School

of

Electronics and Communication Engineering

Minor Project Report

on

Museum Information Broadcasting

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled **" Museum Information Broadcasting"** is a bonafide work carried out by the student team **"Bhagyalakshmi M.K.(01FE18BEC042), Sakshi Dodamani(01FE18BEC149), Sanobar Mateen R Morab(01FE18BEC156)"**. The project report has been approved as it satisfies the requirements with respect to the mini project work prescribed by the university curriculum for BE (VI Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2021-2022.

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ABSTRACT

Museums have collection of artefacts at display for visitors. This project uses Blue-tooth Low Energy (BLE) ibeacon for each artefact that are placed around the museum. Users smart device having the custom built Application will detect BLE signal, using the strength of signal from the detected beacons: decides the information to be displayed to user. Thus approach to indoor detection based on UUID obtained and RSSI signal strength of available beacons is provided in this report.

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Chapter 1

Introduction

Positioning and localisation is the zest of modern applications. There are many applications relying on the location data for example real time tracking of delivers and recording of running routes. While GPS has become the standard technology for outdoor applications there is no similarity widespread technology for positioning indoors or in other areas where GPS is not available. With the rapid growth of Internet of Things [IOT] more and more devices around us are getting connected. Blue-tooth Low Energy[BLE] is one of the key technologies that enable this quick growth. One of the main advantage of BLE is that many state of the art indoor positioning system such as iBeacon or Estimote use BLE.

1.1 Motivation

- Tourism sector of a country is a continuous source of income, and that is because it wont get exhausted easily.
- Museum management still adopts conventional mechanisms, without involving the latest technological advancements.
- There is a large amount of data available on the artefacts in the museum,and there are may different types of artefacts and sometimes the museums fail to give the complete information about the artefacts to the visitor.

1.2 Objectives

- To develop a custom beacon detection application for Museum information broadcasting.
- To detect nearby artefacts, each of which is tagged with a beacon:broadcasting UUID (Universally Unique Identifier -iBeacon technology).
- To identify nearest artefact, provide information about the same. To add a technological touch to the conventional museums, which will attract the younger generation.

1.3 Literature survey

- Paper 1

  Title: Museum Interactive Information Broadcasting Using Indoor Positioning System and Blue-tooth Low Energy [1]

  Published on: December 2018

  This Blue-tooth Low Energy Pilot Project is implemented in Trowulan Museum Indonesia. Museum visitors can use their smart phone to receive BLE beacon signal. The application on smart phone will send the BLE beacon ID that they receive to the server then the server will gives BLE beacon location (on map). The application on smart phone will calculate BLE beacon signal strength (RSSI) and the BLE beacon location to locate the visitor location on the map. The server then will broadcast information about the artefact near the visitor. This information will attract the visitor to see the artefact on the museum.

- Paper 2

  Title: Indoor positioning system using BLE beacon to improve knowledge about museum visitors [2]

  Published on: February 2020

  This project tries to map the visitors location with the museum map. This mapping uses indoor positioning system using BLE beacons, these beacons are placed at some parts of the museum and the signals emitted by beacons are detected by the application that is installed on the museum visitor's mobile phone. The location of the visitor will be calculated using Trilateration method and Kalman filter. This application sends the data for the main server. The data is then mapped on the museum map using a website application to find out the location and how long visitors are at a particular location in the museum. Using this information the museum manager can analyse whether there are any particular locations in the museum that museum visitors rarely pass, the number of visitors enter each museum area at a particular time, which museum areas/artefacts that often visited by visitors, how long they spend time in each area and which artefacts get a lot of attention and time from visitors, whether each artefacts display placement is suitable to the museums needs. With this information, the museum manager can rearrange display artefacts etc.

1.4 Problem statement

Develop an application for Museum information broadcasting, which scans for available iBeacons and displays the information of artefact, based on the proximity(RSSI value).

1.5 Application in Societal Context

Museums are places where the all the artefacts are conserved obtained by the archaeologists so that the people who visit the museum get a chance to obtain knowledge about the history, like what kind of civilizations, eras have gone by to get what we have today. A recent study reveals that museums are being visited by the the people and it is also not reaching the expectancy level visitors want to widen their day at the venue and indoor navigation technology provides this . Indoor positioning systems has a lot of applications. The certain applications are way finding for humans in railway stations. Using the the indoor positioning system we will broadcast the data of the artefact to make sure the visitor gets all the information in order to increase the visitor experience.

