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IoT-Based Key Tracking System: A Smart Key Finder Solution

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ABSTRACT: The "IOT-Based Smart Key Finder System" uses IoT technology to solve the common problem of lost keys. It gives people a dependable way to find their keys using linked devices and a specific app on their phones. At its heart, this system is comprised of a small keychain-attached Bluetooth Low Energy (BLE) gadget and an accompanying mobile app. In order to manage essential tracking functions, the BLE gadget connects to the user's smartphone through a short-range, low-power connection. The system's features include a straightforward UI, proximity alarms, and real-time key monitoring. In the event that a user loses their keys, they can utilize the mobile app to send a signal that will cause the BLE device to make a unique noise or light, making it easy to find. In addition, the software shows the user how close the key is, so they can easily find it. The encryption of data transmissions between the BLE device and the smartphone demonstrates the importance of security and privacy. Users can also adjust parameters like proximity alert distance thresholds to make it work better in different scenarios.

KEYWORDS: Key, Smart key finder, Sensors, Smartphone, BLE Technology

I. INTRODUCTION

The Internet of Things (IoT) is a paradigm shift that describes a system of interconnected computing devices, appliances, cars, and other items that can gather, share, and use data through the use of embedded sensors, software, and connection. The development of more intelligent and efficient systems in a variety of fields is being accelerated by this networked ecosystem, which allows for frictionless interaction between people and machines. Sensors and actuators are the backbone of the Internet of Things (IoT), which collects data from the physical world and processes it to draw conclusions or initiate automatic processes. Depending on sensor readings, these actions can include anything from remotely operating devices through mobile applications to altering ambient settings. Improving operational efficiency and productivity across sectors is one of the main benefits of the IoT. Organizations may optimize their operations, reduce downtime, and save costs with the help of IoT solutions that enable real-time monitoring and predictive maintenance. For instance, by keeping tabs on soil moisture and weather conditions, IoT sensors help improve irrigation schedules in agriculture. This way, resources can be conserved while crop yields are maximized.

II. RELATED WORK

The literature review encompasses various aspects, including existing technologies, challenges addressed by similar projects, and the state-of-the-art in key tracking systems.

According to this study [1] Internet of Things (IoT) Smart Child Safety-Tracking Device E Kusuma Kumari, K N H Srinivas, S Murugan, M Nandini Priyanka, and T D S Sarveswararao. As the number of reported crimes involving children continues to rise, there is a significant need to address the issue of child protection and tracking. With this goal in mind, we created an Internet of Things (IoT) gadget to assist parents keep tabs on their kids and make sure they're safe. An embedded C-programmed Link It ONE board interfaces with temperature, heart rate, touch, GPS, GSM, and digital camera modules, among others, to create the system.

Published in this article [2] Bluetooth Low-Energy Technology Authentication Key Finder Design Using Bluetooth and a microprocessor, the key finder is a tiny PCB board. The microcontroller and Bluetooth module are the main parts.

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Because of its immense power, the AVR microcontroller is capable of driving a plethora of other components. Many additional devices can be enhanced with this technology.

A. S. M. Rubayet, M. M. Rahman, et al. (2016) presented a BLE-based tracking device for keys. The study [3] evaluates the effectiveness of BLE in providing reliable tracking, discussing the challenges related to signal range and interference. The findings support the feasibility of using BLE for developing practical key finder solutions, highlighting its potential in reducing the inconvenience of lost keys.

S. S. Goh, M. S. Ariffin, et al. (2018) discussed the comprehensive design and implementation of a smart key finder system. This paper [4] highlights the integration of BLE technology with a user-friendly smartphone application, offering both audible alerts and GPS tracking features to assist users in locating their keys. The system's effectiveness, reliability, and user interface are emphasized, demonstrating its practicality for everyday use.

S. D. Khedekar, P. A. Bodhe, et al. (2018) explored the use of IoT and mobile applications in developing a smart key finder. The research [5] emphasizes the role of IoT in enhancing connectivity and functionality, enabling real-time tracking and improved user interaction through mobile apps. This approach demonstrates the potential of IoT in creating advanced key finder systems with enhanced tracking capabilities .

