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INDOOR NAVIGATION SYSTEM

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Abstract: Most of the time, due to the failure of the GPS in indoor locations, the accuracy of navigation and guidance will be very poor which in turn provides inaccurate and biased results. This project proposes a novel solution leveraging ESP8266 devices and RSSI technology to achieve accurate and real-time positioning within indoor environments. By deploying ESP32 device strategically, including a Bluetooth module, MPU 6050 mounted on a car and fixed nodes mounted on walls, the system measures signal strength and calculates distances using RSSI to navigate the car to the desired location.

Keywords: Global Positioning System (GPS), Received Signal Strength Indicator (RSSI), Espressif (ESP8266), Bluetooth, Magnetic Pick Up (MPU).

I. INTRODUCTION

In today's interconnected world, navigation technology has become an integral part of our daily lives. From GPS systems guiding us on the open road to location-based services helping us find the nearest restaurant, navigation technology has revolutionized the way we move through the world. However, one significant challenge remains: how do we navigate accurately within indoor spaces where GPS signals often falter or fail to penetrate?

Indoor navigation is a formidable challenge, and the limitations of GPS technology in such environments necessitate the development of innovative solutions. Indoor navigation system will often rely on the alternative technologies like WI-FI Positioning, Bluetooth beacons, or inertial navigation sensors to overcome the GPS limitations. These systems will typically involve mapping indoor places and various sensors to track the object movements. This project sets out to tackle this issue by creating an Indoor Navigation System using ESP8266 technology. By utilizing a combination of hardware and software, this system offers the promise of reliable and precise indoor navigation, providing users with the same level of guidance they've come to expect outdoors.

II. LITERATURE REVIEW

The paper [1] proposes a design of a mobile augmented reality-based indoor Navigation System. In this paper, research and comparisons were done to determine the appropriate techniques of indoor positioning, pathfinding, and route guidance for an indoor navigation method. The aim of this project is to present a simple and cost- effective indoor navigation system. The proposed system uses the existing built-in sensors embedded in most of the mobile devices to detect the user location, integrates with AR technology to provide user an immersive navigation experience. In this project, an indoor navigation mobile application was developed and tested. The development demonstrates the usage of Indoor Atlas which enables indoor positioning through technology fusion to detect user's position and obtain the route to destination, and AR Core to display.

The paper [2] proposes development of Ontology-Based Indoor Navigation Algorithm for Indoor Obstacle Identification for the Visually Impaired, In this paper, an ontology-based indoor navigation algorithm is introduced for the detection of indoor obstacles. It has been adapted to meet the requirements of people with visual impairment, achieving trajectory prediction while supporting accurate route planning and alerting the visually-impaired user to the presence of obstacles.

The paper [3] proposes Optimization of map matching algorithms for indoor navigation in shopping malls. Maps used in car navigation systems differ from indoor maps due to the fact that they were designed to address different needs. Therefore, map matching techniques used for outdoor navigation cannot be applied indoors without significant modifications. The main aim of this paper is to present modified map matching algorithm for special usage such as indoor navigation in shopping malls, hotels and airports.

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There search concentrates to improve accuracy of positioning engine and natural presentation of pedestrian trajectory. The article includes the indoor map matching algorithm proposals, with the highlights of their strengths and weaknesses.

The paper [4] proposes a trust-based system which process social network information and models it into a trust network. By extracting corresponding trust-related parameters of social network data, a network structure has been implemented. Afterwards a Bayesian Belief Network (BBN) was constructed.

The system was evaluated by performing a personal recommendation survey. Trusted Network filter as well as the Most Untrusted Nodes filter plugin was utilized in the evaluation process to assess real Facebook data. Results show that the system has a high accuracy. The main limitation identified is that “human factors” could not be measured through such a computerized system, which is a key factor that affects 'Trust'.

III. PROPOSED WORK AND OBJECTIVES.

In the above system, an ESP8266 device is positioned at the corner of the room or indoor space, with power supplied either by a power adapter or a battery. As the transmitter is situated at the corner, the coordinates of the placed transmitter will be basically taken as (0,0) which represents the X and Y coordinates of the room.

