INTERNAL NAVIGATION SYSTEM FOR SRI LANKAN PARKING SYSTEM : "PAY AS YOU PARK"

2021_198

Project Proposal Report

Lahiru Vernon Ferreira

B.Sc. (Hons) Degree in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology
Sri Lanka

February 2021

INTERNAL NAVIGATION SYSTEM FOR SRI LANKAN PARKING SYSTEM : "PAY AS YOU PARK"

2021_198

Project Proposal Report

B.Sc. (Hons) Degree in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

February 2021

Declaration

I declare that this is my own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor : ……. Date : ……...

Abstract

Urban areas and dense communities are expanding, so the need for new applications to assist in planning and optimization is rising and although there are many both inside and outside parking areas in Sri Lanka, in present Sri Lanka, an urban area like Colombo faced a huge traffic jam due to inefficient vehicle parking, the number of vehicles used in the country by people, etc.

When focusing on vehicle parking in Sri Lanka, sometimes people are unable to find a free parking slot, and even if people find a slot, it is hard to find the exact way to the parking slot. Sometimes people could not find people's own vehicles inside the parking area because of the huge number of parking slots and the number of vehicles that are parked there.

"Pay as You Park" is the proposed smart parking system and internal parking navigation is one of its research components. Users are able to find the way to the reserved parking slot through a mobile application, and the system is based on BLE Beacons to find the way to a particular parking slot. BLE Beacons have to be placed in each and every parking slot to identify the parking slots. To estimate the positions RSSI can be used. [1]

By the implementation of this smart parking system, users can find the way not only to the parking area but also to the parking slot which is reserved inside the park. Users only need a mobile device that has Bluetooth and good network connectivity.
When a user enters the parking area, the mobile application will guide the user to the reserved parking slot until the user parks the vehicle, and the user will also be guided by the system to find the vehicle where the user has parked the vehicle. "Pay as You Park" smart parking system can be utilized in day-to-day parking issues faced by people in the present days.

Table of content

Declaration of the candidate & Supervisor		i
Abstract		ii
Table of content		iii
List of figures		iv
List of tables		v
List of abbreviations		vi
1.	Introduction	1
	1.1 Background	1
	1.2 Indoor positioning technology comparison	1
	1.2.1 Wi-fi based indoor positioning	1
	1.2.2 BLE Beacon based indoor positioning	2
	1.2.3 UWD based indoor positioning	2
	1.2.4 RFID based indoor positioning	3
	1.3 Research problem	4
2.	Objectives	5
	2.1 Main objective	5
3.	Methodology	6
	3.1 Flow chart of the introduced system	6
	3.2 System architecture	6
	3.3 Research component system architecture	7
	3.4 Bluetooth technology and applicable areas	8
	3.4.1 Internal navigation using Bluetooth	8
	3.4.2 Beacon internal navigation applicable areas	8
	3.5 Range based schemes	11
4.	Conclusions and Recommendations	13
Reference List		14

List of figures

Figure 1.1 - Summary of Indoor Position Comparison 3
Figure 3.1 - The way of Beacon passes signals to the smartphone 10

List of tables

3.1 Technology Comparison Tabular view 10

List of abbreviation

Abbreviation	Description
BLE	Bluetooth Low Energy
UWB	Ultra-Wide Band
RFID	Radio Frequency Identification
WCL	Weighted Centroid Localization
AWBCL	Average Weighted Based Centroid Localization
RSSI	Received Signal Strength Indicator

1. Introduction

1.1 Background

People spend a lot part of their daily lives indoors. Locations such as schools, colleges, workplaces, hospitals, shopping, Shopping centers, etc. Indoor positioning is a trivial problem, as satellite-based approaches (e.g. GPS) do not work properly within buildings. Wi-Fi, ZigBee, RFID and BLE are more for indoor positioning research, favored.

1.2 Indoor Positioning Technology Comparison

There are many kinds of indoor positioning in world-wide. Some of them are,

- Wi-fi based indoor positioning
- BLE Beacon based indoor positioning
- UWB based indoor positioning
- RFID based indoor positioning

Below have the brief description of the technologies and figure 1.1 shows the comparison in a tabular way.

