Bluetooth beacon based indoor navigation for campus.

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ABSTRACT

The paper proposes a solution to the issue of visitors and students being unable to find their way on a campus due to the unavailability of receptionists or security. The proposed solution involves installing BLE beacon transmitters in various locations on the campus and using a BLE Terminal app on a smart phone or tablet to route users from their initial location to their required destination. The paper also highlights the advantages of using BLE beacons over GPS, particularly indoors where GPS signals may be blocked and less accurate. BLE beacons use low-energy Bluetooth connections to transmit messages directly to a smartphone or tablet, allowing for more precise tracking of a user's location. It suggests that this technology could also be used in a retail setting to target consumers with personalized messages, and that it could be implemented in schools and colleges to benefit visitors and students during examinations. Finally, it mentions that the solution involves embedded systems using Bluetooth technology with controllers that perform specific tasks. Bluetooth Low Energy is explained as a wireless personal area network technology that is designed for low energy consumption and cost, while maintaining a communication range like that of its predecessor, Bluetooth. BLE beacons are also noted as being inexpensive, accurate, simple to deploy, and supported by most mobile operating systems.

Keyword: - *BLE – Bluetooth low energy*

1. INTRODUCTION

1.1 OVERVIEW

Bluetooth beacons are small radio transmitters that use BLE to broadcast signals, which can be detected by nearby devices, such as smartphones. These beacons do not require an internet connection and can act as an intermediary device to guide users to their destination. BLE beacons are popular due to the widespread usage of Bluetooth-compatible devices, such as smartphones. The reliability, low energy consumption, and deployment constraints of BLE beacons are discussed to identify research opportunities and directions. The proposed system aims to use Bluetooth technology and an embedded system for routing visitors and students in a campus or examination center. The system is designed to overcome the risks and issues associated with traditional methods, such as interaction with guides, language barriers, inaccurate information, and network issues with GPS and 4G-5G connectivity.

The main objective is to implement a Bluetooth beacon-based solution for routing that can guide users accurately and efficiently without the need for an internet connection.

1.2 BASIC CONCEPTS

Bluetooth Low Energy (BLE) technology is used for beacon registration and identification of necessary information at the external device based on MAC address. BLE is available for all new smartphones and has various fields of

application, including advertisement and retail. In these applications, users can receive information about discounts and promotions when passing a store or coming near a certain department. BLE can also be used for indoor positioning systems and university wireless infrastructure development. The project described aims to provide a solution for campus tours where visitors can use their own smartphones to receive guided information about highlighted places on the campus. The use of BLE beacons allows the campus locations to "talk" and demonstrate themselves to visitors.

2. METHODOLOGY

The Fig -1 shown below explains the complete flow of the methodology along with the objectives.
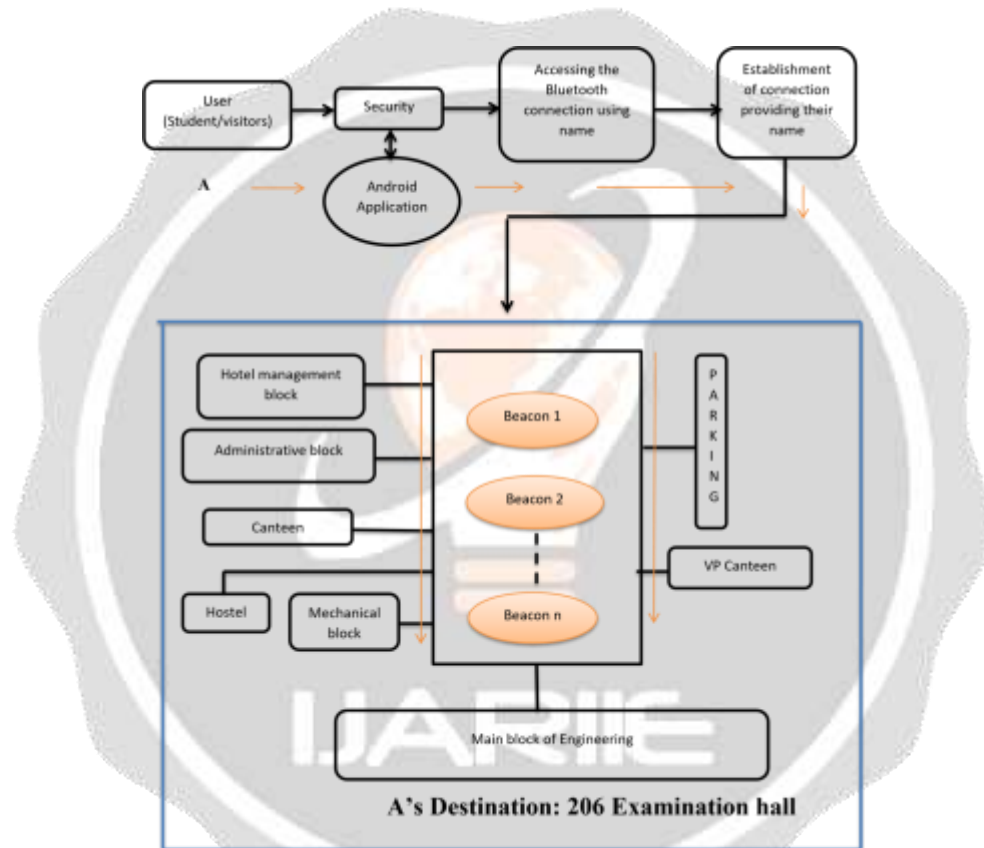
Fig -1: Methodology