The RSSI concept utilizes the known coordinates of known transmitter to determine real-time location of the robotic car in the indoor space while the part of this concept is executed by the ultrasonic sensor.

The robotic car, equipped with a motor driver, MPU 6050, DC motors, and wheels, incorporates an ESP8266 receiver. This receiver acquires the data and interacts with the motor driver, allowing the robotic car to move to the provided target location. Code is developed for car movement, while the compass module assists in car orientation.

STEP 1: Setting up the development environment which includes installing Arduino IDE Software for ESP8266 programming.

STEP 2: Developing a code using RSSI technology to calculate distance between transmitter and receiver.

STEP 3:Connecting the motor driver to the ESP8266 receiver and implementing the code to control the motors based on sensor reading

SETP 4:Integrating the compass module to ESP8266 receiver and developing a code to read data from compass module

STEP 5:Connecting 5V battery or power adapter to Arduino board ensuring it meets voltage and current requirements

STEP 6:Arduino board supplies the received power to all the components based on their voltage requirements

STEP 7:Conecting the ESP8266 to the android bluetooth terminal app using Bluetooth module

STEP 8:After succesfull connection,the initial car position coordinates will be shown on bluetooth terminal app.

STEP 9:The targeted position coordinates will be given on bluetooth terminal app

STEP 10:Based on coordinates given by the user the robotic car will move to the targeted location.

