Grenze International Journal of Engineering and Technology, January Issue

Implementation of Self-Cancelling Turn Indicators for Golf Carts

Prashobe Gowthami K.H[1] and Dr. S. Pradeepa[2]
[1]Power Electronics, Department of Electrical and Electronics Engineering BMS college of Engineering Bangalore, India
Email: prashobe.epe22@bmsce.ac.in,
[2]Professor, Department of Electrical and Electronics Engineering BMS college of Engineering Bangalore, India
Email: spradeepa.eee@bmsce.ac.in

***Abstract*— For convenience and safety installing self-cancelling turn signals is revolutionary. To improve traffic flow and avoid confusion for other drivers, these systems automatically turn off turn signals once a turn is completed. CAN-enabled steering angle sensors and CAN-enabled steering stalk in golf carts make it very simple to determine when a turn is completed. A microcontroller receives data from these sensors, processes it, determines whether to turn on or off the indicators, and resets the steering stalk to the neutral position. In addition to resolving present problems, these intelligent systems incorporate cutting edge technology into electric vehicles. This strategy promotes responsible driving by adhering to safety standards and rules. It makes driving safer and smoother by lowering the likelihood of turn signal failures. It also reduces the possibility that drivers would inadequately leave their turn lights on, which might confuse oncoming traffic. In addition to supporting the larger trend towards safer smarter cars, this technology increases golf cart users' convenience and safety.**

***Index Terms*— self-cancelling, steering angle sensor, steering stalk, CAN-enabled, microcontroller, turn signals.**

I. INTRODUCTION

Self-cancelling turn signal is one of the important techniques found in all automobiles to enhance the safety of drivers. Other than steering angle sensor self-cancelation can be achieved through gyroscope, position sensors, hall effect sensors, and speed sensors etc. But in this project CAN- enabled steering angle sensor and steering stalk is used. ESP32 has a 32-bit LX6 microprocessor and provides Wi-Fi and Bluetooth connectivity for embedded devices. Here ESP32 dev module is used as a microcontroller which can be used in automation and controlling applications [1-2].

To give an input to the microcontroller boards, a 12-5V DC-DC buck converter is designed. Buck converter is a step- down converter that steps down the input voltage to get a desired output voltage. The converter is designed including all the parameters with 12V as an input and 5V as an output [3].

This technology can also be integrated into two-wheeler and four-wheeler vehicles, to reduce the accidents on roads. Automation can also be achieved by using other microcontroller boards and sensors [4-5].

Control area network (CAN) protocol is used for communication purposes. It has a controller and transceiver. For communication, nodes and bus lines are important.

Grenze ID: 01.GIJET.11.1.16_1

CAN needs at least two nodes and two bus lines called CAN-H and CAN-L for communication. Nodes can be any devices that can send and receive the CAN messages when connected to the bus. Bus line is the medium through which the data can be transmitted between nodes. For this project, MCP2515 CAN module is used for CAN communication [6].

II. ESP32 DEVKIT MODULE OVERVIEW

ESP32 DEV Module is a versatile development board ideal for embedded systems, home automation and IOT (internet of things). It has a strong dual core processing, integrated Wi- Fi and Bluetooth module and has a several GPIO pins for connecting sensor and other devices. It supports SPI, I2C, I2S, UART, and PWM communication protocols.