1.2.1 Wi-fi based indoor positioning

Wi-Fi-based real-time indoor positioning systems, such as smartphones, tablets, and Wi-Fi tags, locate and track active Wi-Fi devices. Depending on the preconditions, the accuracy of Wi-Fi used for server-based indoor localization ranges from eight to fifteen meters. [2]

Advantages :

Capability to control all Wi-Fi-enabled devices, ability to track visitor behavior, wide range of devices (up to 150m).

Disadvantages :

The degree of accuracy offered by BLE or RFID, high latencies and randomized MAC address usage are difficult to achieve when the system is not connected to the Wi-Fi network.

1.2.2 BLE Beacon based indoor positioning

Beacons are small wireless devices that use Bluetooth Low Energy, also known as Bluetooth Smart, to relay signals. They are relatively inexpensive, can run for up to five years on button cells. With Bluetooth 4.0.0, accuracy is usually less than eight meters. The new 5.1 version of the Bluetooth specification allows for path finding use cases and offers less than one meter of accuracy. Beacons are scalable and highly portable in all sorts of different formats.[2]

Advantages :

Flexibility and Efficiency of Cost

Disadvantages :

Signal dispersion attenuations inside houses, layout alteration instability and radio interference.

1.2.3 UWB based indoor positioning

Ultra-wideband is a radio technology with a short range. The precision is less than 30 cm, which is slightly higher than when dealing with Wi-Fi or beacons. You can also reliably calculate height differences.[2]

Advantages:

High accuracy, low latency times, no interferences

Disadvantages:

Higher cost and battery life is less than beacon

1.2.4 RFID based indoor positioning

RFID is a type of wireless communication that identifies objects through radio waves. Passive RFID technology only operates close to specialized RFID readers providing a 'point-in-time' role.[2]

Advantages:

Very high accuracy, no battery needed

Disadvantages:

Short range signal transmission, installation need significant planning and infrastructures can be expensive.

comparison of different technologies for server-based indoor positioning

Technology	Accuracy	Range	Suitable for	Tracking	Transmitter power supply	Battery lifetime
Wi-Fi	< 15 m	< 150 m	area detection		or	medium
BLE 4.0	< 8 m	< 75 m	area detection			high
BLE 5.1	< 1 m with line-of-sight					
UWB	< 30 cm	< 150 m	area detection		or	medium
RFID	presence detection only	< 1 m	spot detection		— (passive RFID tag)	— (passive RFID tag)

figure 1.1 - Indoor Positioning Technology Comparison

1.3 Research problem

Although there are many outside navigation systems using GPS to find a parking area, most parking lot in Sri Lankan urban areas are lack of internal parking navigation systems.

Even though there are indoor parking systems sometimes drivers have faced difficulty to find the way to the exact parking slot inside a parking area and [4] Due to specific technological problems and/or significant investment costs, indoor positioning and navigation services are still under investigation and development.

There is satellite technology which can use to identify a particular place or area but within houses, satellite-based positioning cannot be used, Since the building's structure distorts or consumes the structure, with signals.[3]