1.6 Organization of the report

This report presents system design, implementation details and optimization discussion respectively in chapters 2,3 and 4 respectively.

- System design: In the system design section, how Each BLE beacons will broadcast their identification (UUID) using Bluetooth signal is explained. The application on user mobile phone will detect the beacon ID that is around it.
- Implementation Details: The project is implemented using Application installed on the visitor's Android phone that scans for beacon and displays the information of the artefact based on RSSI value.
- Optimization: Software optimization techniques.

Chapter 2

System design

In this chapter, we list out inferences and discuss on system functionality, working and expectation.

- In the museum, every art-piece is tagged with a BLE beacon.
- Each of these beacons will broadcast their own unique identification(UUID).
- Museum visitors will have to use their smart phone to receive beacon signal.
- An application extensively built for the museum, which has all information about the artefacts and also identifies beacons of the museum is to be installed on visitors smartphone.
- This application scans and lists all the beacons in the vicinity of mobile phone.
- Based on this information and beacon strength signal (RSSI), the application determines the nearest artefact tagged to the ID.
- The application server now broadcasts information about the artefact designated to be nearest among all available beacons, from previous computation.

2.1 Functional block diagram

Block diagram shown in Figure 2.1, depicts the transmitter and receiver sections of the entire Museum information broadcast system. As shown in the figure, transmitter is implemented using the simulator application. The transmitter as well as receiver applications both need blue-tooth to be enabled. The recent updates to the Google Android API affecting Bluetooth Low Energy(BLE) technology requires location permissions to be granted in order to use the application. Thus applications on both the ends will need two user permissions - to enable blue-tooth and access device location.

The beacon simulator accepts UUID to broadcast(this project strictly considers iBeacon transmitters). After configuring the beacon with UUID to be transmitted and transmission power, its put on broadcast mode. This configuration is to be done for each beacon(i.e. for each artefact) in the museum.

The receiver section of Museum information broadcast system is another application developed extensively for the specific Museum. After blue-tooth is enabled and location permission

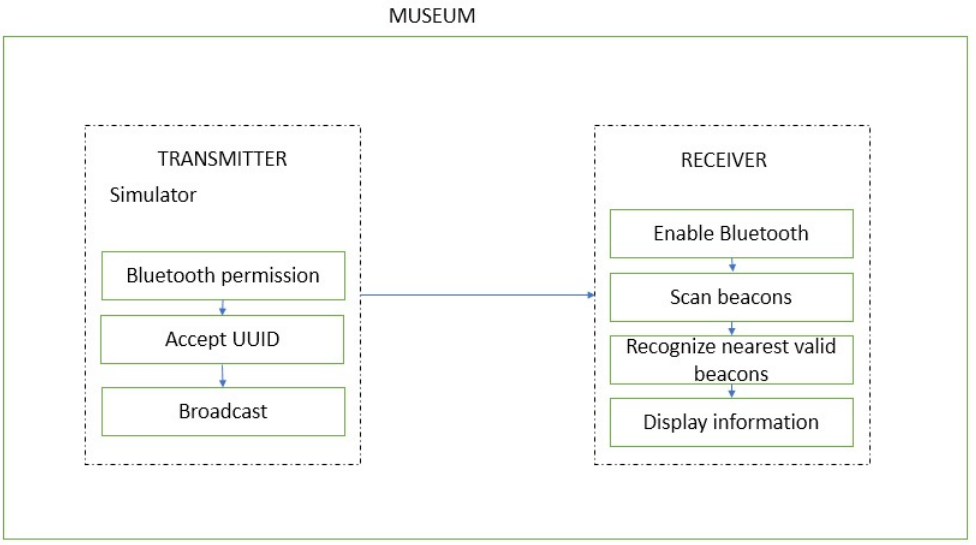


Figure 2.1: Block Diagram for Museum Information Broadcasting

granted, the application starts scanning for available/discoverable BLE devices. From this list of available BLE devices, nearest beacon is identified by the application. After identifying the nearest beacon, information about the artefact tagged with that beacon is displayed to museum visitor on the application in their smart device.

