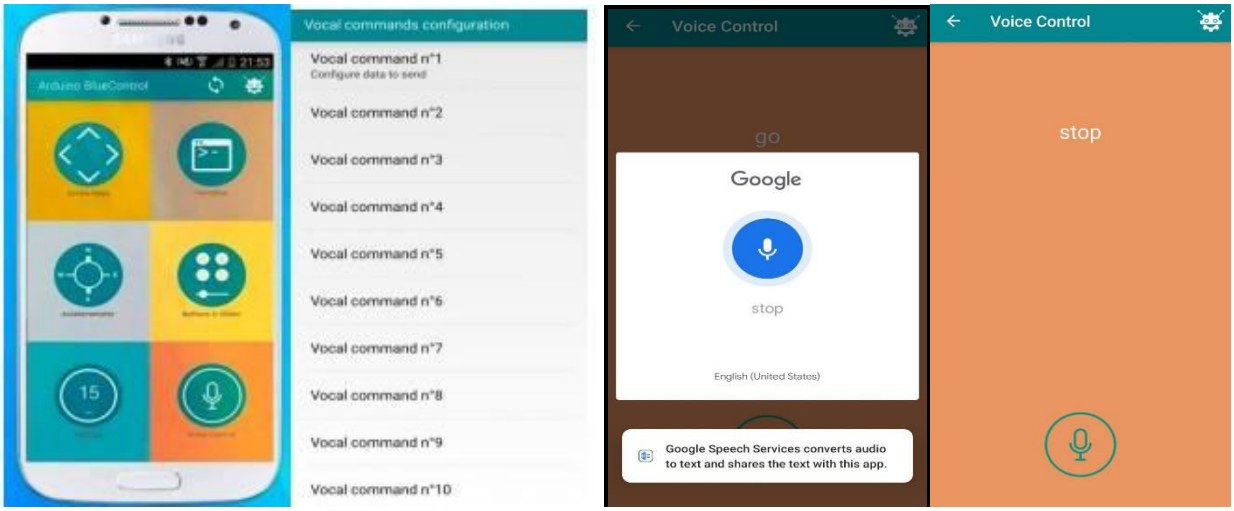
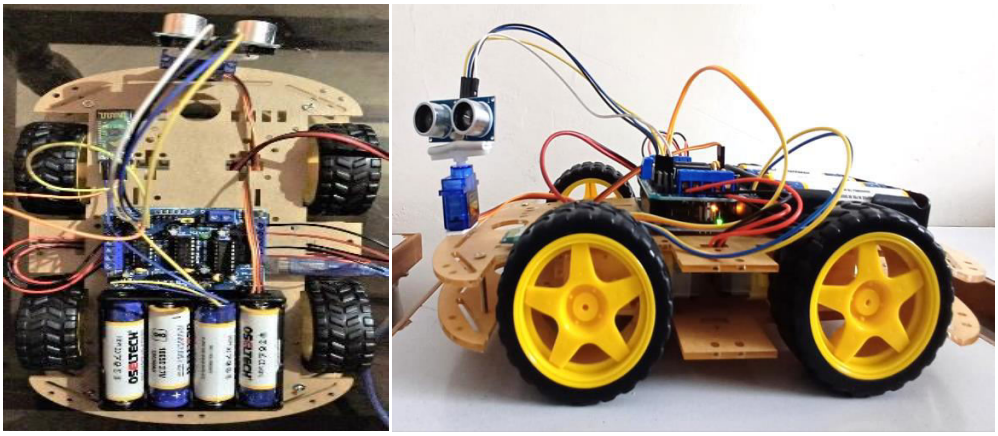


(i) (ii) (iii) (iv)

Fig 6: (i) Arduino blue control interface (ii) Voice command configuration window
(iii) Mic to provide the voice commands (iv) The commands recognized by the app

VI. RESULTS AND DISCUSSION

The robot is being controlled through an android application. Using Bluetooth, a communication is established between the robot and the android application. The robot movements can be controlled by voice commands, the robot stops when an object is detected in its path and resumes back the movement when next command is given.
Fig 7 shows the different views of the mobile robot during its movements. The observed results are the robot moves in forward, backward, left and right directions. And to stop the robot stop command is used.



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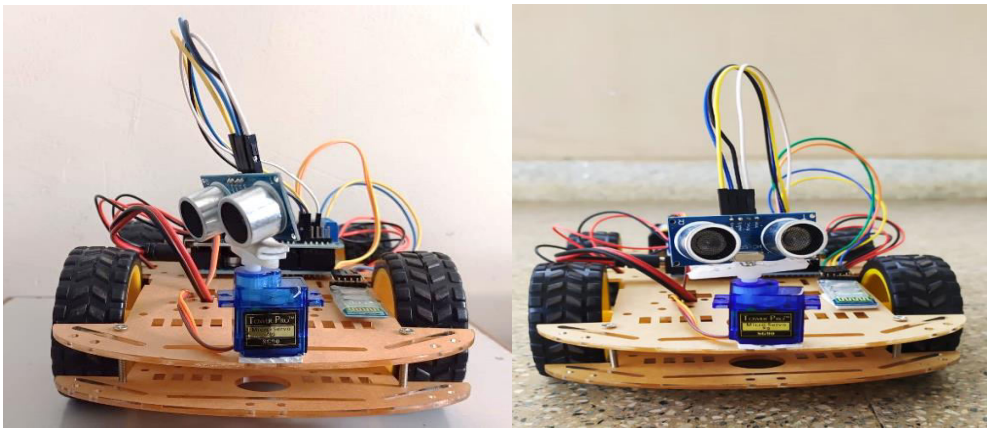