III. METHODOLOGY

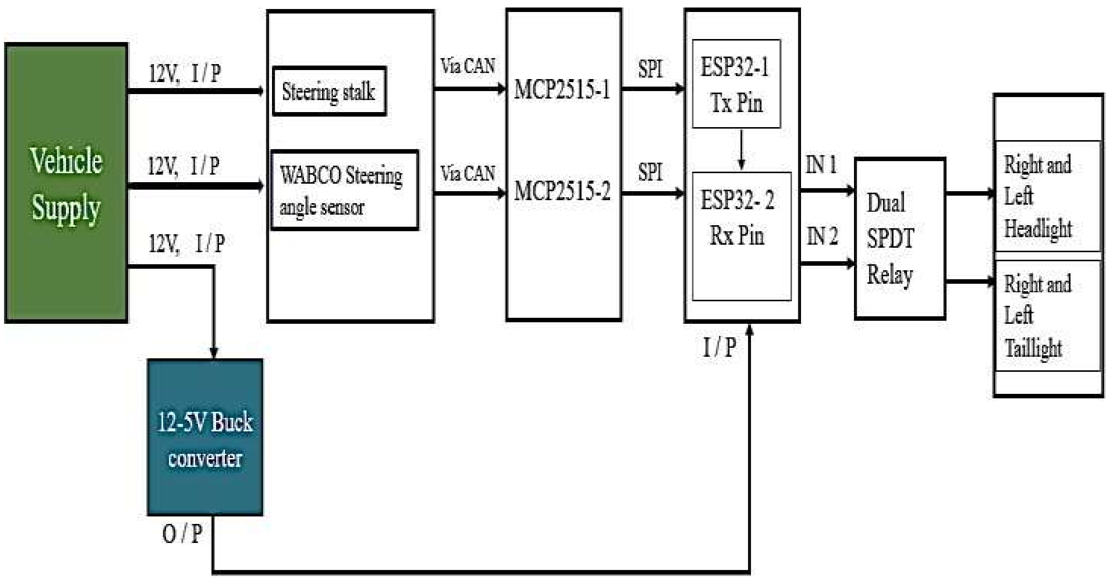


Figure 1. Block diagram that integrates with vehicle

Fig.1 shows the block diagram of the project that integrates with the vehicle. It includes 12V input supply from the vehicle, 12-5V buck converter, steering stalk, WABCO steering angle sensor, two MCP2515 CAN module, two ESP32 DEV module as a microcontroller, SPDT relay, right and left front headlight and taillight from the vehicle and connecting wires. Taking the vehicle DC-DC buck converter 12V output as an input and connecting that to 12- 5V buck converter, steering stalk, wabco steering angle sensor and relay common pin, that gives power to all these devices. The steering stalk and wabco steering angle sensor operate on 12V input. 120ohm terminating resistor should be connected across the CAN-H and CAN-L lines to avoid the signal reflection and to reduce the noise during the CAN communication. When the steering stalk is actuated upwards, both the right headlight and taillight will turn on. We must rotate the steering wheel to the right side, after the completion of the turn when the steering wheel comes back to neutral position both headlight and taillight will turn off. When the steering stalk is actuated downwards, both left headlight and taillight will turn on. Now we must rotate the steering wheel to the left side, after the completion of the turn when the steering wheel comes back to neutral position both headlight and taillight will turn off.

IV. SIMULATION

To achieve the simulation for this project, the simulation is done in Wokwi software by using C language. It supports and offers a solution for microcontrollers like Arduino, ESP32, Raspberry Pi Pico etc., It has an inbuilt library, that supports virtual circuit creation and testing by selecting the necessary components from their library. For the simulation, instead of using the steering angle sensor, I have used potentiometer because steering angle sensor cannot be integrated in this software. The simulation circuit consists of a potentiometer, ESP32, two

LED's, two resistors, and an OLED display. The ground (GND) pin of potentiometer is connected to ground of ESP32, wiper pin is connected to GPIO pin 35 of ESP32. VCC is connected to 3.3V of ESP32. Two LEDs represent the left and right indicators. The left LED anode pin is connected to pin number 19 of ESP32 through a resistor. The right LED anode pin is connected to pin number 18 of ESP32 through a resistor. The OLED display is used to display the turn signal which has four pins. Fig. 2 Shows the algorithm for the simulation of the project. The first step is to configure the LEDS and OLED display. After initializing the OLED, it will display "Self-cancelling turn indicators" for five seconds. If it is not initialized properly the program will end. The software reads the potentiometer value in the main loop. The rotation value is set for 0-100. When the value is >70, the right LED is turned ON and it displays "Right turn" in OLED display for 500ms. When the value is <30, the left LED is turned ON and it displays "Left turn" in OLED display for 500ms. When potentiometer wiper is in neutral position both the LEDs are in an off position. After making the connection as per the circuit, the code is uploaded to check the working of the project.