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IV. BLOCK DIAGRAM

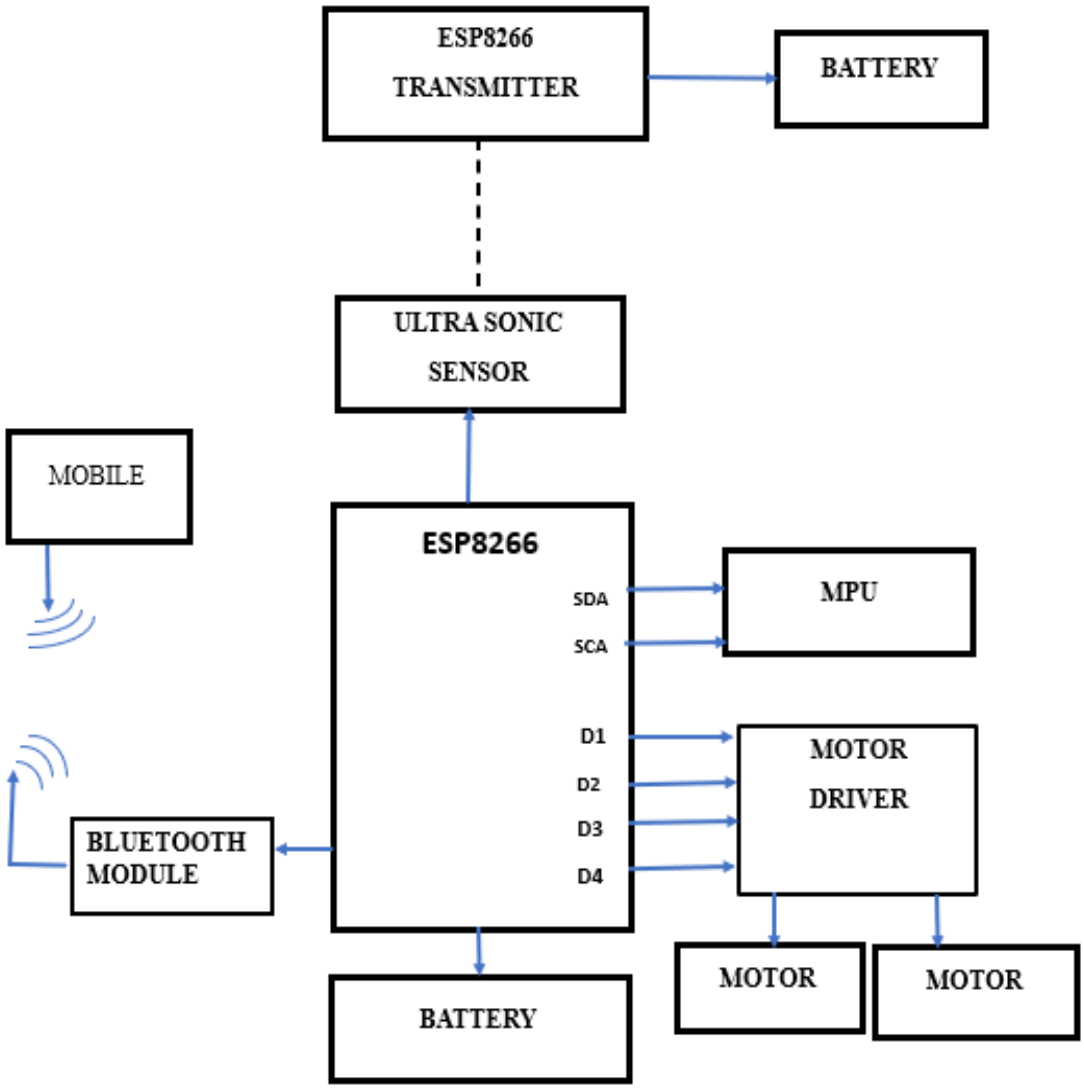

Fig 1: Block Diagram of the proposed solution

The system consists of an ESP8266 transmitter and receiver communicating wirelessly via Wi-Fi. The ESP8266 transmitter is powered by a battery. The ESP8266 receiver, also battery-powered, connects to a Bluetooth module for communication with a mobile device, an ultrasonic sensor for obstacle detection, and an MPU motor driver that controls the motors. The mobile device communicates with the receiver's Bluetooth module, allowing for remote control and data exchange. The ultrasonic sensor sends obstacle data to the receiver, which processes the information and commands the motor driver to control the motors accordingly

V. HARDWARE REQUIREMENTS

i. ESP8266 MICROCONTROLLER:

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ESP8266 Is a single core microcontroller with Wi-Fi and Bluetooth 5. It is based on the open- source RISC-V architecture. The presence of the both Wi-Fi and Bluetooth 5 connectivity not only make device configuration easy but also facilitates a variety of use-cases based on dual connectivity.

Wi-Fi and Bluetooth with having long range support will help in building devices with great coverage.

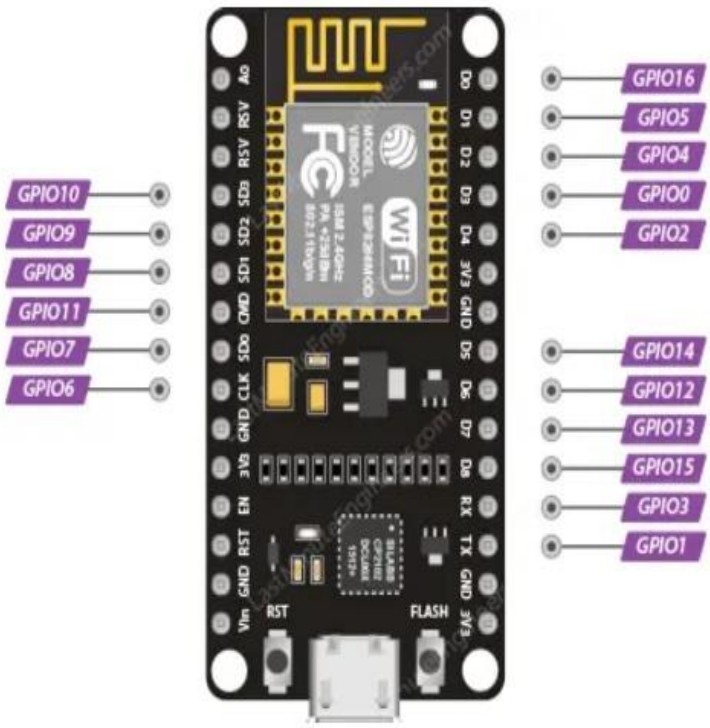

Fig 2: ESP8266 Microcontroller

ii. MOTOR DRIVER:

Figure 3: Motor driver

Motor driver is an integrated circuit chip that is used to control motors in autonomous robots and embedded circuits. Motor driver controls the direction of motor based on the commands or instructions received from the controller.

