Voice Based UGV control

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***Abstract*—In this paper, we demonstrate how to guide an unmanned ground vehicle (UGV) using a gamepad interface as well as voice commands. This is done through an android application for sensing voice or touch on the phone and relaying the control data to the UGV via Bluetooth. In the process, we show how this platform offers a low-cost alternative for porting artifical intelligence (AI) algorithms on hardware.**

I. Introduction

Autonomous navigation has been a major area of research in robotics, with pioneering projects such as [1], [2], [3], demonstrating autonomous navigation in complex environments. End-to-end learning approaches, such as NVIDIA's system for self-driving cars [4], have further simplified navigation pipelines by mapping sensor inputs directly to control outputs. Surveys on intelligent vehicles highlight a wide variety of autonomous driving applications [5], and research on fully autonomous systems explores both the hardware and software required for robust navigation [6]. In parallel, speech-based human-robot interaction has enabled intuitive control of robots in constrained environments, including intelligent wheelchairs and mobile robots [7]–[9], and robust speech recognition datasets such as Google's Speech Commands [10] have accelerated development of voice-controlled systems.

Inspired by the above, this work presents a scaled-down prototype using an ESP32 microcontroller and an L293D motor driver IC to build a voice-enabled toy car, integrating simple navigation with bluetooth control and speech commands for user interaction.

II. Hardware Setup

The components used in this project and their description are listed in the Table I. The steps for toycar assembly are given below.

1) Assemble the chassis, fix the motors and mount the wheels to build the toycar.
2) Fix the breadboard on the base of the toycar.
3) Plug the **L293D** motor driver IC in Fig. 1 on the breadboard.
4) Connect the L293D output pins to the motors (M_1, M_2) according to Table II.
5) Connect the ESP32 in Fig. 2 to L293D as per Table III.

III. Software

A. Dabble

1) Install the *Dabble* app using Google Playstore in an Android mobile.

Item	Qty.	Description
Chassis Frame	1	For holding all components.
Side Wheels	2	Drive wheels for UGV movement.
Center Wheel	1	Caster wheel for stability and smooth turning.
Motor Mounts	4	Holds motors in place.
ESP32	1	Microcontroller used for control and wireless communication.
L293D Motor Driver IC	1	For driving and controlling the DC motors.
Power Bank	1	Provides portable power supply to the system.
DC Motors	2	Used for propulsion of the toy car.
Breadboard	1	For making circuit connections.
Jumper Wires	11	For making electrical connections between components.
Micro-USB cable	1	Connection between the ESP32 and the power bank.

TABLE I
List of Components

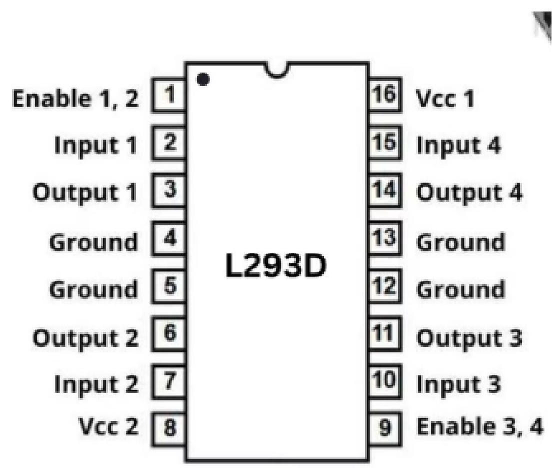

Fig. 1. L293D Motor Driver IC

L293D IC	3	6	11	14
Motors	M_1 (+)	M_1 (-)	M_2 (+)	M_2 (-)

