ISSN (Print): 0974-6846 ISSN (Online): 0974-5645

Anti-Loss Key Tag Using Bluetooth Smart

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Abstract

Objectives: The most common asset tracking systems used are RFID, Wi-Fi, Cellular, WSN, Robots, GPS etc. While using such techniques, the energy consumption will be increased; proximity range cannot be met and are costly. **Statistical Analysis:** So the developers started to build up a less complex, compact and energy efficient object tracker with the use of Bluetooth Low Energy. **Findings:** This paper aims at developing a Key Tag that identifies the location of the minute objects within the specified proximity area. The main components are: I) Bluetooth Low Energy, II) Smartphone. The key functions are performed by Bluetooth Low Energy (BLE) module and smart phone application. The important feature of this key tag is its low power consumption through the usage of Bluetooth Low energy that has the key feature of sleep mode for most of the time and only wakes up when the connection is initiated. **Improvements:** Low power consumption is achieved by limiting the actual connection times to a very few ms the results achieved through BLE analysis is presented and discussed here.

Keywords: ARM Cortex M0, Bluetooth Low Energy, GATT, Key Tag, Proximity

1. Introduction

In this busy world many people has the infuriating habit of losing things or misplacing them. Challenging this problem, a new device which could locate the lost object, with help of the smart phone application may be the solution. The asset tracking is not new; many researches and many asset tracking systems are developed in order to challenge the problem of this asset tracking. For example, in used smart phone applications to obtain the solution for efficient tracking architecture. The energy saving and position accuracy is demonstrated with the use of BLE. It proposes a tracking system especially for the use in construction sites which uses both Radio Frequency Identification(RFID's) and BLE devices with an asset management database system maintained in order to have information regarding the assets. For² improving asset exploitation, efficiency and visibility geotracking

service is used. By the use of context monitoring schemes, realistic and cost effective tracking is developed. Hence the mobile asset tracking is personalized with reduced overhead and increased transparency with predefined routes and it addresses the efficient ways in asset tracking and performs tracking by monitoring the context information in a distributed, proficient and scalable fashion. In ³ studied simple and practical system to locate the remote objects via collaboration of phone sensors and photos is used that led to the evolution of Camloc. But this Camloc couldn't explore the localization accuracy. It proposes the possibility of tracking the remote objects through cameras and built-in inertial sensors. In ⁴ presents asset tracking to improve the battery life which uses the following:

- RFID tags
- BLE tags
- Smartphone

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It is best known for its energy saving architecture which uses the technique of switching the Global Positioning System (GPS) only when it is required and let it be in sleep when not in use. This way most of the energy can be conserved which suggests the architecture aimed at tracking the assets with the use of two android applications such as, proximity Locator and Dynamic objects Location Finder. In this paper a key tag is developed which is used to locate the object exactly. This project helps in locating the lost device which uses Bluetooth smart and displays on tracking phone how close or far way the user is 5. Proposed location recognition algorithm which automatically recognizes the objects that enter and it works on cloud. The Smartphone is used to sense the location very accurately irrespective of crowd and the details are saved to cloud. This reduces the time wastage and thereby the accuracy can be increased. The approach presented here exploits the algorithm integrated with the cloud platform, which uses the HD Wi-Fi finger printing system with GPS/HPS systems. In² developed an indoor positioning system for remote tracking. It proposed K-NN algorithm on the central server remote tracking system and the sensors placed in the target area can be used to track through BLE tags. An algorithm which is used to track the exact location of moving objects is developed by in⁸, which mainly focuses on Low energy consumption. For this, a selective approach algorithm is adopted, which is based on one hop neighbor. In order to conserve the energy the sensors are operated in such a way that they will be active only when requested, which is done with the help of selective approach algorithm. This method improves the network life time. An⁹ evaluation method is proposed to track object online without any ground information. The method used is Template Inverse matching resulting in an efficient and stable tracking technique. This is applicable only for template-based methods. A10 technology using GPS, GSM along with DTMF based robot for tracking the exact position of the asset is developed. It is developed around ARM 7 controller and designed using Proteus 7.1. The cost of developing is more but the location of the asset can be found very accurately. The main application of this key tag is to find the misplaced objects¹¹ and to act as a remainder of important things. If the device goes out of range (100 meters), it can still be detected on Smartphone of the user with the same application, through an alert.

To attain this goal the following are the main characteristics to be taken into account:

- Battery life (Energy Consumption): Since the Key tag
 uses Bluetooth Low Energy rather than GPS there is
 no problem of draining of battery. Once the battery
 is placed it lasts for about one complete year and there
 is no issue of charging it again and again.
- Operating range (Achieving good level of accuracy):
 Although BLE is a short range communication; it focuses on accuracy i.e., exactly tracking the object.
- User Interface: The use of this Key tag is very simple and user friendly. There is no need of pre ordaining.

The earlier works about this system are discussed in the section II. To the best of author's knowledge, this is first architecture using ARM cortex M0 with in-built BLE, aiming for low power consumption. The system architecture details sketched in figure 1 are discussed in section III. The proposed and developed work and results with functionality are discussed in section IV and V respectively.