The above figure describes a scenario where a user named A visits the security for an enquiry and is guided to their required destination using the Smart College Routing System. To begin with, the user is asked to install the required Android app and gets logged into the BLE Terminal by providing their name. The destination is intimated to the security, who presses the corresponding button, causing the LED to glow and store the names in the memory for record. After the connection is established with the Bluetooth device using the Smart or Android phone, the user's Bluetooth gets connected to the nearest Bluetooth beacon, which creates a path and displays the destination in their personal device. The Bluetooth beacons guide the user towards their destination by automatically connecting to the next Bluetooth beacon in the path and redirecting the user if they are getting on the wrong path.

It also mentions that the Bluetooth beacons can be charged using a normal AC power supply of low voltage, and in case of power cuts, a temporary battery can be used. Overall, the proposed system is designed to help users navigate indoor locations easily and efficiently using Bluetooth technology.

Fig -2: Campus Navigation

2.1 MODULE EXPLANATION

This module discusses the use of Bluetooth technology, specifically Bluetooth low energy (BLE) beacons, in an embedded system. The system utilizes beacons to track the locations of individual blocks or rooms and transmit messages or prompts directly to a tablet or smartphone via a low-energy Bluetooth connection. The system is intended to enhance people's lives and potentially create a new market for retailers to better target consumers. The inbuilt Bluetooth module in ESP 32 is used in the system to wirelessly communicate with a mobile phone.

3. SOFTWARE AND HARDWARE

3.1 SOFTWARE

The software that is used for the implementation are:
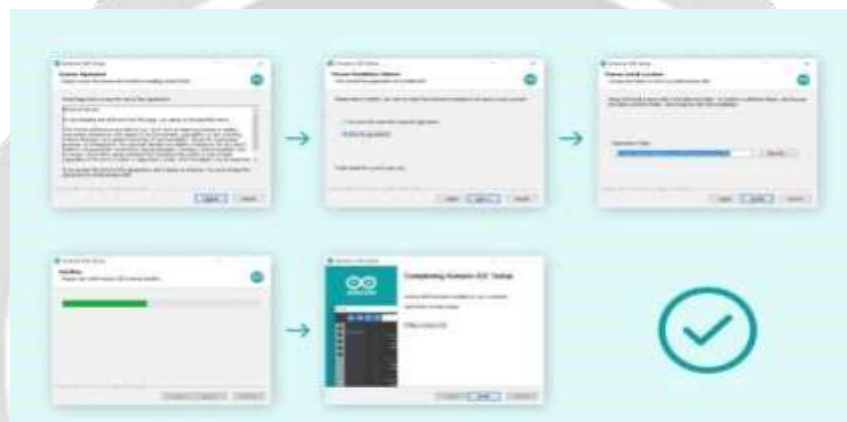
- Arduino IDE
- C Programming language
- Java Script