2. Objectives

2.1 Main Objective

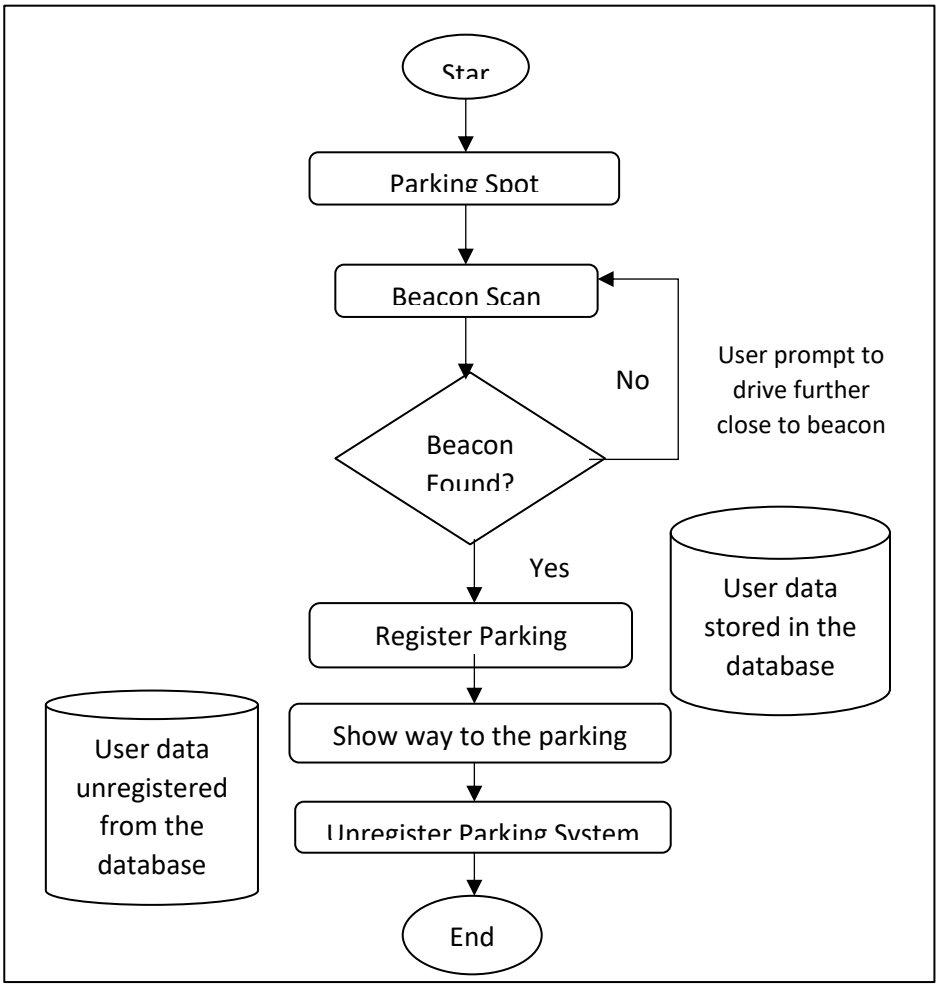
In the proposed system "Pay as You Park", there are four main components and, in this research proposal, has explained one of those main research components. That is internal navigation system inside a parking area such as navigation inside an indoor/ outdoor garage, navigation inside a parking which owns by shopping malls etc. So this internal navigation helps users to find a reserving parking slot which will be reserved by the users. By implementing this system drivers will not get headache to find the actual parking slot and drivers will not waste the time to find the parking slot inside the parking area. As a side solution of this system, the traffic jams in urban areas will be reduced. By implementing the proposed system, it will be easy to find the distance between the parking slot and the user and also the accuracy of the existing systems are lower than the proposed system. Proposed system has a more accurate navigation because of using the models and filters.