A. Output of simulation

From Fig. 2 when potentiometer rotation is >70 Right LED is turned ON and Fig. 3 shows when potentiometer rotation is <30 Left LED is turned ON.

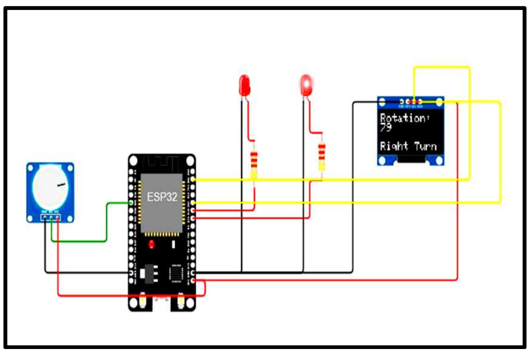


Figure 2. Right turn is displayed in OLED display

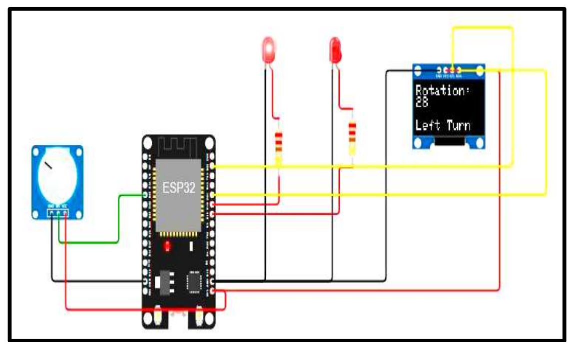
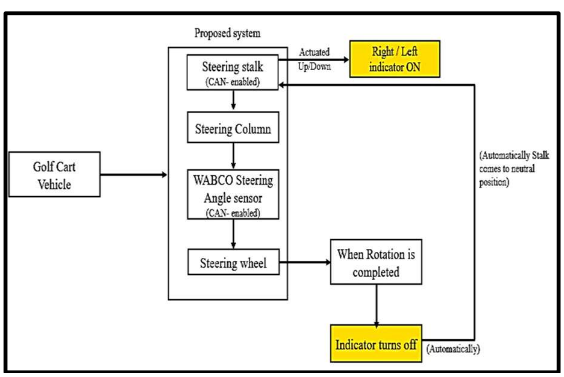


Figure 3. Left Turn is displayed in OLED display

V. EXISTING SYSTEM

The existing system in the Golf-Cart vehicle does not have the self- cancellation feature, only manual cancellation exists. When the steering stalk is actuated, and after the turn is completed, it requires the user to cancel the turn manually. Fig. 4 is the existing system present in the Golf vehicle.



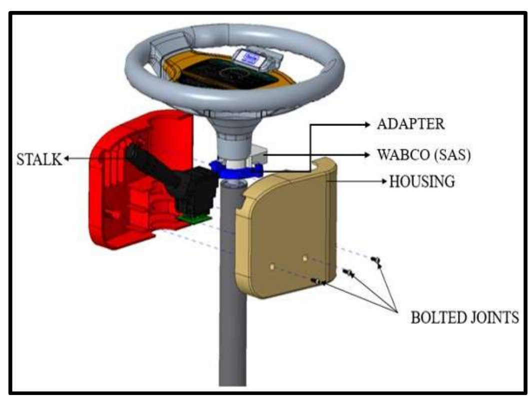


Figure 5. Proposed system for golf vehicle

VII. HARDWARE DESIGN AND PROGRAMMING FOR ESP32

Fig. 6 shows the PCB board design of the project. It includes all the components on a single board. It consists of 12-5V buck converter, two MCP2515 CAN bus controller module, two ESP32 development boards and a Dual SPDT relay. From the vehicle 12V supply the 12-5V converter, sensor and stalk are powered up.