3.1.1 Arduino IDE

The Arduino IDE is a software application used to write and upload code to Arduino boards. It is open-source and compatible with various operating systems, such as Windows, Mac OS X, and Linux. The programming languages supported by the IDE are C and C++. To use the Arduino board, it is connected to a computer via USB, where it interfaces with the Arduino development environment (IDE). The user writes the Arduino code in the IDE and then uploads it to the microcontroller, which executes the code and interacts with various inputs and outputs, including sensors, motors, and lights. Arduino boards are programmed using a c/c++ "dialect," meaning most c/c++ code will work, but not all standard libraries will be compatible. The Arduino Uno is programmed using the Arduino Software (IDE), which is an Integrated Development Environment that is common to all Arduino boards and can run both online and offline. The IDE contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Download the Arduino IDE

Fig -3: Arduino IDE software

Fig -4: Arduino IDE software installation steps

Fig -5: Arduino IDE editor

3.1.2 C Programming language

C is a popular programming language that is imperative and procedural, which means that programs written in C follow a sequence of steps or procedures to solve a problem. C has a static type of system, which means that variables are assigned a type at compile-time, and that type cannot be changed during runtime. In C, all executable code is contained within subroutines, which are also called functions. Function parameters are passed by value, which means that a copy of the value is passed to the function. However, arrays are passed as pointers, which means

that the function receives the address of the first item in the array. Pass-by-reference is simulated in C by explicitly passing pointers to the thing being referenced.

C program source text is free format, which means that whitespace and indentation are not significant. Semicolons are used as statement separators, and curly braces are used for grouping blocks of statements. It has a small, fixed number of keywords, including a full set of control flow primitives such as if-else statements, while and for loops. C also has a large number of arithmetic, bitwise, and logic operators such as addition, multiplication, logical OR, and bit shifting. In C, more than one assignment may be performed in a single statement, which can help to write more concise code.
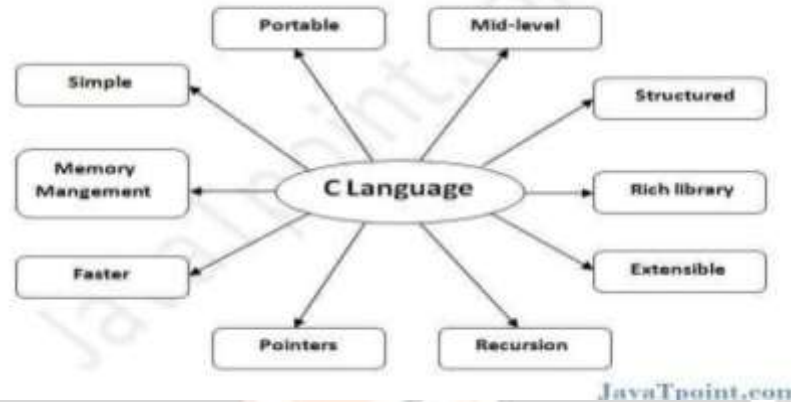

Fig -6: Structure of C

3.1.3 JavaScript

JavaScript, or JS, is a programming language that is widely used on the web, often in conjunction with HTML and CSS. It is a high-level language that adheres to the ECMAScript standard and supports dynamic typing, prototype-based object-orientation, and first-class functions. JavaScript is a multi-paradigm language that supports event-driven, functional, and imperative programming styles. It also offers APIs for working with text, dates, regular expressions, standard data structures, and the Document Object Model (DOM). JavaScript is typically executed on the client-side of a web application, and all major web browsers have a dedicated JavaScript engine for executing code on users' devices. Features of JS include:

- Scripting. JavaScript executes the client-side script in the browser.

- Interpreter. The browser interprets JavaScript code.

- Event Handling.

- Case Sensitive.

- Control Statements.

- Supports Functional Programming.

Fig -7: JavaScript logo

3.2 HARDWARE

3.2.1 ESP 32

ESP32 is a family of microcontrollers that are designed for low-cost and low-power usage. They come with integrated Wi-Fi and dual-mode Bluetooth capabilities. The microprocessors used in the ESP32 series are either a Tensilica Xtensa LX6 in dual-core and single-core variations, an Xtensa LX7 dual-core, or a single-core RISC-V. The ESP32 also includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. Espressif Systems, a Chinese company based in Shanghai, created and developed the ESP32 and it is manufactured using TSMC's 40 nm process. It is the successor to the ESP8266 microcontroller.