3. Methodology

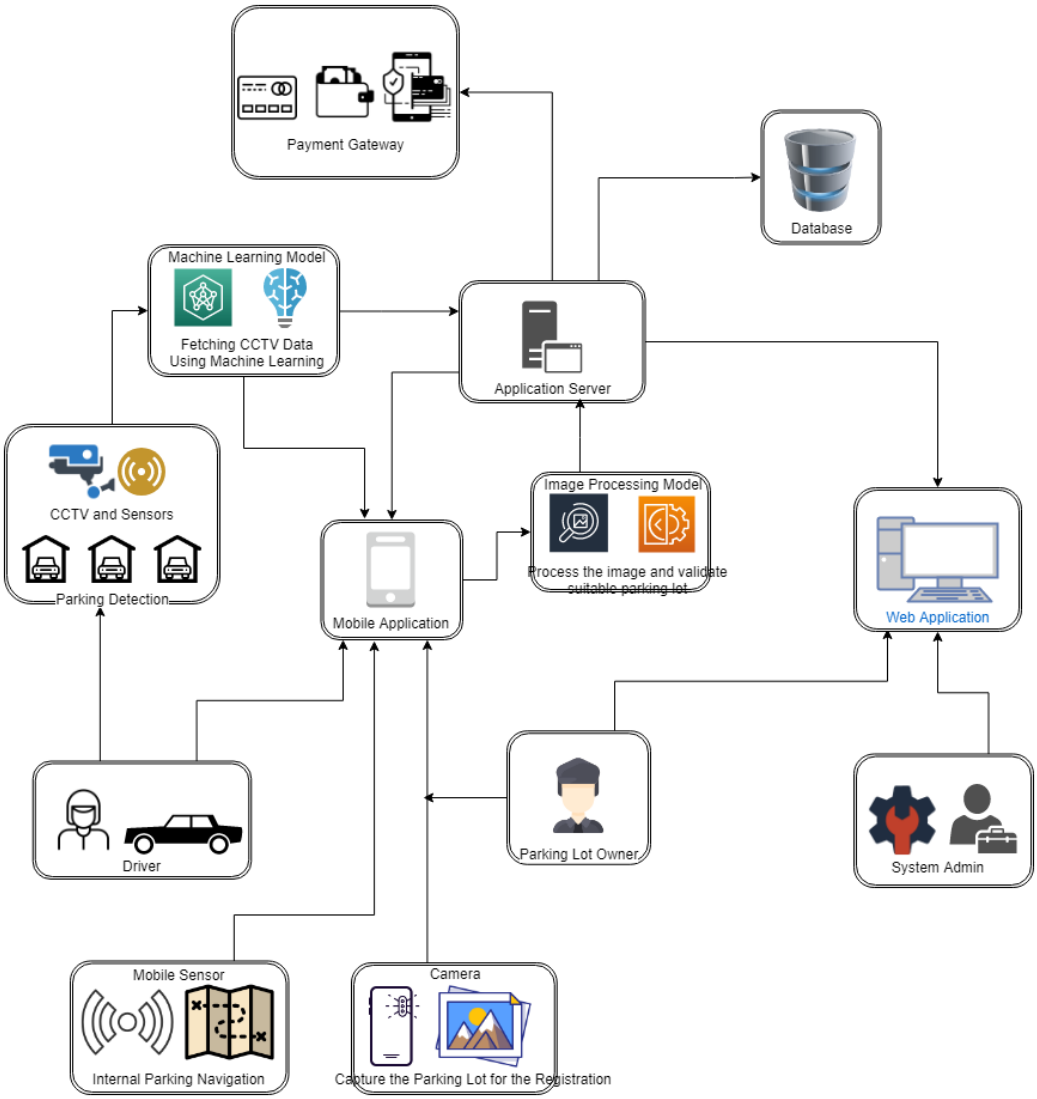
The proposed system "Pay as You Park" is a smart parking system that has the capability of four main research components and internal navigation inside the parking area is one research component of those four research components.

By using Machine Learning technology, can estimate the positions of the user who enters into the parking lot and also can estimate the position of the free slot as well. The mobile application will be developed by using flutter or android studios.