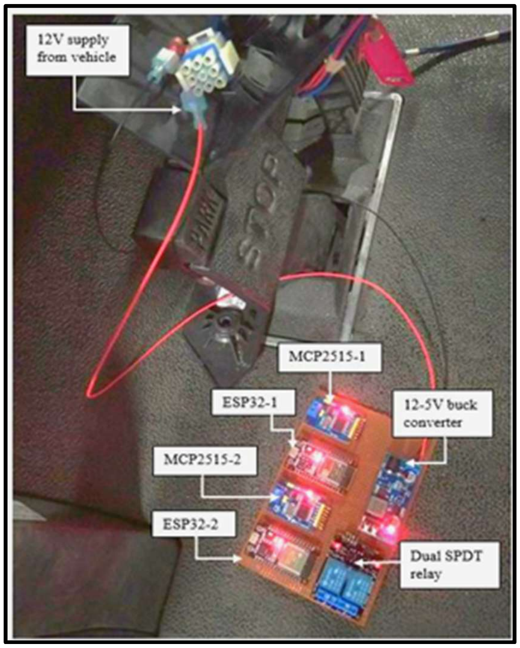


Figure 6. PCB board

Step 1: - Start

Step 2: - Initialization

-Include the SPI and MCP2515 library

Step 3: - Define variable

-Set CS pin to 5

Step 4: - Setup Function:

-Initialize serial communication

-Initialize SPI communication

-Reset the MCP2515 CAN controller

-Set the CAN bitrate to 500 kbps and 8 MHz clock

-Set the MCP2515 to normal mode for operation.

Step 5: - Convert an unsigned integer value to a hexadecimal

Step 6: - Loop Function:

-Continuously check if a CAN message is receiving

-if received message is MCP2515::ERROR_OK

-Convert the second byte of CAN messages into hex decimal

-Convert hex decimal string to decimal integer

-Print the decimal integer

Step 7: - End

Figure 7. Algorithm for transmitter side

The output of 12-5V buck converter is connected as an input for ESP32 boards. The ESP32 GPIO pin 25 and 26 are connected to IN1 and IN2 of dual SPDT relay. The SPI pins of MCP2515-1 CAN module are connected to ESP32-1 GPIO pins similarly the MCP2515-2 CAN module are connected to ESP32-2 GPIO pins. Where steering stalk, MCP2515-1, ESP32-1 modules act as a “transmitter” and steering angle sensor, MCP2515-2, ESP32-2 modules act as “receiver”. Fig.7 shows the algorithm for transmitter side. Fig. 8 shows receiver side algorithm of sensor calibration and final algorithm to check the working of the project.

Step 1: - Start

Step 2: - Initialization

-Start serial communication at 115200 baud

-Initialize SPI communication with the MCP2515 CAN controller

-Reset the MCP2515

-Set the MCP2515 to normal mode

Step 3: - Main Loop

-State = idle

Step 4: - Idle state

Step 5: - State= Calibration 1

Step 6: - State = Wait 1

Step 7: - State= Calibration 2

Step 8: - State = Wait 2

Step 9: - State = Done

Step 10: - End

Figure 8. Algorithm for calibration of sensor

Step 1: - Start

Step 2: - Initialization:

-Include the SPI library

-MCP2515 library

-Standard library

Step 3: - Define Variables

-Canmsg

-mcp2515

-angle, max angle, min angle, stalk Position

-Led Right, Led Left

-Indicator State, Indicator Start Time

Step 4: - Function

-Combine Bytes Function

-Bytes To Hex Function

Step 5: - Main Loop

-Read Stalk Position

-Print Stalk Position

-Read and Process CAN Data

-Update Angle Limits

Control Indicators:

-Stalk Position == 1: Left ON

-Stalk Position == 2: Right ON

-Stalk Position == 0

- max_angle > 40 and angle <= 40: Left OFF
- min_angle < -40 and angle >= -40: Right OFF
- angle between -40 to 40: Turn OFF both lights