Fig -8: ESP 32

3.2.2 Power supply

Power Jack, 9V/12V 1A AC/DC Adaptor is a power connector into which you can plug your compatible power supply.

Fig -9: Power Jack, 9V/12V 1A AC/DC Adaptor
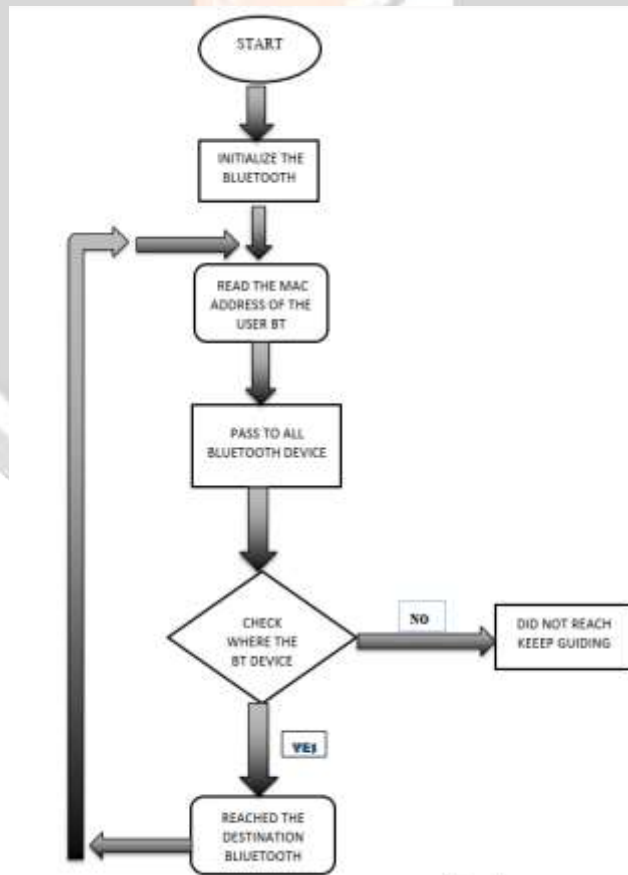
3.3 DESIGN FLOW DIAGRAM

Fig -9: Flow Diagram

ALGORITHM:

1. Collect the information of mac address of the user.

2. Send the same address to all the Bluetooth devices.

3. Start checking the mac address of present location.

4. Guide the user to reach the location of the final Bluetooth.

5. Start from the initial process and continue with the rest of the steps for the new user.

4. IMPLEMENTATION

The implementation starts by downloading the android application. The android application will guide the user to their respective destination. Campus BLE is the application name.

Fig -10: Campus BLE android application

Once the download is done the user can navigate to his desired location by entering the Source address and desination address.

Fig -11: Source and destination address

After the source and destination address are entered the user need to click navigate so that he can move towards his destination.

5. CONCLUSION AND FUTURE SCOPE
5.1 CONCLUSION
In this paper, we propose a design framework for a routing system that utilizes Bluetooth Beacon Technology. This technology is emerging and offers greater flexibility and control to the users. By using smart phones, beacons enable pinpointing of the exact location. The paper specifically describes a college campus routing system that can guide users to their destination using a smart phone or tablet. Some key features of the proposed system include the use of beacon signals to trigger notifications related to specific products or locations, the ease of installation of beacons due to their low cost and battery-powered nature, the use of low Bluetooth energy to transmit signals with a radius of 0-100 meters in open spaces (or 10 meters in the presence of obstacles) at high speeds, and the provision of accurate proximity information. The authors also highlight the potential for beacon technology to assist people in the blind community. Overall, we present a positive outlook on the future of beacon technology, given its many advantages and potential applications.

5.2 FUTURE SCOPE
The Beacon technology is predicted to be a trend in the coming years, as it offers many possibilities for developers and designers to create innovative experiences and services. This technology enables the use of sensors and controllers, which can be implemented in various settings such as shopping malls, transportation systems, airports, railways, and bus stations. This opens millions of possibilities for creating inventive services and experiences for users.

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