**VOICE CONTROLLED AUTONOMOUS VEHICLE USING IoT/AI**

NAGA PREM SAI NELLURE, SANKET MALLAWAT, SHIVEN DESAI, SUPRIYA TANAJI MANE, ISHITA KUNDU, PRASAD PATHAK

**ABSTRACT**

Humans have always been at the top of the animal kingdom. It's a privilege we are all grateful for, but wouldn't it be marvelous if we could substitute our chores for some leisure time? We can start by deploying small functional autonomous cars. Autonomous cars are the elementary steps of progress towards advancement in IoT and Artificial Intelligence. In this paper, we present the idea of a low-cost autonomous vehicle, which will be controlled by voice commands, given by the user. The user may be located at some remote location, but as long as he/she is connected to the Internet, the vehicle will follow voice instructions. The idea is implemented through NodeMCU ESP32, and MIT APP INVENTER. The instructions are fed to the vehicle through Speech Recognizer in the MIT APP INVENTER.

**INTRODUCTION**

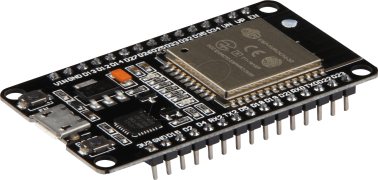
Early 21st century hurled the people in the middle of a transition era – the era of digitalization. This era, still in its inception phase, is termed as ‘Industry 4.0’. Industry 4.0, in simpler terms, is a step ahead in the fields of wireless connectivity, cloud computing, Internet of Things (IoT), Cyber-Physical Systems (CPS), Artificial Intelligence, Augmented Reality, Big Data Analytics, Autonomous Robotics, Industrial Internet of Things (IoT), Simulation and Cybersecurity . Thus, Industry 4.0 is a hypernym of the aforementioned areas. Internet of Things forms the backbone of Industry 4.0. All the sensors and devices are wirelessly connected through IoT. IoT has revolutionized every industry [2]. One such industry is the automotive industry. IoT has made possible the existence of autonomous vehicles or smart vehicles. In this paper, we present one such autonomous vehicle, which follows voice instructions given to it through Speech Recognizer on the user’s smartphone. The outline of this paper is as follows: a briefing of hardware components and software/services used in the device focuses on working of the device, as well as the flow of the processes involved.

**HARDWARE AND SOFTWARE**

The hardware and software requirements are determined to fulfill the required objectives. Sensors and actuators play the most important role in IoT. Sensors are devices which ‘sense’ environment around them for different parameters, such as temperature, humidity, motion, pressure, light, smoke and so on. Sensors sense the environment in the form of signals, converts the signal and outputs it to another electronic device.

**2.1. NodeMCU DEVKIT and ESP32**

NodeMCU is a Wi-Fi enabled development kit, which relies on ESP32 microchip. NodeMCU is programmed in C but is based in Lua. However, C also forms the backbone of Lua. Figure 1 shows a typical ESP32 board. The hardware and software requirements are determined to fulfill the required objectives. Sensors and actuators play the most important role in IoT. Sensors are devices which ‘sense’ environment around them for different parameters, such as temperature, humidity, motion, pressure, light, smoke and so on. Sensors sense the environment in the form of signals, converts the signal and outputs it to another electronic device.



**2.2. Ultrasonic Sensor**

An ultrasonic Sensor can send and receive an ultrasonic signal. The device sends a pulse at 40kHz, which when encounters an obstacle, bounces back to the sensor. The distance or proximity between the device and obstacle is calculated using the time duration between the sending and receiving of the pulse.



**2.3. DC Motor**

DC Motor is an electronic device which runs on direct current. A DC Motor provides a means to convert between two forms of energy – electrical to mechanical. DC Motors are used in vehicles to enable movement. The main advantage of using DC Motors is that they provide speed and direction control mechanism.

**2.4. Motor Driver L239D**

Microcontrollers are not compatible with motors directly. So, an interfacing device between motor and microcontroller is required, so that speed and direction of motors can be controlled. This interfacing device is known as a motor driver. L293D is one such motor driver. Each chip is equipped with 2 H-bridge circuits. These circuits can cause motion and rotate motors.

**2.5. Arduino IDE**

Arduino IDE is an application that is developed in Java. The application follows C/C++ rules of programming. The codes written in the IDE can be uploaded to Arduino boards. Also, some boards other than Arduino, such as NodeMCU support Arduino IDE.