Step 6: - End

Figure 8. Final receiver side algorithm

VIII. Results and Discussion

There were some difficulties in integrating the CAN-enabled parts into the existing vehicle like ensuring the compatibility with the golf cart's design was one of the main issues encountered during the integration of the CAN-enabled components into the golf cart's current electrical system. The automatic cancelation feature removed the need to manually turn off the indicators following a turn, by drivers. A more efficient driving experience was made possible by testing and integrating the parts into the vehicle. From Fig. 9 Transmitter side testing includes steering stalk, MCP2515-1 and ESP32-1. The results are shown in Fig. 10. The CAN ID of steering stalk is 0x4D0 which is in hexadecimal and data length is 8bytes. In 8bytes it has D0 to D7 bits data, the stalk actuation data is received in D1 bit. When the steering stalk is actuated up it sends “2”, in data bit of D1 which turns on the right headlight and taillights indicators on the vehicle. In the same way when the stalk is actuated down it sends “1”, in D1 data bit which turns on the left headlight and taillight on the vehicle. Similarly, when the stalk is in neutral position it sends “0” in D1 bit where both the lights are in off position. Fig. 11 shows Receiver side testing includes wabco steering angle sensor, MCP2515-2 and ESP32-2. The results are shown in Fig. 12 before calibration of sensor the data received is in hexadecimal number. The CAN ID is 0x20 and data length is 5 bytes. Each bit is in hexadecimal number. The first two hexadecimal bits represents the angle. When the sensor is calibrated and rotated anticlockwise or clockwise direction it reads left or right angles as shown in Fig. 13 and Fig. 14. Fig. 15 shows the SPI pin connection of MCP2515 CAN module to GPIO pins of ESP32.

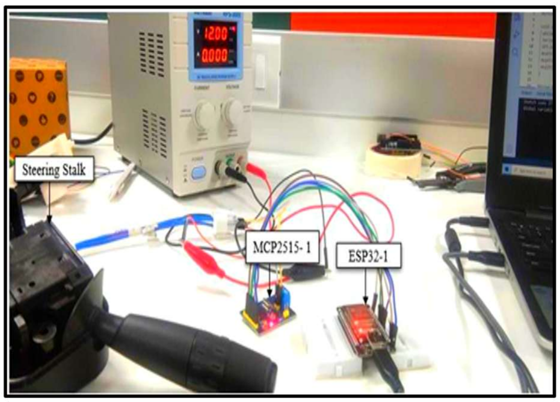


Figure 9. Transmitter side testing

20:01:30.059 -> CAN ID: 0x4D0
20:01:30.059 -> DLC: 8
20:01:30.091 -> Data: 0 2 0 0 0 0 0 0

20:01:31.074 -> CAN ID: 0x4D0
20:01:31.107 -> DLC: 8
20:01:31.107 -> Data: 0 0 0 0 0 0 0 0

20:01:32.084 -> CAN ID: 0x4D0
20:01:32.108 -> DLC: 8
20:01:32.108 -> Data: 0 1 0 0 0 0 0 0