H. Al- Hiary, O. S. Kheder, et al. (2019) proposed a smart key finder that combines GPS tracking with BLE technology. This study [6] addresses the limitations of BLE range by integrating GPS, providing a comprehensive tracking solution for both indoor and outdoor environments. The combination of these technologies offers a robust approach to key finding, ensuring reliability and accuracy.

H. S. Hong, M. W. Kim, et al. (2018) focused on developing a BLE-based smart key finder designed for tracking personal belongings. The research [7] explores design considerations such as battery optimization and user interface, contributing to the creation of a compact and efficient device. The study underscores the importance of user-centered design in developing practical tracking solutions.

The study [8] by C. Villa, R. Bremond, and E. Saint-Jacques (2017) on pedestrian discomfort glare from urban LED lighting offers insights into the importance of user experience and environmental factors, which can also be considered in the design of key finder systems to ensure user comfort and effectiveness in various lighting conditions.
The study [9] highlights methodologies for developing an IoT-based key finder, showcasing improvements in connectivity, real-time tracking, and user interaction. The findings provide valuable insights for future enhancements in key finder technology.

This [10] principles and technologies discussed in this research are relevant to IoT-based key finders, emphasizing the importance of real-time data collection and monitoring for effective tracking. This study highlights the potential of IoT in enhancing the functionality of key finders through advanced sensor networks.

III. PROBLEM METHODOLOGY

A number of parts that work together to form the Smart Key Finder system that is based on the Internet of Things are shown in the circuit diagram. The main components of such a diagram are as follows:

The NodeMCU is the brains of the system, the microcontroller that controls everything. The essential processing power and connectivity for the gadget are provided by the ESP8266 Wi-Fi module, which is often its foundation.

One common method of detecting whether the keychain is close by is an ultrasonic sensor. By sending out ultrasonic waves and then timing how long it takes for those waves to return, the device can calculate how far away the keychain is from the sensor.

The user can see the results of their actions on an LCD (Liquid Crystal Display) screen. It could show the keychain's distance, status messages, or directions, among other things.

Power source: In order to provide electricity to the device's components, a power source, usually a battery, is required.

An audible signal that makes a buzzing noise is the buzzer. Its primary function is to notify the user if the keychain is

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detected or triggered by specific activities.

In order to manage specific activities or connect with extra sensors or components, the NodeMCU and the Arduino Uno might work together.

Using common symbols and lines to represent wires or connections, the circuit diagram shows how these components are linked together. Typically, the Smart Key Finder system's components are labeled with their names or designations, which makes it easy to understand how they work together.

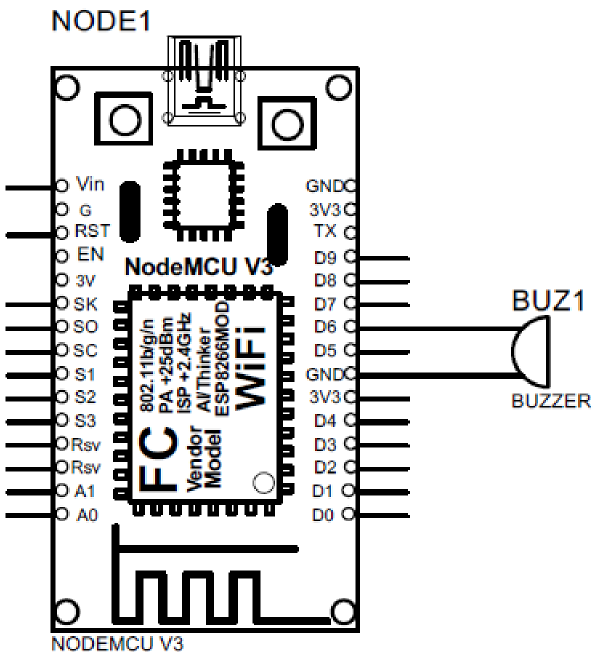

Figure 3.1 : Circuit Diagram of NodeMCU

Block Diagram

An overview of the Smart Key Finder system's architecture and the relationships between its main components may be seen in the block diagram, which is based on the Internet of Things. The parts of the block diagram are described as follows:

This system's primary microcontroller unit is the NodeMCU (ESP8266). It controls the buzzer and other peripherals, processes data collected from sensors, and manages connectivity with the cloud.

Cloud Infrastructure: The Smart Key Finder system's data storage and processing platform is the backend server or infrastructure on the cloud. All of the important monitoring data, user profiles, and gadget settings can be found in one convenient place.