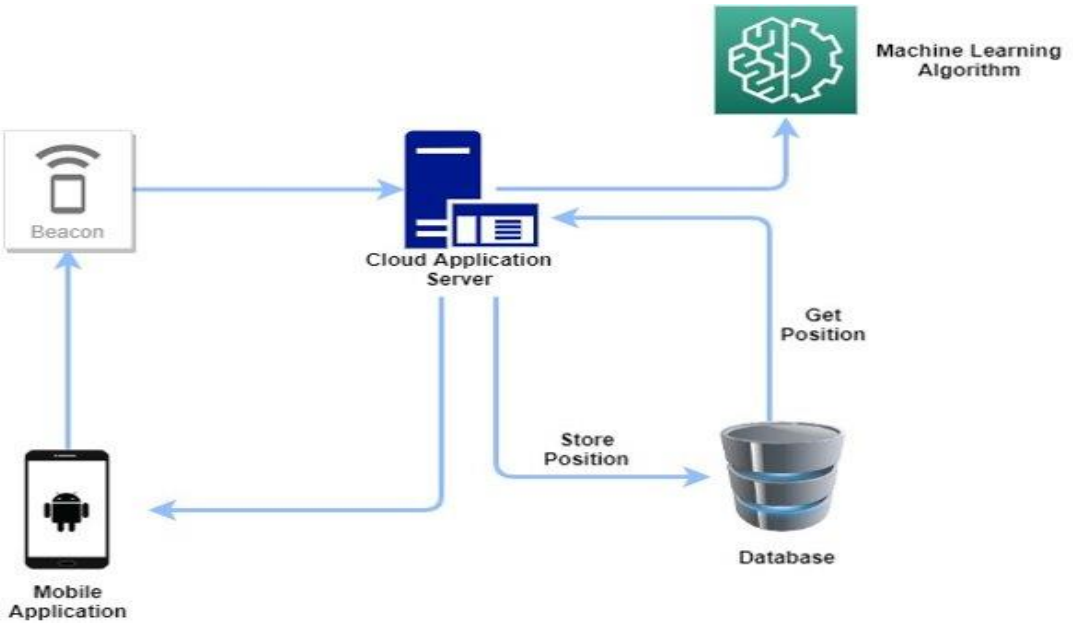
3.1 Flow chart of the introduced system



3.2 System architecture



3.3 Research component system architecture



3.4 Bluetooth technology and applicable areas

"Pay as You Park" is the system going to be implemented in the research project. In this system, users are able to find the way to the parking slot, and the proposed internal navigation technology is BLE beacon-based indoor positioning. At the heart of the indoor positioning market is Bluetooth. The technology itself is not new; since the 1990s, Bluetooth's functionality has been well-known. But it was the emergence of the BLE version of energy-saving Bluetooth that paved the way for many new application scenarios, making Bluetooth an industry standard available today on most devices.

3.4.1 Internal navigation using Bluetooth

Since GPS does not run indoors, Bluetooth is a strong alternative, and the go-to option for indoor navigation applications is BLE beacons. Beacons can send out Bluetooth signals, but beacons are not able to transmit them. Beacons are relatively

inexpensive, can run up to several years on button cells, and have a maximum range of 30 meters
indoors (Ranges are different from Beacon series to series) . A location accuracy of up to one meter can be achieved. Positioning happens on the user's mobile device in client-based solutions, ensuring optimal data security. There is a need for an app and Bluetooth must be enabled. Also possible is a server-based solution (asset or individual tracking) using beacons.
Several beacons are needed for positioning in client-based applications. Without much effort, beacons can be glued or screwed to ceilings or walls and can be easily incorporated into any environment. The user is directed to the destination, while user's location is determined automatically. It is also possible to cause an event using the beacon infrastructure, such as showing a coupon or information on a smartphone.

3.4.2 Beacon internal navigation applicable areas

There are incredibly diverse benefits of internal navigation using beacons. For one thing, it optimizes the consumer or customer experience and, secondly, the profitability of businesses. Automatically placed indoor navigation applications are also deployed at train stations, airports, shopping centers, museums, and large office buildings. It is possible to equip such applications with other useful features. In this proposed system, Beacon technology will be used to implement internal navigation inside the parking area.

For instance, location or situation-related data obtained by users directly on their smartphones. Below are some pros and cons of internal navigation using beacon.

Pros:

- Cost Effective
- Low energy consumption
- Flexible integration into the existing infrastructure
- Compatible both android and iOS

- Medium Accuracy

Cons:

- Additional hardware
- An application required for client-based solution

3.1 The way beacon passes signals to beacon

Indoor Positioning Service	Technology Name	Accuracy	Advantages	Disadvantages	Cost (Installation/Unit)
Radar	Wifi	2-3m	Low Price/existing infrastructure	Low accuracy/complex system	Low/Low
iBeacon	Bluetooth	0.5-3m	Smartphone user unit/ease of access	Need many beacons for better precision	High/Low
Ubisense	UWB	15cm	Very precise/very robust	Expensive Unit and installation	High/High
LANDMARC	RFID	2m	Very cheap user unit	Location delay for 7.5s	High/Low
Lock8	Ultrasound	3cm	Smart phone user unit/ precise	Require new infrastructure for every unit	Low/Low

3.1 Technology comparison table

3.5 Range Based Schemes

There are two Range based schemes. Distance Estimation and Position Estimation are two of it.