Chapter 3

Implementation details

3.1 Specifications

- Beacon(Signal Broadcasting): Application "Mobile Device Simulator for Beacons".
- Provisioner(Receiver): Custom built Application "Museum Beacon".
- IDE used for Android Application Development: ANDROID STUDIO.
- Bluetooth Communication Protocol used: iBeacon by Apple(introduced in 2013) Though introduced by Apple, it is also available on Android Devices.
- Beacon Library used: Android Beacon Library [3].

UUID Generation: 16 bit Universally Unique ID is obtained from official website of Bluetooth SIG(Special Interest Group) provides an online UUID generator tool [4].

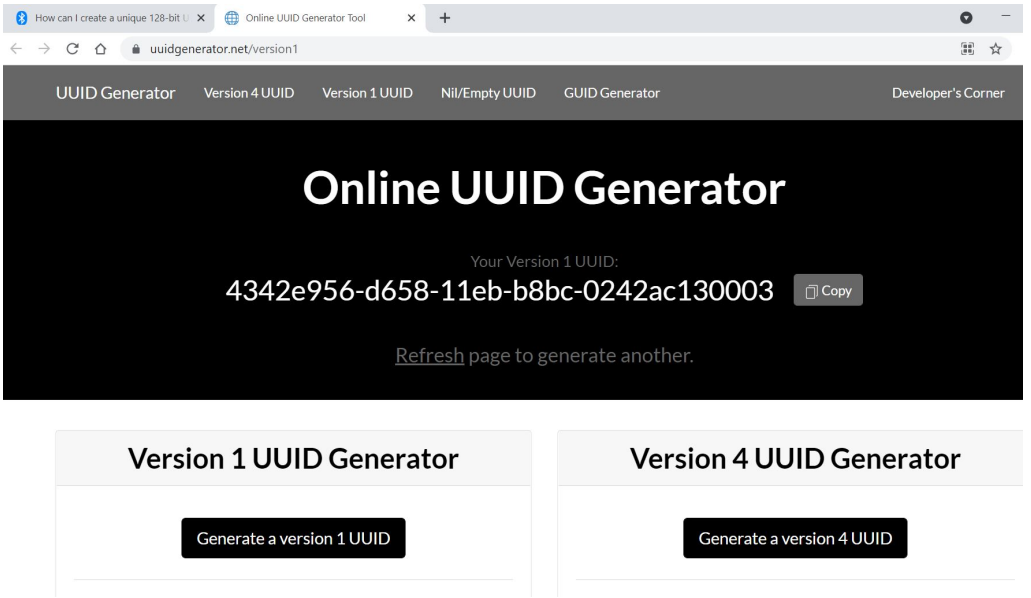


Figure 3.1: Online UUID Generator

Beacon Layout: The detection of ibeacons, relies on following Beacon format

"m:2-3=0215,i:4-19,i:20-21,i:22-23,p:24-24"

Table 3.1: Beacon Layout Details

m	matching byte sequence for this beacon type to parse (exactly one required)
s	ServiceUuid for this beacon type to parse (optional, only for Gatt-based beacons)
i	identifier (at least one required, multiple allowed)
p	power calibration field (exactly one required)
d	data field (optional, multiple allowed)
x	extra layout

For given format of iBeacon, referring Table 3.1 we infer that:

- **m:2-3=0215**
  iBeacon will be decoded when an advertisement is found with 0x0215 in bytes 2-3
- **i:4-19,i:20-21,i:22-23**
  Three-part identifier will be pulled out of bytes 4-19, bytes 20-21 and bytes 22-23, respectively
- **p:24-24**
  A signed power calibration value will be pulled out of byte 24

3.2 System Architecture

Figure 3.2 shows the final design to be implemented. The implementation demonstration uses 3 painting, thus 3 pre-defined UUID for each. UUID and the corresponding name of paintings are shown in Table 3.2

Table 3.2: Paintings and their assigned UUIDs'

UUID	Painting Name
1f6b3981-f247-4721-b847-bc62d412ff8e	Mona Lisa
3df861a4-0acd-4e47-8d49-8bfb478a0d2e	Starry Night
75b8098b-729e-4307-8a21-d9b8d729204b	Glow of Hope