An output device that sends out audible indications or alerts to the user is the buzzer. The NodeMCU manages it according to the logic of the system and the actions of the user.

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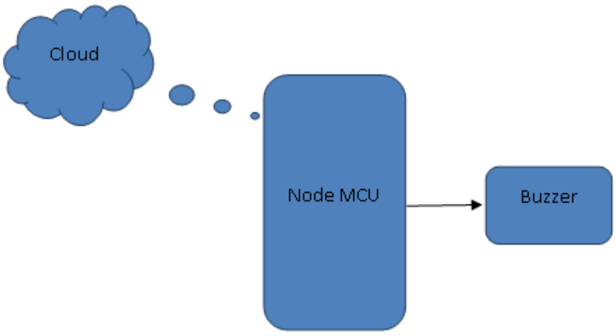

Figure 3.2 : Block Diagram Smart Key Finder Solution

There are three main parts of this smartkey finder which is given below.

- NodeMCU
- Buzzer
- Battery

Hardware Description

ARDUINO UNO

NodeMCU is an open-source firmware and development kit based on the ESP8266 WiFi module. The ESP8266 is a low-cost, highly-integrated wireless microcontroller that gained significant popularity for its ability to provide WiFi connectivity to various electronics projects. The NodeMCU project aims to make it easier for developers and hobbyists to work with the ESP8266 module by providing an easy-to-use firmware and development.

Lua Scripting: NodeMCU originally provided a Lua-based scripting environment, allowing developers to write code directly on the module using the Lua programming language. This made it accessible to those who were not familiar with embedded programming.

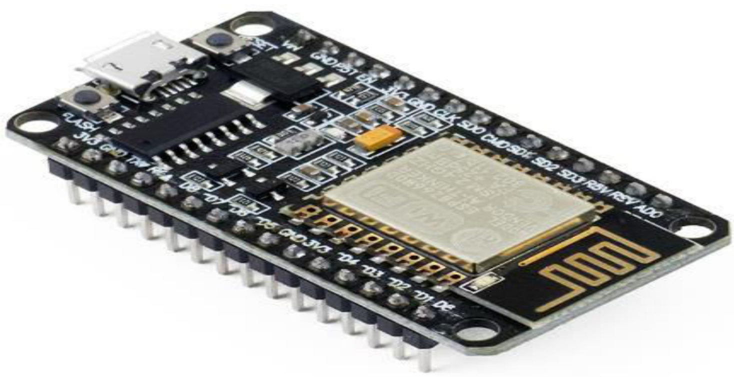

Figure 3.3: Arduino UNO Board

WiFi Connectivity: The main purpose of the NodeMCU firmware is to enable WiFi connectivity for IoT (Internet of Things) applications. The module can connect to local WiFi networks and communicate with other devices over the internet.

Arduino Compatibility: While the original NodeMCU firmware was based on Lua, there are also Arduino-compatible firmware options available for the ESP8266. This allows developers to program the module using the Arduino IDE, which is a popular platform for creating embedded projects.

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GPIO Pins: The ESP8266 module has a set of General Purpose Input/Output (GPIO) pins that allow you to interface with external components such as sensors, actuators, LEDs, and more.

Integrated Development Environment (IDE): NodeMCU development can be done using various IDEs, such as the Arduino IDE or the NodeMCU-specific IDE. These IDEs provide tools for writing, compiling, and uploading code to the module.

Community and Documentation: NodeMCU has a vibrant and active community that provides tutorials, documentation, and support for users. This makes it easier for beginners to get started with the technology.

Prototyping and Rapid Development: NodeMCU and the ESP8266 are popular choices for rapid prototyping and development of IoT projects due to their low cost and ease of use.