Research attempts have been made in the literature to reduce the distance error and improve the accuracy of the location. The centroid localization algorithm proposed by uses the coordination of beacons to estimate the location of the unidentified mobile positioning using the centroid formula, but with this algorithm, the position accuracy is very poor. The algorithm for Weighted Centroid Localization uses weight to estimate location as a factor. The AWBCL algorithm based on the WCL algorithm has improved the accuracy of the spot, but the position error is still high.[5]

RSSI based and ToA/TDoA-based are distance estimation schemes. Below are the pros and cons of the distance estimation methods.

RSSI Based :

Pros:

- Low Complexity
- No Time Synch
- Low Power

Cons:

- Low Accuracy

ToA/TDoA based:

Pros:

- High Accuracy

Cons:

- High Complexity
- Time Synch
- High Power

By using RSSI with filters can improve the accuracy of the distance. Kalman Filter can be used in such scenario. There are high levels of noise in the obtained RSSI measurements. [5] Therefore, the raw RSSI measurements require filtering to obtain better and accurate data. Researchers used the Kalman filter in literature to predict RSSI errors in positioning related to wireless LAN.

$$RSSI = 10n \log_{10} d + A$$

RSSI = Received Signal Strength Indicator in -dBM
n = path-loss exponent
d = the distance from transmitter
A = the reference value, RSSI 1m away

4. Conclusion and Recommendation

Consequently, it is clear from the estimates obtained that the BLE technology is the most optimum way for internal navigation in indoor and outdoor parking. The best combination of efficiency, ease of implementation and price for all technologies is given by Bluetooth Low Energy. In order to construct a navigation system in indoor, BLE is rightly a priority technology today.

However, with a combination of many solutions and the distribution of common benefits, it is possible to create a universal technology suitable for large-scale applications.

Due to the low accuracy in RSSI of user's positioning and to get the user's accurate position RSSI can be used with the Kalman filter. By using RSSI and Filters, the system able to show the distance between user and the free parking slot. So user will not be get any errors like latency of the exact position.

Reference List

[1] Smart Parking System Based on Bluetooth Low Energy Beacons with Particle Filtering Andrew Mackey, Student Member, IEEE, Petros Spachos, Senior Member, IEEE, and Konstantinos N. Plataniotis, Fellow, IEEE

[2] Batistic, L., & Tomic, M. (2018). *Overview of indoor positioning system technologies. 2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO).*

[3] Bluetooth-based Indoor Navigation Mobile System Adam Satan Institute of Information Science University of Miskolc Miskolc, Hungary satan@iit.uni-miskolc.hu. Satan, A. (2018). *Bluetooth-based indoor navigation mobile system. 2018 19th International Carpathian Control Conference (ICCC).*

[4] Intelligent Indoor Parking Győző Gódor*, Árpád Huszák* and Károly Farkas†, * † Inter-University Centre for Telecommunications and Informatics, Debrecen, Hungary *Department of Networked Systems and Services, Budapest University of Technology and Economics, Budapest, Hungary Email: {godorgy, huszak, farkask}@hit.bme.hu

[5] Improve Indoor Positioning Accuracy Using Filtered RSSI and Beacon Weight Approach in iBeacon Network Laial Alsmadi Faculty of Engineering and IT University of Technology Sydney Sydney, Australia Xiaoying Kong Faculty of Engineering and IT University of Technology Sydney Sydney, Australia Kumbesan Sandrasegaran Faculty of Engineering and IT University of Technology Sydney Sydney, Australia

[6] Recurrent Neural Networks For Accurate RSSI Indoor Localization Minh Tu Hoang, Brosnan Yuen, Xiaodai Dong, Tao Lu, Robert Westendorp, and Kishore Reddy.

[7] Insoft beacon Technology (online):
https://www.infsoft.com/technology/positioning-technologies/bluetooth-low-energy-beacons