Figure 10. Results of transmitter side testing

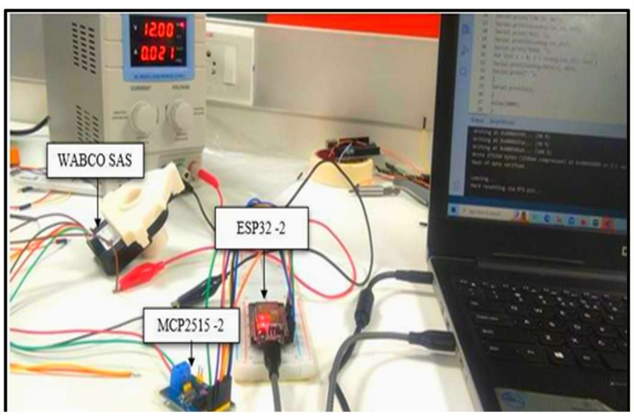


Figure 11. Receiver side testing

Received CAN Message:
CAN ID: 0x20
DLC: 5
Data: 1D FC 0 7 19

Received CAN Message:
CAN ID: 0x20
DLC: 5
Data: 1D FC 0 7 5D

Received CAN Message:
CAN ID: 0x20
DLC: 5
Data: 1D FC 0 7 91

Figure 12. Results of receiver side testing

CAN ID: 0x20 5 Data: C3 FD 1F 7 51	Left Turn Angle is: -57.30
CAN ID: 0x20 5 Data: 9D FD 0 7 EF	Left Turn Angle is: -61.10
CAN ID: 0x20 5 Data: B FD 34 7 9	Left Turn Angle is: -75.70
CAN ID: 0x20 5 Data: A FD 2 7 3E	Left Turn Angle is: -75.80
CAN ID: 0x20 5 Data: 9 FD 2 7 97	Left Turn Angle is: -75.90

Figure 13. Results of Left turn angle after calibration

```
CAN ID: 0x20 5 Data: B3 1 0 7 97     Right Turn Angle is: 43.50
CAN ID: 0x20 5 Data: 12 5 0 7 10     Right Turn Angle is: 129.80
CAN ID: 0x20 5 Data: 88 4 0 7 FC     Right Turn Angle is: 116.00
CAN ID: 0x20 5 Data: 8E 3 0 7 8A     Right Turn Angle is: 90.00
CAN ID: 0x20 5 Data: D5 3 22 7 F3    Right Turn Angle is: 98.10
```

Figure 14. Results of Right turn angle after calibration

Connections:

MCP2515 → ESP32

SCK → D18
SI → D23
SO → D19
CS → D5
GND → GND
VCC → 3.3V

Figure 15. MCP2515 to ESP32 SPI connection

IX. CONCLUSION AND FUTURE SCOPE

Self-cancellation of indicators is achieved in Golf carts, by using the simple and basic electronic components. Even though this is an existing technology found in modern vehicles, it is done in a unique way by using development boards and CAN modules which reduces the manual cancellation. This project may fail if there is any malfunctioning in the sensor or in any other component. If it happens replace the components and connect them in the same procedure and program it that will work. In future this technology on the vehicle can be upgraded with artificial intelligence, that integrates with the Advanced driver assistance system (ADAS). Through the integration of GPS data, turn completion times may be predicted according to driving speed and route. After the turn is completed, the system may immediately disable the turn signal reducing the risk of manual cancellation. It may use the Internet of Things to connect to map providers in addition to predicting traffic congestion on new routes. In addition to the system, the cloud will offer information on the archive's driving patterns. In the event of an injury, providing information to the neighbourhood police or ambulance service may also be beneficial.

REFERENCES

[1] Shuvabrata Dey, Tulip Bera “Design and Development of a Smart and Multipurpose IoT Embedded System Device Using ESP32 Microcontroller” 2023 International Conference on Electrical, Electronics, Communication and Computers (ELEXCOM).

[2] Ankit Koushal, Rahul Gupta, Farman Jan, Kamaldeep, Vikram Kumar “Home Automation System Using ESP32 and Firebase” 2022 Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC).

[3] Sairatun Nesa Soheli, Ummay Shabrina Aney, Shahidul Islam Mahmud “Designing A Highly Effective DC-DC Buck Converter for Sustainable Electronic Applications” 2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST).

[4] C. Kaushik, Chaitna Sri Koganti, Vaddi Sowmya Sree “Automatic Turn Indicating System Using Smart Turn Signal Circuit in Motorcycles” 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC).

[5] Mithun M. S., Utpol Tarafdar and Hemanth Sankar P. “A New Auxiliary Steering Angle Sensor for Power-Steering in Four-Wheelers” 2021 IEEE 5th International Conference on Condition Assessment Techniques in Electrical Systems (CATCON).

[6] Rachana Khamamkar, Ashru Jadhav, Shreyas Thoke, Prof. Girish Chaple “Smart Vehicle Safety Monitoring System Using CAN Protocol 2018 IEEE Punecon.