2. System Architecture

The main components involved in this Key tag are:

- ARM Cortex M0.
- BLE
- Light Emitting Diodes.

2.1 ARM Cortex M0

The main reason of using ARM cortex M0 is that it is the smallest and most power and energy efficient controller. The nested vectored interrupt controller in Cortex M0 is the key characteristic that helps in the low energy consumption. This controller has three different reduced-power modes, which helps to obtain the goal of low power¹².

2.2 Bluetooth Low Energy (BLE)

BLE is a smaller and extremely optimized version of Classic Bluetooth. However, it has wholly different lineage and design goals. Compared to the other wireless standards, BLE has gone further faster because its fate is so intimately tied to the exceptional growth in smart phones, tablets, and mobile computing. Bluetooth low energy is a radio standard enabling the Internet of things. The maximum or Peak power consumption is only 15mA, and the average power consumption is of only about 1 uA. As shown in Figure 1 the architecture of this key tag consists of the following. A mobile phone which acts as host

is integrated with different client devices. In more detail, each objects (Wallet, Bag, Watch etc.,) that we think important, is tagged with this key and is used normally. Whenever we find it to be missing then our smart phone application is used to track our object. BLE is introduced into android with API 18 i.e., 4.3 version. But this project is developed under recent version of API 21. The updated version of SDK 18 and above only can operate this key tag due to its backward compatibility support.

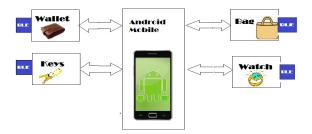


Figure 1. Architecture of Key Tag.

3. Object Tracking Functionality

In this paper, a different architecture that uses BLE in-built in ARM cortex M0 is used which tracks the object that is tagged to the key. Whenever the object is found to be missing, the smart phone application is used to track the device which buzzes when the device is near to the mobile. Initially all the services and characteristics of BLE are in sleep mode. They become active only when the interrupt occurs and wakes up the condition. The data is transmitted back and forth between smart phone and BLE tag using GATT (Generic Attribute profile)¹³. In vision 5 IDE is used for simulating and debugging the code and Android studios is used to develop the Android application for the key tag with basic features. When you want to find the exact location of your device then activate your BLE first then search for the nearby BLE devices. Once the device is found and connected to your mobile, it shows all the services and characteristics assigned under that device. After that you should assign alert to the device (i.e., High alert, Mild alert, and Low alert). Depending on the alert set the speed of the LED/Buzzer varies, as shown in Figure 2. The link lost service in the application is used to pop-up a message whenever the device is away from the proximity range. The battery service is used to know how much battery exists and gives notification incase the battery drains out.

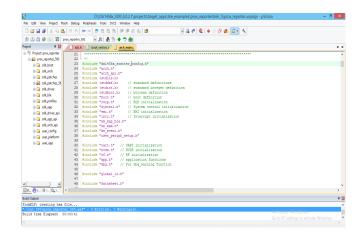


Figure 2. The Build Output in Keil IDE.

4. Results and Discussion

The simulation results of the code are shown in Figure 3 which is completely coded with Bluetooth stack, Drivers for LED's, GPIO's and RTOS. It is debugged using J-LINK/J-TRACE Cortex. The output is built in Keil U vision 5 IDE. The Bluetooth stack is coded in a layered approach comprising of Controller, Host and Apps which contains different profiles like GATT, GAP, HCI, ATT, L2CAP, Link layer, RF. The project is coded in such a way that it can act as host as well as device. It is coded using Embedded C and the simulated code is dump into the hardware module and is debugged. By the use of Android Studios software, android application is developed shown in Figure 4. With the help of drag and drop options the basic app is created. Services and characteristics are developed according to the application.



Figure 3. The Key Tag with LED Blinking when the Device is Found.

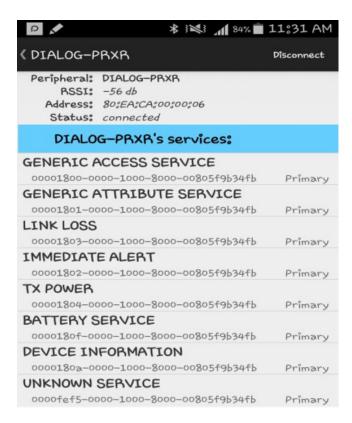


Figure 4. The Services and Characteristics of Android Application.

5. Conclusion

With the use of BLE in-built in ARM Cortex M0, a compact, low power and Energy efficient tracking system is developed. Bluetooth stack and other peripherals are integrated into RTOS. This key tag can accurately track the device within the 150 meters range of open field. The android application developed in gives information regarding the Link lost, battery life, immediate service, device information through which the lost device can be tracked. The device is much secured and cannot be accessed through any other mobile because each individual device with BLE is assigned with a 16 bit UUID (Unique user ID).

6. Future Scope

This work can be extended by using the external GPIO pins (42). With these few other sensors like Fire sensor and Gravity sensor can be configured so that the application vastness can be increased.

7. Acknowledgement

The first author is grateful to whole team of On Chip Technologies and Dr. K. Sreenivasa Ravi for the guidance and constant supervision.

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