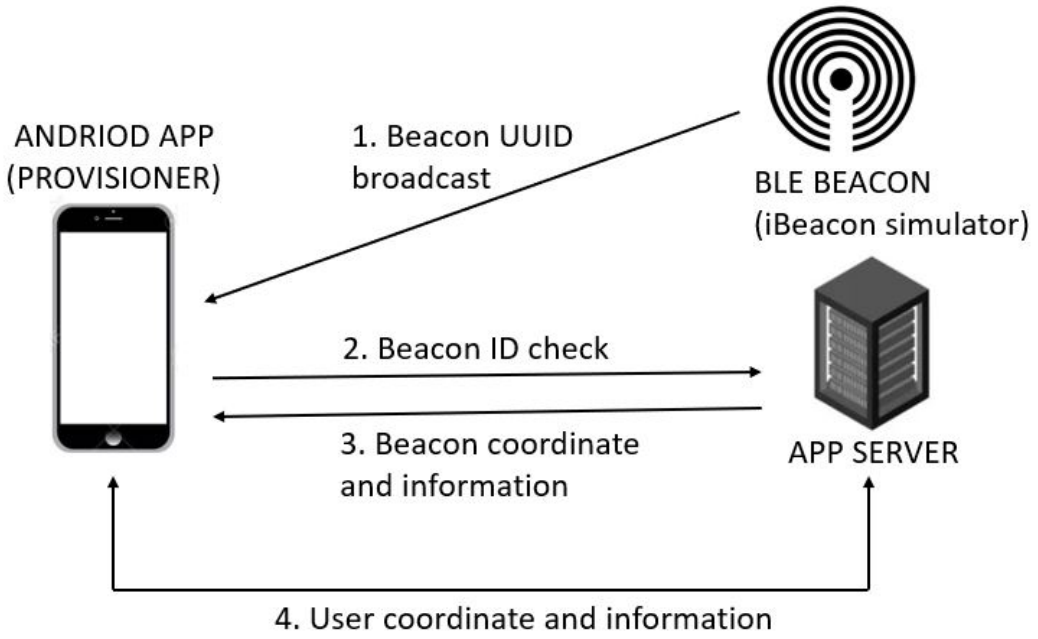


Figure 3.2: Final Design of transmission and reception

3.3 Algorithm

Beacon Simulator(transmitter)

1. Start application.
2. Create iBeacon, by providing UUID to transmit.
3. Begin the beacon broadcast.
4. Transmit the ibeacon packet every 125ms(default application value).

Receiver Application

1. Start application.
2. Enable blue-tooth.
3. Grant location permission.
4. Check if blue-tooth is enabled and location permission is granted if not, display message and shut down the application.
5. Otherwise, start BLE device scan.
6. Display the list of all discovered iBeacons.
7. If there are multiple beacons detected, the one with the strongest signal is identified.
8. Display information of the artefact tagged with this beacon.
9. Update beacon list and repeat steps from 5-8 periodically.
10. Stop