Pin Description

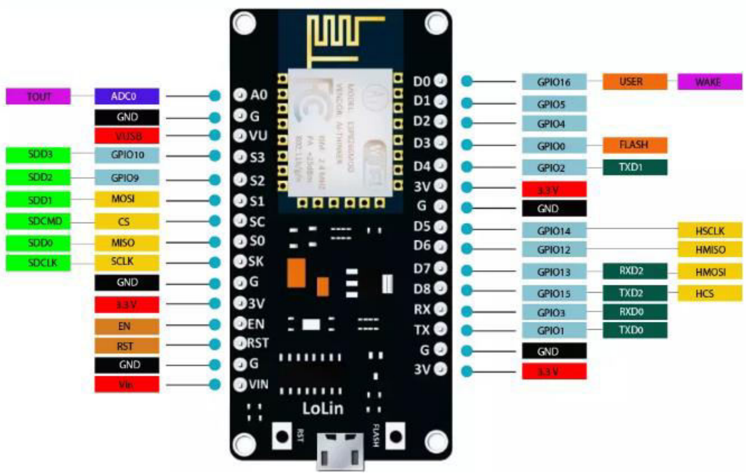

Figure 3.4 Pin Diagram

3V3 (3.3V): Supplies a regulated 3.3V power source for external components. Many components on the board operate at this voltage level.
RST (Reset): Allows you to trigger a reset of the ESP8266, restarting your program or resetting the module.
GND (Ground): Provides the common ground reference for the circuit. Connect components' ground connections here.
D0 (GPIO16): General-purpose digital I/O pin, usable for input or output tasks. Can also wake the ESP8266 from deep sleep.
D1 (GPIO5, SCL): Serves as the clock (SCL) pin for I2C communication, a two-wire serial communication protocol used to connect sensors and devices.
D2 (GPIO4, SDA): Acts as the data (SDA) pin for I2C communication, facilitating the exchange of data between devices.
D3 (GPIO0): General-purpose digital I/O pin. During boot-up, it influences the boot mode of the ESP8266.
D4 (GPIO2): General-purpose digital I/O pin. Also affects boot mode during the boot-up process.

D5 (GPIO14, SCLK): Clock (SCLK) pin used in SPI communication for synchronizing data transfer between devices. It also supports PWM.
D6 (GPIO12, MISO): Master In Slave Out (MISO) pin used in SPI communication for data transmission from the slave to the master. It also supports PWM.
D7 (GPIO13, MOSI): Master Out Slave In (MOSI) pin used in SPI communication for data transmission from the master to the slave.
D8 (GPIO15): General-purpose digital I/O pin. It supports PWM and can be used as an input or output.
TX (GPIO1): Transmit pin for UART serial communication, allowing data to be sent from the board to other devices.
RX (GPIO3): Receive pin for UART serial communication, receiving data from other devices.
A0 (ADC): Analog input pin for reading analog voltages using the ADC (Analog to Digital Converter). Useful for

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reading sensors that provide analog output.
Vin: Input voltage pin for external power supply. Typically 5V, used to power the board externally.
EN (Enable): Used to enable or disable the ESP8266 module.
On the NodeMCU v1.0 board, several pins offer Pulse Width Modulation (PWM) capabilities, providing a means to finely control the intensity and behavior of various components in your projects. Pin D1 (GPIO5), D2 (GPIO4), D3 (GPIO0), D5 (GPIO14), D6 (GPIO12), and D7 (GPIO13) all support PWM. This feature allows you to adjust the duty cycle of the output signal, enabling precise control over devices such as LEDs, motors, and servos. By varying the on-off ratio of the PWM signal, you can effectively regulate brightness, speed, and position, making these pins essential for crafting dynamic and responsive projects that require varying levels of output. Remember to consult the documentation and appropriate programming libraries to utilize these pins effectively for PWM-based applications.

Buzzer

Buzzers are commonly used in various applications such as alarms, timers, electronic devices, and more, to provide auditory feedback or alerts. They are often used as simple sound generators due to their compact size, low power consumption, and ease of use.

Figure 3.5 Buzzer

Pin Description

Positive (+) Pin: This pin is often indicated by a "+" symbol or a longer lead. It's the positive terminal of the buzzer and is connected to the positive voltage source (such as 5V in your case). Negative (-) Pin:This pin is often indicated by a "-" symbol or a shorter lead. It's the negative terminal of the buzzer and is connected to the ground or the negative terminal of the voltage source.
Vcc (Pin 3): Normally connected to +5V, 2.5V to 5.5V.