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iii. MPU 6050:

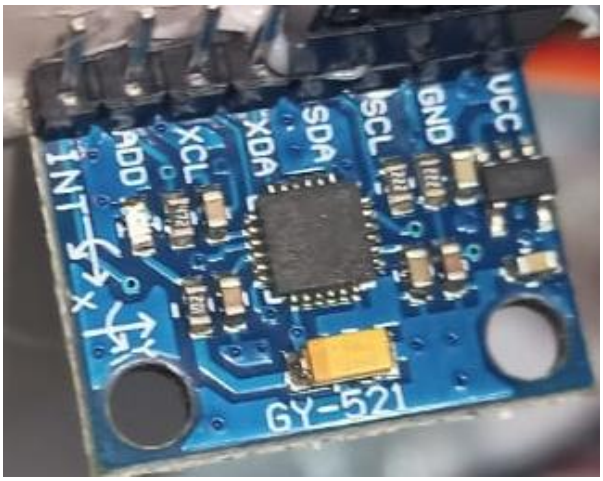

Figure 4: MPU 6050

MPU6050 and it is an IMU device that stands for Inertial Measurement Unit. It is a six-axis motion tracking device that calculates a three-axis accelerometer and three-axis gyroscope data. This MPU 6050 is a sensor that helps to determine the orientation or direction of the robotic car movement within a building or enclosed space.

iv. DC MOTOR:

Figure 5: DC Motor

Motor is a device which converts the electrical energy into mechanical energy through the interaction of magnetic fields and the electric current. Motors will operate on the principles of the electromagnetism, utilizing coils and magnets to create force and rotation. DC motors are majorly found in battery-powered devices and many automotive Application.

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v. JS-SR04T ULTRASONIC SENSOR

Figure 6: DC Motor

A waterproof ultrasonic sensor module, such as the popular JSN-SR04T, is a robust and reliable device designed for distance measurement in challenging environments. Unlike standard ultrasonic sensors, the waterproof design allows it to function effectively in wet or humid conditions, making it ideal for outdoor applications. The sensor emits high-frequency sound waves and measures the time it takes for the echoes to return after bouncing off an object, calculating the distance based on this time interval. This technology is widely used in applications such as level sensing in tanks, obstacle detection in autonomous vehicles, and distance measurement in marine environments. The sensor's ability to provide accurate readings in harsh conditions enhances its versatility and utility in various industrial and commercial settings

vi. HC-05 BLUETOOTH MODULE:

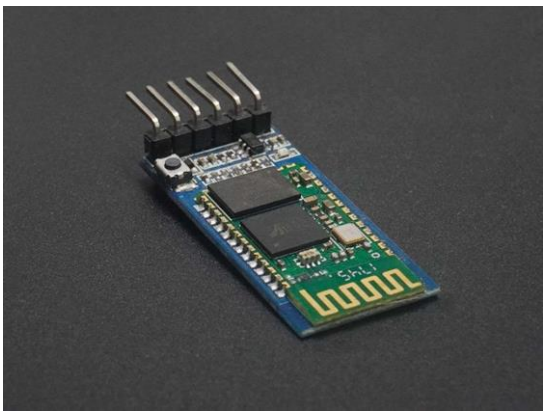

Figure 7: HC-05 Bluetooth Module

HC-05 is a Bluetooth module which is designed for wireless communication. Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

To communicate smartphone with HC-05 Bluetooth module, smartphone requires Bluetooth terminal application for transmitting and receiving data. This Bluetooth terminal application for android and windows are available in respective app store.

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VI. SOFTWARE FLOW OF THE PROPOSED SYSTEM