TABLE II
L293D and Motor connections

ESP32	32	33	25	26	GND	5V
L293D IC	3	6	11	14	GND	VCC 1

TABLE III
L293D and ESP32 connections

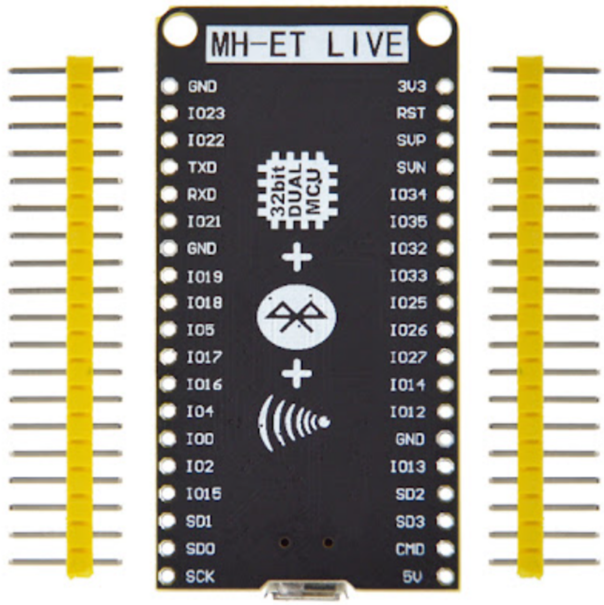

Fig. 2. ESP 32

2) Upload the following code to the ESP32 using PlatformIO.

```
wget https://github.com/gadepall/voice-ugv/blob/main/
codes/dabble_gamepad.cpp
```

3) Open PlatformIO, select New Project and then fill in the details (name, board & framework).
4) Then replace contents in src/main.cpp with the above code, now run & upload that code to ESP32.
5) After uploading the above code, plug the ESP32 to a power bank via a micro-USB cable.
6) Open the Dabble app and connect to the ESP32 via bluetooth. The app interface is available in Fig. 3
7) Now use the *Gamepad* of the app in Fig. 4 to control the toycar.
8) Operate the left-side control buttons labeled *Forward, Back, Left & Right* to give the respective commands.

B. Arduino Bluetooth Controller

1) Install the *Arduino Bluetooth Controller* app using Google Playstore in an Android mobile.
2) Upload the following code to the ESP32 using PlatformIO.

```
wget https://github.com/gadepall/voice-ugv/blob/main/
codes/ABC_voice.cpp
```

3) Open PlatformIO, select New Project and then fill in the details (name, board & framework).
4) Then replace contents in src/main.cpp with the above code, now run & upload that code to ESP32.
5) After uploading the above code, plug the ESP32 to a power bank via a micro-USB cable.
6) Open the Arduino Bluetooth Controller app and connect to the ESP32 via bluetooth. The app interface is available in Fig. 5