3.4 Flowchart

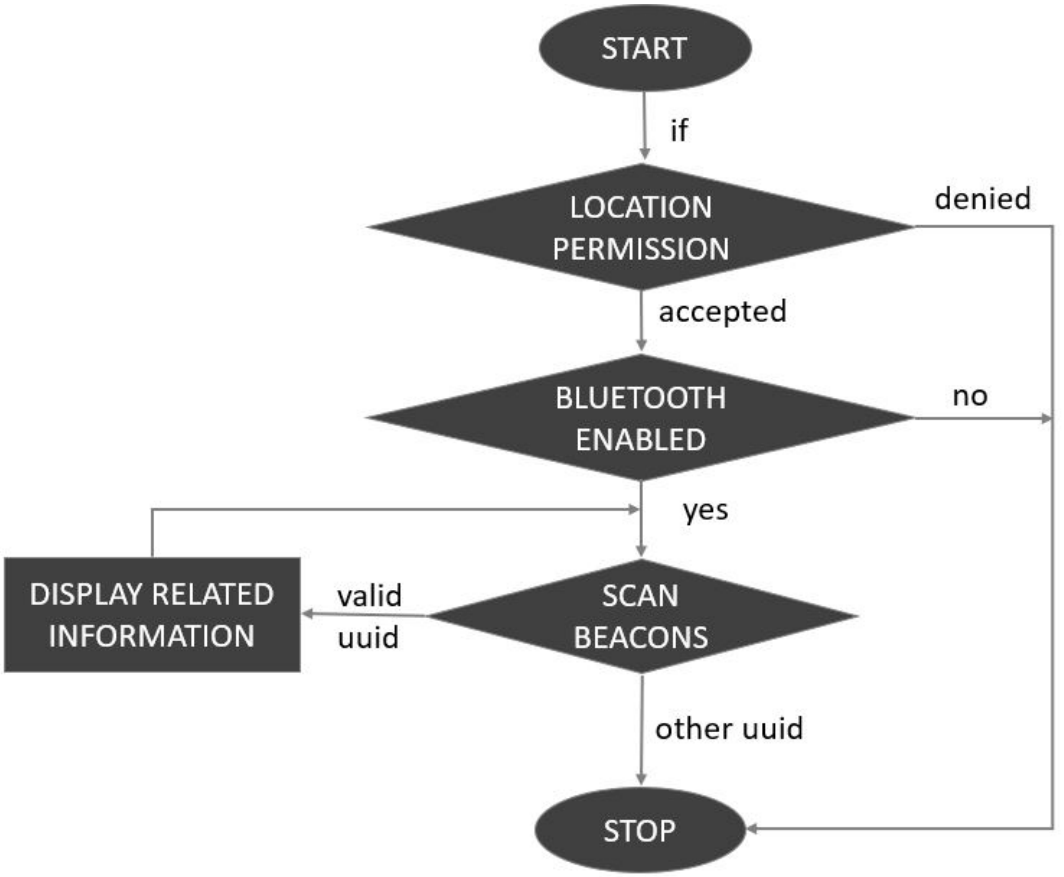


Figure 3.3: Flow Chart for BLE beacon detection application

Figure 3.3 shows flowchart for BLE receiver application. Once application is installed and launched in users android device, it asks for location permission. If accepted, application goes on to check if blue-tooth is enabled. In case if blue-tooth is off or location permission is denied application stops.

After setting up the application, iBeacon scan begins. If a beacon transmitting anyone UUID from Table 3.2 is detected, information about the related artefact is popped on application screen. If valid UUID is not detected, screen looks like as shown in the first row of Table 5.1.

Chapter 4

Results and discussions

This chapter discusses the implementation results for application "Discover Bluetooth".

4.1 Result Analysis

The transmitter section of system is implemented as a part of "Beacon Simulator" application, while receiver application is "Discover Bluetooth".

Figure 4.1 shows the pre-optimization result of ibeacon scan on receiver application "Discover Bluetooth". As seen in the figure, Beacon Simulator is simulating only two beacons, but the receiver application detects three bluetooth devices. That is, it detects the blue-tooth enabled smart-phone along with the beacons that the device is simulating.

Drawbacks of "Discover Bluetooth" Receiver Application:

1. As the name of App suggests, the receiver scanned all available "Bluetooth" as well as "BLE Beacons".
2. No dynamic updation of available beacons list.

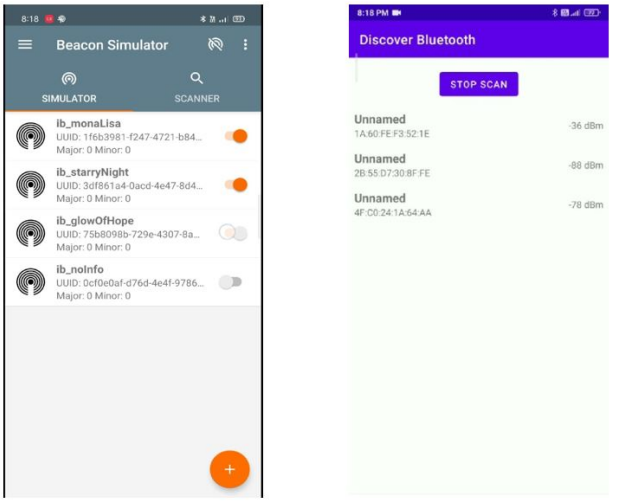


Figure 4.1: Pre-Optimization Result - available iBeacon list

Chapter 5

Optimization

5.1 Introduction to optimization

The previous chapter lists the drawbacks of first application built - 'Discover Bluetooth'. This chapter touches onto the improvements made over the application and provides a final full-fledged application ready to be installed on visitors smart-phone.