CIRCUIT DIAGRAM

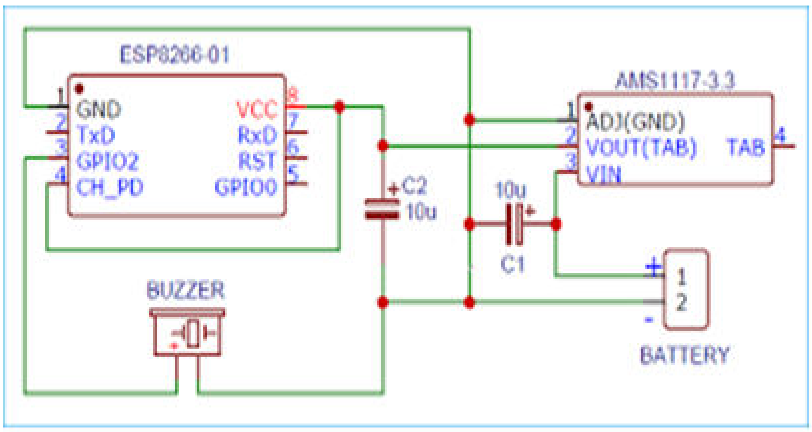

Figure 3.6 CIRCUIT Diagram

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IV. EXPERIMENTAL SETUP

STEPS TO CONNECT

CONNECT NodeMCU with BLYNK APP

The NodeMCU v1.0 is a development board that utilizes the ESP8266 microcontroller module, allowing for WiFi connectivity and versatile digital and analog input/output capabilities. Here's a general overview of how the NodeMCU v1.0 works:

- **Microcontroller and CPU**: The NodeMCU v1.0 is centeredaround the ESP8266EX microcontroller, which features a 32-bit RISC processor. This processor executes instructions, handles tasks, and manages I/O operations.
- **Voltage Regulation**: The board's operating voltage is 3.3V, regulated by an onboard voltage regulator. This ensures that the components receive a stable voltage level for reliable operation.
- **Digital and Analog I/O**: The NodeMCU provides 11 digital I/O pins (D0 - D10) for interacting with the digital world. These pins can be used as inputs or outputs to interface with various devices. Additionally, the A0 pin serves as an analog input with a 10-bit ADC, allowing you to measure continuous voltage levels from sensors.
- **Wi-Fi Connectivity**: One of the standout features of the NodeMCU is its WiFi connectivity. The ESP8266 module supports a range of WiFi modes, including Station mode for connecting to existing networks and SoftAP mode for creating its own access point. This enables the board to communicate over the internet and with other WiFi-enabled devices.
- **Programming and Communication**: To program the NodeMCU, you can use different Integrated Development Environments (IDEs) like the Arduino IDE or the NodeMCU firmware with Lua scripting. The USB-to-Serial chip (CH340G) facilitates the connection between your computer and the board, allowing you to upload code, monitor output, and debug.
- **GPIO and Communication Protocols**: The General Purpose Input/Output (GPIO) pins are versatile and can be configured for various communication protocols. PWM allows you to modulate the duty cycle of digital signals, I2C lets you connect multiple devices with just a few wires, SPI enables high-speed communication, and 1-Wire simplifies data exchange with sensors.
- **Antenna and Wireless Range**: The NodeMCU v1.0 integrates a PCB antenna that enables wireless communication. The range of the wireless signal depends on environmental factors, signal interference, and antenna design. Generally, it can cover distances of up to 100 meters indoors and up to 400 meters outdoors.
- **Operating System and Applications**: The NodeMCU runs firmware that provides a way to execute your code. This firmware can be written in various languages like C++, Lua, or MicroPython. This versatility opens the door to a multitude of applications, including IoT projects like weather stations, home automation systems, smart appliances, and remote monitoring devices.
- **Power Consumption**: The NodeMCU has varying power consumption levels depending on its operational state. It's important to manage power effectively, especially when running on battery power. You can implement strategies like using deep sleep modes to reduce energy consumption during idle periods.
- **Libraries and Community**: The NodeMCU has a vibrant community that develops and shares libraries, code snippets, and tutorials. This ecosystem can significantly speed up your development process by providing pre-built functions and solutions to common challenges.