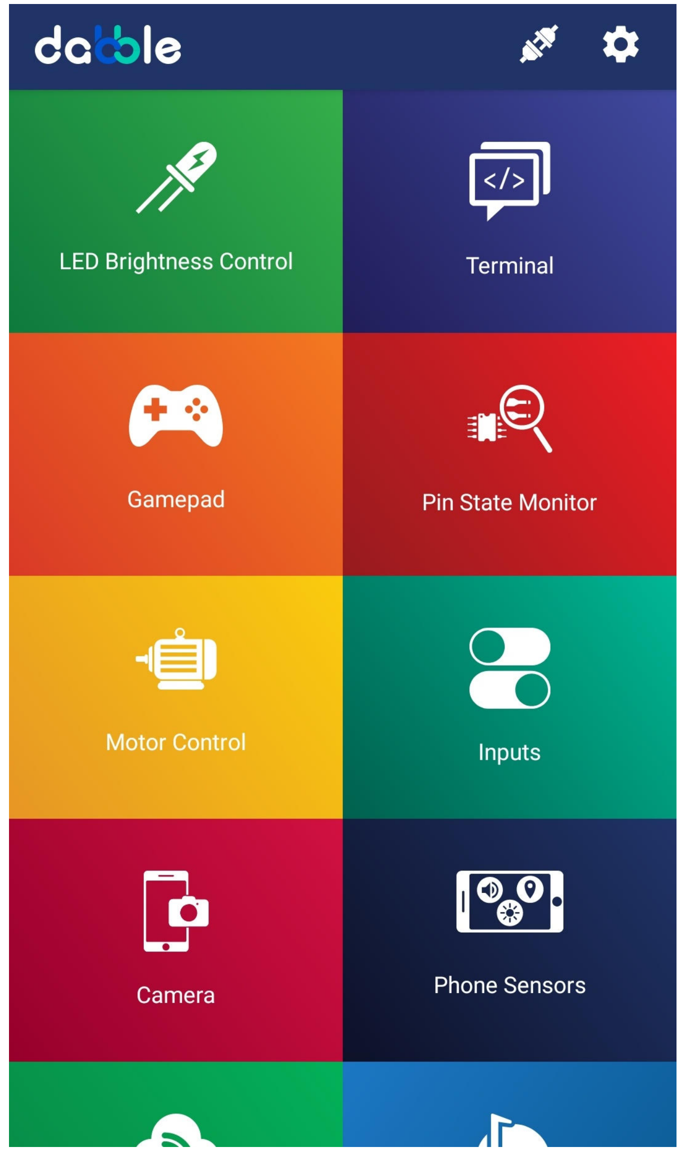

Fig. 3. Dabble Interface

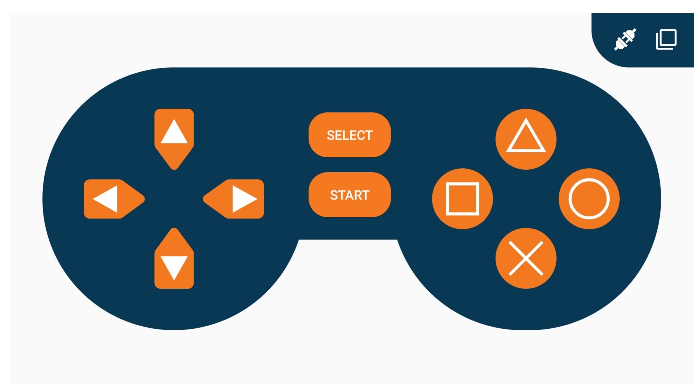

Fig. 4. Gamepad in Dabble App

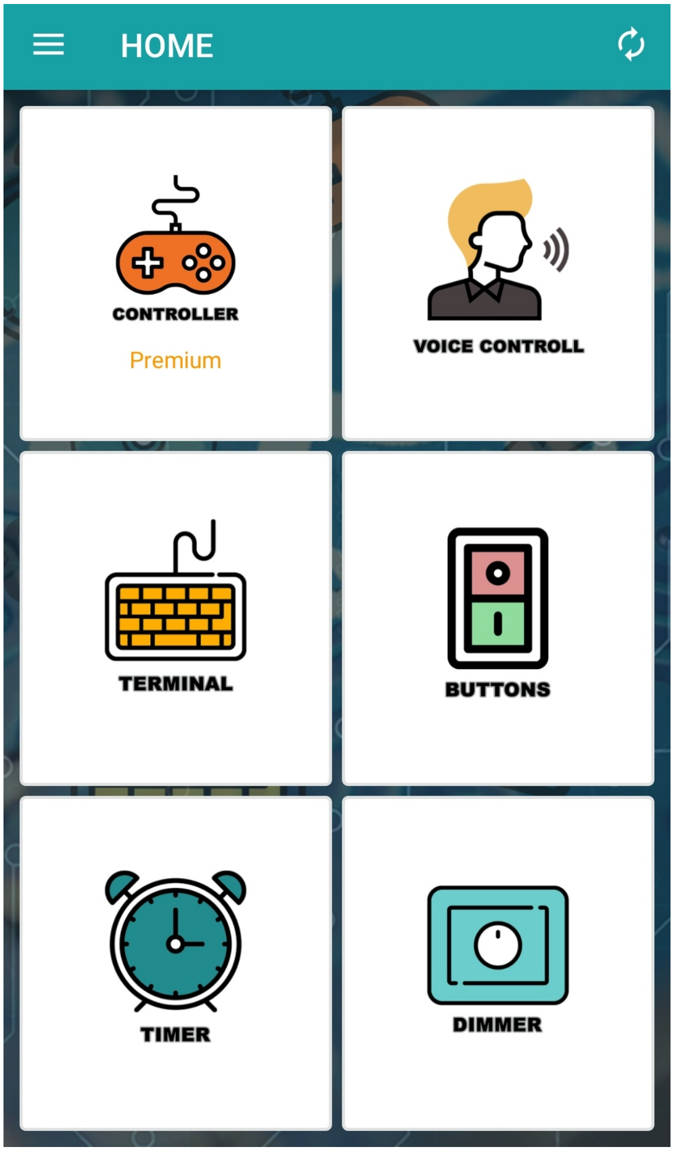

Fig. 5. Arduino Blueetoth Controller Interface

7) Now use the *Voice Control* section of the app to control the toycar.
8) The commands which the voice control takes are *Left, Right, Forward, Back & Stop*.

IV. Conclusions and Future Research

We have assembled a UGV platform and shown how it can be used for AI prototyping using an speech recognition android app in combination with an ESP32. However, this requires making function calls to a proprietary server in realtime where the actual speech recognition algorithms are being executed. The challenge is to design a micro-algorithm using a native dataset and porting the same to the ESP32, saving cost, computing resources, as well as bandwith. This will be addressed in future work.

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