(iii) (iv)

Fig 7: (i) Top view of the robot (ii) left movement (iii) right movement (iv) front view

VII. CONCLUSION

The voice-controlled Robot with obstacle detection is a successfully designed that has the potential to perform various industrial and domestic applications related to automation in daily activities. The use of voice commands allows for easy and intuitive control of the robot, making it suitable for tasks such as firefighting, automated plant watering, and military purposes where human intervention may be risky or not feasible.

Overall, voice-controlled robots have significant potential in various domains, and further advancements and applications are expected in the future. The development of such robots can greatly contribute to automation and efficiency in various industries, also improve the quality of life for individuals with disables.

VIII. FUTURE SCOPE

A robotic arm can be mounted on the mobile robot to assist bedridden patients. It can also be utilized to assist disabled individuals who may have limited mobility but can provide voice commands to operate the robot and perform tasks on their behalf. Furthermore, the project can be further developed into a fully automated humanoid robot capable of detecting enemies in a war field and taking appropriate action.

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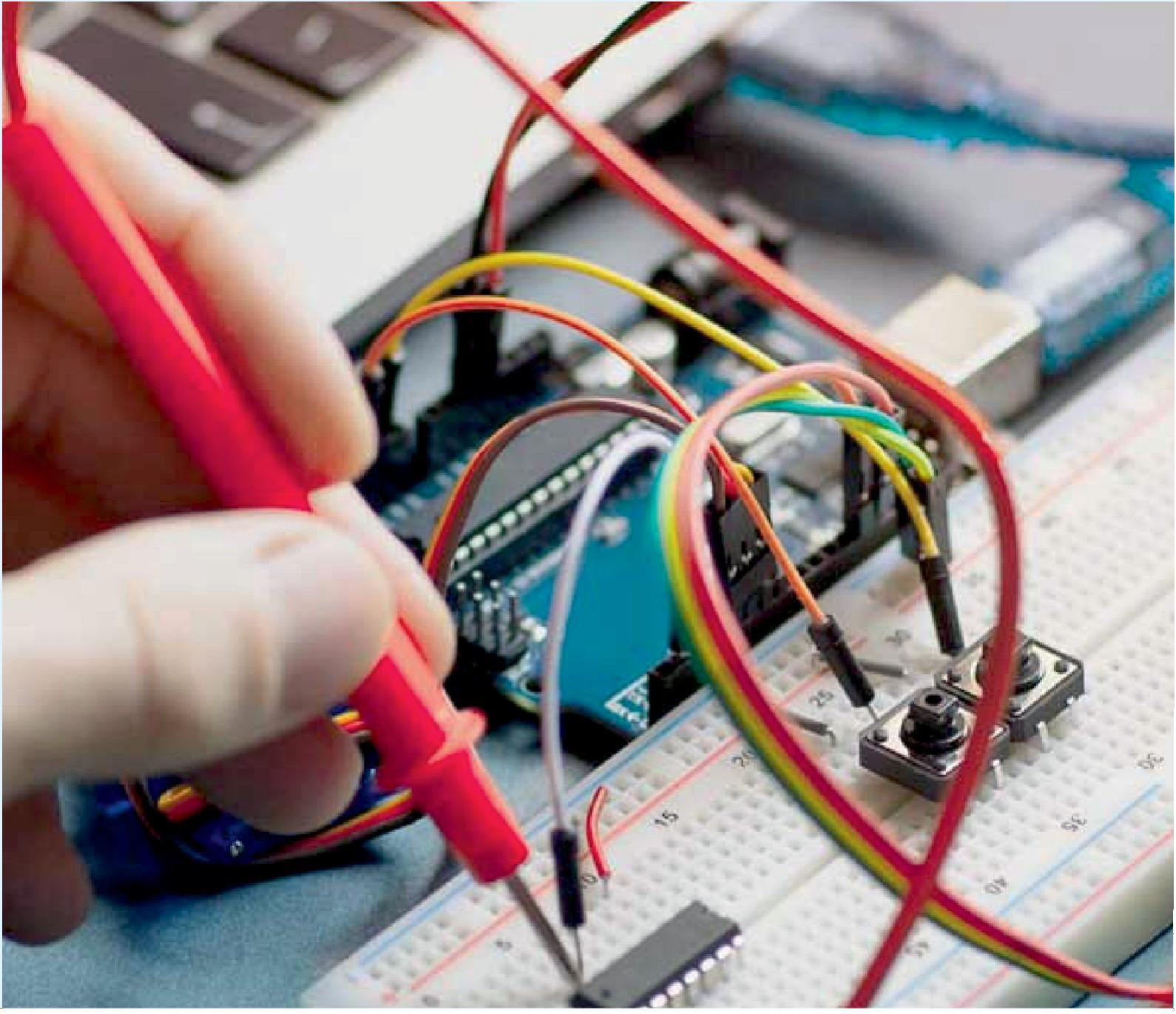

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