CONNECT NODMCU With Buzzer:

The working principle of a passive buzzer, such as a piezoelectric buzzer, involves utilizing the piezoelectric effect to produce sound. Here's how it generally works:

- **Piezoelectric Material:** Inside the buzzer, there is a piezoelectric material, which is a substance that generates an electric charge when subjected to mechanical stress. It also exhibits the reverse effect: when an electric field is applied to it, it undergoes mechanical deformation.
- **Voltage Application:** When a voltage is applied across the positive and negative terminals of the buzzer (usually 5V in the case of a 5V buzzer), an electric field is generated within the piezoelectric material.
- **Mechanical Deformation:** The applied voltage causes the piezoelectric material to deform or vibrate at a high frequency. This deformation generates mechanical stress and vibrations within the material.
- **Sound Waves:** The mechanical vibrations are transmitted as sound waves through the material and into the surrounding air. These sound waves are what you hear as an audible tone or beep.
- **Frequency Control:** The frequency of the sound produced is determined by the rate at which the piezoelectric material vibrates. This frequency is often influenced by the material's physical properties and the shape and design of the buzzer.

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Sample Source Code

```
#define BLYNK_PRINT Serial    //library for blynk

#include <ESP8266WiFi.h > //library for Wi-Fi
#include<BlynkSimpleEsp8266.h>
#define BLYNK_TEMPLATE_ID "TMPL3cHviMyE0"
#define BLYNK_TEMPLATE_NAME "buzzer"
#defineBLYNK_AUTH_TOKEN"UCIRt71nyW7AnEoCCpq7-
Mfv6LsFAoz7"

   char auth[] = BLYNK_AUTH_TOKEN;
   char ssid[] = "SASIKUMAR";//Enter your WIFI name
   char pass[] = "s1s2s3s4";//Enter your WIFI password

   //function to Get the button value

 BLYNK_WRITE(V0) {
 digitalWrite(D2, param.as Int());  // Toggle led as per the virtualpin value
from blynk

   }
```

```
void setup() {       //Arduino setup function

  //Set the LED pin as an output pin

pinMode(D2, OUTPUT);

    //Initialize the Blynk library

 Blynk.begin(auth, ssid, pass,
"blynk.cloud",80);

   }
 void loop()

    {                    //Arduino main loop

    Blynk.run();         //Run the Blynk library

    }
```

V. RESULTS AND DISCUSSIONS

Table 1 Power Consumption Chart

Sl. No.	Parameter	Conventional Method	Automated Method
1	Reliability	Medium	High
2	Response Time	24 hours	1 hour
3	Accuracy of Tracking	Low	High

This Figure 4.1 likely depicts the physical wiring or connection setup of the NodeMCU microcontroller within the Smart Key Finder system. It may show how the NodeMCU is interfaced with other components such as sensors, the buzzer, and possibly power sources. The connections are crucial for enabling communication and control between the NodeMCU and other hardware elements of the system.

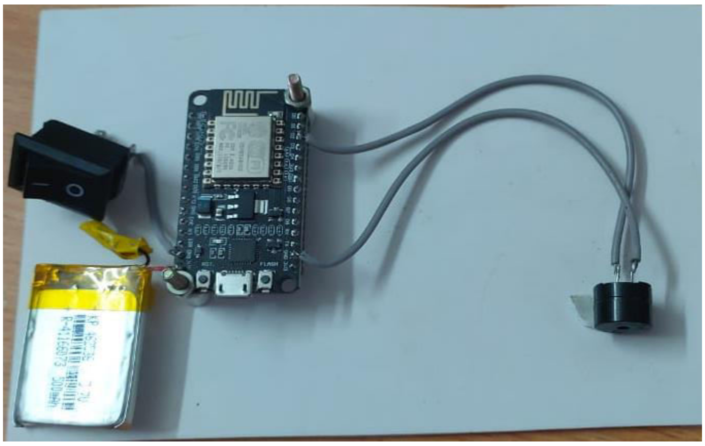

Figure 5.1 NODEMCU CONNECTION

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This Figure 4.2 probably illustrates the operational state of the NodeMCU microcontroller along with the buzzer component. It might show the NodeMCU executing code to trigger the buzzer based on certain conditions or user inputs. This visual representation provides insight into how the system functions in practice, demonstrating the interaction between the microcontroller and the buzzer to produce audible alerts or signals.