**2.7. Google Assistant**

Google Assistant is a personal assistant, which operates on voice commands. It is powered by Google. It works as most other virtual assistants do, such as Siri, Cortana, Alexa or Jarvis

**3. Methodology**

The vehicle is made using ESP8266, which can be controlled using voice commands given by the user through Google Assistant in the smartphones. The user can instruct the vehicle using any of the following instructions:

1. “Go Forward” or “Move Forward”

2. “Go Backward” or “Move Backward”

3. “Go Left” or “Move Left”

4. “Go Right” or “Move Right”

5. “Shutdown”

The voice commands have no semantic ambiguity and the vehicle moves based on the meaning of commands. Two DC motors power the vehicle for motion. Initially, all pins of both motors are disabled (or at LOW state). To move in different directions, different combinations of pins are enabled (or at HIGH state).

**3.3. Connections**

L293D is used as a motor driver for interfacing between DC motor and microcontroller. It allows the bidirectional flow of voltage to enable rotation. 2 motors are connected. Input pins of motors are connected to digital pin D3, D4, D5 and D6, initially set to LOW. Table 1 provides configuration of pins for different movement.

Additionally, the Ultrasonic Sensor is also connected to avoid obstacles.

Table 1. Pin Combinations for Motor Movements

Voice Command D2 D4 D13 D33 Movement

None/Initial State 0\* 0 0 0 None

Move Forward/Go Forward 1\*\* 0 1 0 Forward

Move Backward/Go Backward 0 1 0 1 Backward

Move Left/Go Left 0 1 0 0 Left

Move Right/Go Right 0 0 0 1 Right

Shutdown 0 0 0 0 Stop

\* 0 or LOW or Ground State or 0V \*\* 1 or HIGH or 5V (or 3.3V depending on the board)

**3.4. Programming the Module**

The programming is done in Arduino IDE and the code is then uploaded to NodeMCU board. The code employs MQTT protocol where we setup publisher and subscriber objects. Connect the corresponding feed with the publisher object in the program. Connect the board to PC and upload it to the NodeMCU ESP8266 board after connections.

**MIT APP**



***Server to server communication***

**V.RECOGNIZER**

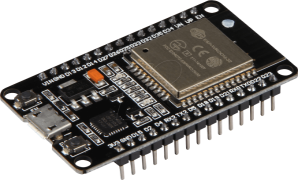
**Firebase**

GATEWAY

CLIENT APP.

IOT PLATFORM

***Device to Server communication***



**USER**

***Device to Device communication***

**ESP32**





**Ultrasonic**

**SENSORS**

**3.5. Bringing Everything into Action**

Log into Google Account on the smartphone. Bring up Google Assistant. Feed the exact commands which were put into Firebase.

**4. Related Work**

Many voice-controlled bots have been made. There are a variety of approaches employed to make these bots.In, Humayun et al. suggest the use of an Arduino board and the voice commands given are first converted to text through an Android app. Arduino has no inbuilt Wi-Fi capability. So they suggest to use Bluetooth and SPI interface. Smartphone and the board are connected using Bluetooth. The robot, then, interacts with the user in the form of pre-recorded sounds. In, AT mega 2560 based microcontroller and EasyVR module for speech recognition. The authors suggest to convert the received audio signals to the digital values. Every value has predefined movement associated to it. Transmission and Reception of the signals is carried out via Zigbee module. In and , the authors suggest Arduino Mega microcontroller and voice recognition through the Speech Recognizer block inside app created using MIT App Inventor 2, which is a drag-and-drop service allowing users to create apps compatible with Android and iOS The point to note here is that Arduino-based microcontrollers have no native support for Wi-Fi. They have Bluetooth module in them, which gets the work done, albeit with more complexity. With ESP8266 and Wi-Fi connectivity, the job becomes relatively simpler. We chose to integrate Google Assistant for voice recognition, as it has ready support for Firebase and it is exposed to more corpus than custom-built voice recognition tools. Google Assistant can be easily replaced by other assistants. We chose Google Assistant because in , the authors have shown after comprehensive survey, that Google Assistant has best performance.

**5. Future Scope and Conclusion**

Internet of Things (IoT) is the ever-growing field. The only way is forward for this area. Autonomous Robots are widely studied area in IoT. Use of robots and automation drastically improve productivity and help reduce resource wastage. They are an easy replacement for human, without much life-threatening risk at hazardous locations (ex –factories). Although limited to selected voice commands for now, we aim to expand this further using Machine Learning and NLP. Further improvements include the addition of DHT sensor to sense temperature and humidity. Due to its size, it can reach and penetrate areas where humans cannot reach and hence, we can detect regions of extreme temperature and humidity (farms where crops grown so large that ground below is hardly visible). Also, an initial and obvious expansion of the project would be to attach a camera for better exploration from remote areas. But then the problem of limited pins arises in NodeMCU boards. We don’t need to look much further; Raspberry Pi is the solution. But it comes at the cost of increasing complexity. As is the case with most things in the nature, nothing comes free of cost. All said and done, we can all agree upon that the autonomous vehicles and robots will be the stepping stones to the world of IoT in the coming years.

**Acknowledgements**

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