5.2 Optimization technique

Changes incorporated:

- Android Bluetooth functions scan for all available Bluetooth devices, thus we shift to Android Beacon Library. This narrows the devices detected to BLE beacons only [3].
- Scan for the beacons periodically and update list.

The final application thus developed after all discussed optimizations is - "Museum Beacon"

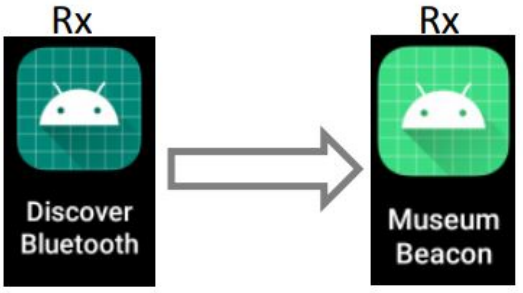


Figure 5.1: "Museum Beacon" - optimised application over "Discover Bluetooth"

5.3 Post Optimization results

In Figure 5.2 we observe the number of detected BLE devices is equal to the number of beacons being broadcast. This shows, the detection of beacons alone and not bluetooth devices.

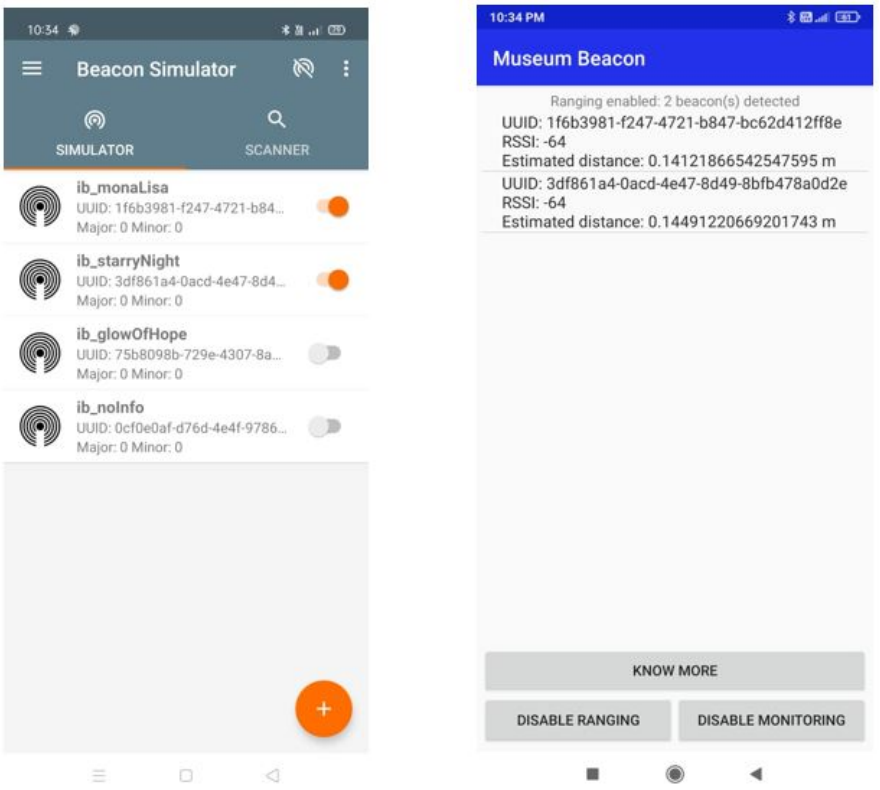
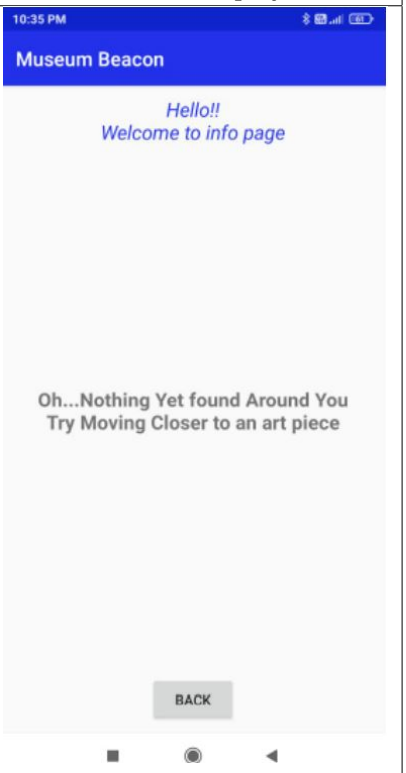
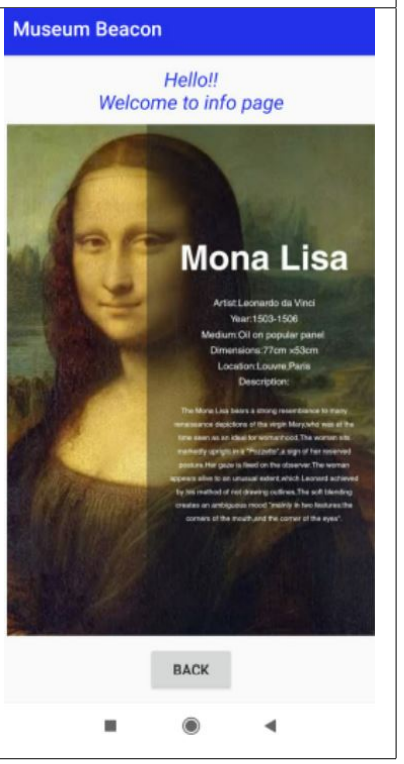
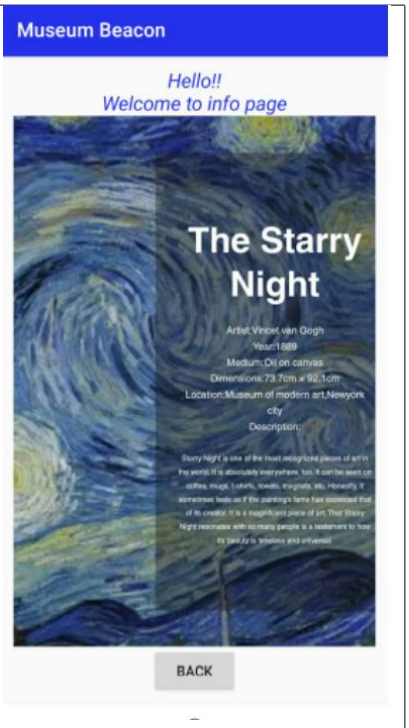
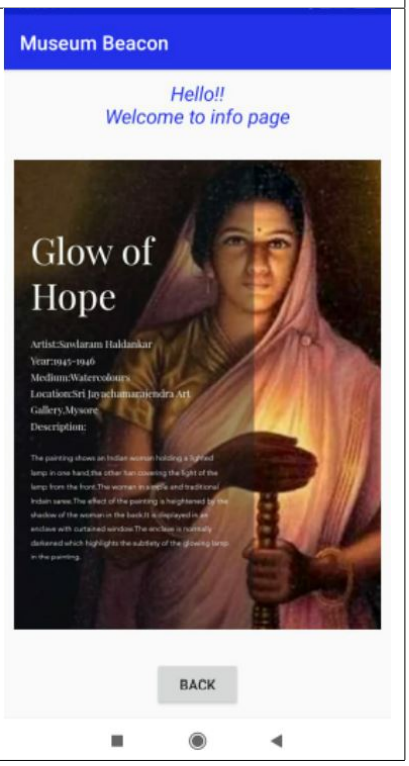


Figure 5.2: Post-Optimization Result

Below Table 5.1 shows the screen output for various conditions:

Table 5.1: Condtion and respective screen Display

Condition	Screen Display
When there is no beacon	
Beacon of 'Mona Lisa' is nearest	

Beacon of 'Starry Night' is nearest	
Beacon of 'Glow of hope' is nearest	

Chapter 6

Conclusions and future scope

6.1 Conclusion

- The desired receiver app has been built and tested for iBeacons.
- The information displayed changes based on which beacon has strongest RSSI value among all available beacons.
- The application is tested using Beacon Simulator.

6.2 Future scope

BLE beacons are easy to install and maintain and most of the organizations prefer it in order to improve their customer experience. There is a high demand for this technology in shopping malls, museums, exhibition, parks and everywhere, where indoor navigation and location-based content is important.

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