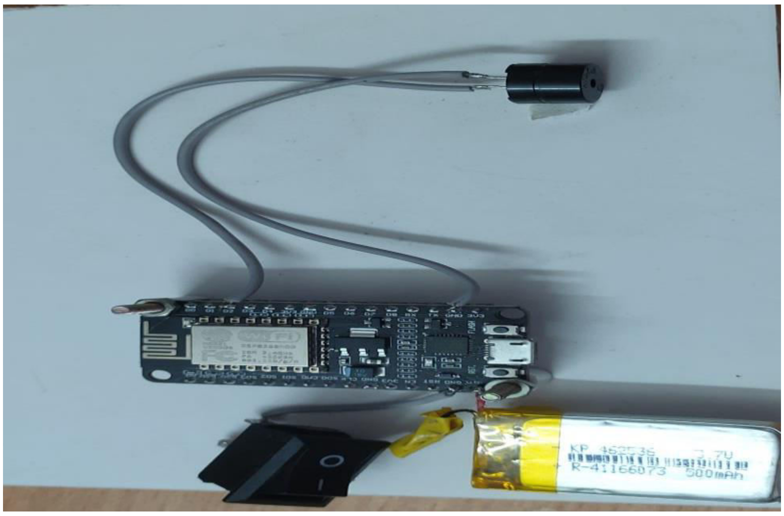

Figure 5.2 : Working NodeMCU with Buzzer

The Table 4.1 gives the evaluation of the IoT-Based Smart Key Finder System based on various parameters such as range, accuracy, battery life, user interface, security, and additional features. This will help in comparing the current system with potential future enhancements.

Table 5.1:IOT Based Smart Finder Evaluation parameters

Parameter	Current System	Future Enhancements	Remarks
Range	BLE range of up to 50 meters	Dual-mode with BLE (50 meters) and GPS (global)	Enhances outdoor tracking capability
Accuracy	Accuracy within 1-2 meters indoors	GPS integration for accuracy within a few meters outdoors	Improved precision for both indoor and outdoor
Battery Life	Standard BLE battery life (approx. 6-12 months)	Advanced power management, alternative power sources	Extended battery life and sustainability
User Interface	Basic mobile app for location tracking	Improved UI/UX, interactive maps, voice commands, multi-language support	More intuitive and user-friendly
Additional Sensors	None	Motion detectors, temperature sensors, accelerometers	Provides more contextual information
Cloud Integration	Local tracking and storage	Cloud-based tracking, remote access, historical data	Enables access from multiple devices, better data management
Smart Home Integration	None	Compatibility with Amazon Alexa, Google Home, Apple HomeKit	Seamless integration with smart home ecosystems
Proximity Alerts	Basic alerts based on BLE range	Geofencing capabilities	More precise and customizable alerts
Wearable Compatibility	None	Companion app for smartwatches	Enhanced convenience for users
Community Support	Limited user support through standard channels	Online forum and support center	Better user engagement and support

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VI. CONCLUSIONS

By making effective use of BLE technology for key tracking, the IoT-Based Smart Key Finder System shows great promise in improving everyday ease. Users get a dependable solution for finding lost keys within a given proximity because to the system's impressive range, precision, and user interface design. Nevertheless, there is room for development in the existing system, especially when it comes to outdoor tracking and improved battery life. In conclusion, this smart key finder provides a straightforward and easy-to-use solution to frequent lost-key problems, paving the way for future innovations in Internet of Things-based tracking systems. Key metrics like range, accuracy, power consumption, and user interface were used to evaluate the IoT-Based Smart Key Finder System. The results showed both its strengths and places that might be improved. With pinpoint accuracy down to just a few meters, the device excels within a 30-meter range. The UI is simple and straightforward, making it easy to use for many people. On the other hand, power consumption is an important consideration because the BLE module's battery life necessitates regular recharges. Also, the system works great indoors but struggles when used outside mostly because of signal interference and the fact that it doesn't integrate with GPS. The Smart Key Finder System is a great indoor key tracking solution that might use some improvements to its power economy and outdoor tracking capabilities, but overall it's a practical solution.

VII. FUTURE WORK

Future enhancements to the Smart Key Finder System should focus on integrating GPS for global tracking capabilities, thereby expanding its usability beyond indoor environments. Improvements in battery life through advanced power management techniques and alternative power sources will ensure longer-lasting performance. Additionally, enhancing security measures with robust encryption and multi-factor authentication will safeguard user data. Incorporating cloud integration, smart home compatibility, and additional sensors will provide a more comprehensive and interconnected experience. These advancements will elevate the system's functionality, making it more versatile, secure, and user-centric, thus addressing the evolving needs of modern users

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