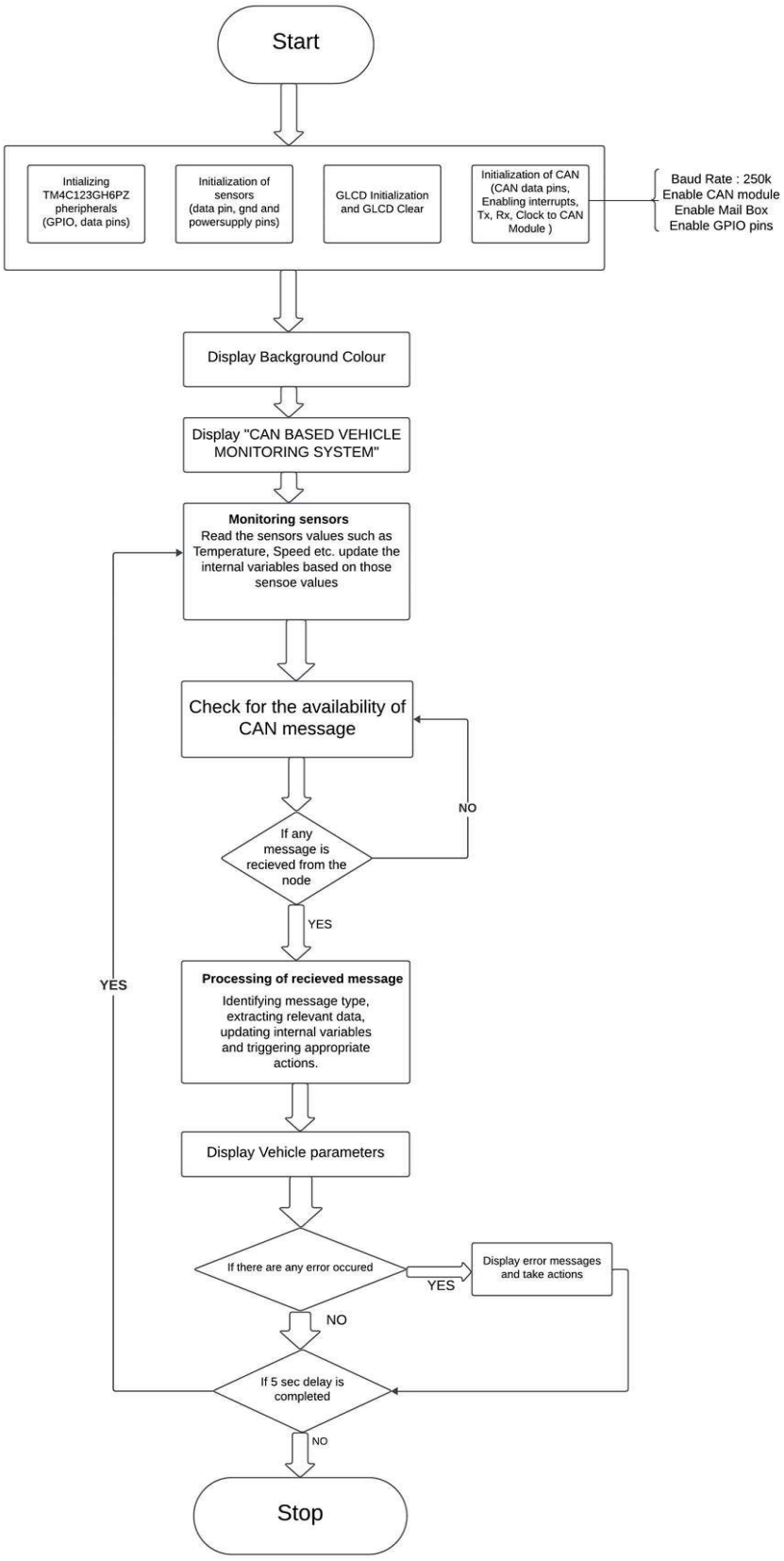

Fig 8: Software Flow of the system

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VII. CONCLUSION

In this paper, the algorithm described is: RSSI (Received Signal Strength Indicator). The first innovation is the construction of the car and developing code for the car, the final innovation is navigating the car to the target location with the help of the RSSI algorithm and the ultrasonic sensor. Both RSSI algorithm and ultrasonic sensor are used in order eliminate the problem we have faced while navigating the car as there was 92% usage of the memory even before the completion of the project and to their ease of implementation and high accuracy.

To this date, there are no universal systems for indoor navigation, nor is there an approach for developing such systems. An even more serious challenge is to find a way to navigate moving object. This report proposes method for creating an indoor navigation system, hence with the help of all the innovations mentioned above the navigation for the robotic car will be successfully implemented with high accuracy.

In this paper, the 2-D model of the navigation system which uses a transmitter and an ultrasonic to move the robotic car to the target location based on X-Y Co-ordinates has been completed and has been successfully designed.

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