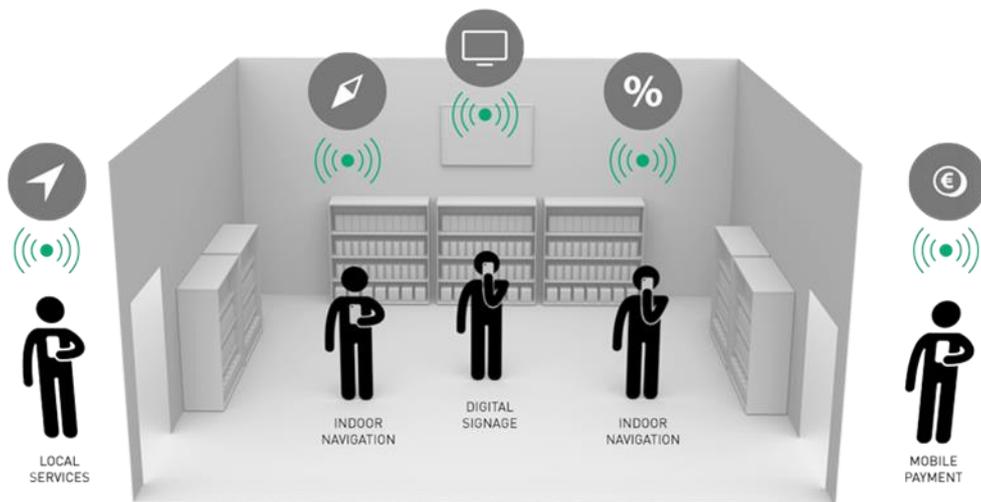


Using Beacons for Location-based targeted advertisement to nearby users.



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One Semester Project (40 Credits)

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Project Description

Beacon technology is changing the way consumers interact with brands, making devices more helpful, smart and ultimately revolutionizing the way retailers measure the offline impact of online ads, and engaging nearby users with information that they wish to discover and be interested in.

Nearby notifications make shopping better by helping shoppers get things done with their phone, such as scanning items to get reviews or splitting the bill for their table in a restaurant. The technology also makes it easier for consumers to get useful information, whether that means seeing if an item is in stock or locating that same item while in-store.

While these kinds of communications often rely on other types of location signals, beacon signals take precision and quality to the next level, compared to other technology's such as geofencing. For its users, beacons can give a brand an edge in a world where omni-channel shopping is becoming the norm and consumers expect to get what they want, when they want it. A survey conducted by Food and Drug Administration (FDA) shows that shoppers are more willing to shop at places where they are able to locate a specific item in less than 2 minutes and wish to learn more about they buy, this shows us that having the information if an item is in stock or locating that same item while in-store and providing in-depth information about and item is vital for customers.

In this project I will be developing a IOS mobile application and the back-end software and hardware infrastructure that allows beacons to transmit targeted advertisements to nearby users. In-order to create the low voltage transmitting beacons I will be using Raspberry Pi's and Bluetooth modules.

There are a number of functionalities that must be taken into consideration when undergoing this project. Focusing on the most important aspect of the system which is the creating the proximity algorithm, that allows us to calculate how close we are to the emitting source, this information allows to interact with the physical environment and provide feedback to the user.

The core project relies on the using Bluetooth low energy beacons, that transmits proximity information, in order to create this hardware, I will be using Raspberry Pi version 2 and Bluetooth modules, with custom scripts running in order to create a mesh network, that allows many Raspberry Pi's to share information and interactions of users.

A number of additional functionalities will be implemented to give the user more information regarding nearby products, whether that means seeing if an item is in stock or locating that same item while in-store, this information is delivered via nearby notifications when the user enters a proximity range.

The system will also collect user proximal data, as this information will allow us in a later date to deduce what areas are most popular and create a user travel log, which contains which path the user took and how long they stayed in a specific area for.

I will plan to initially develop the main functionality of the app and hardware infrastructure, then iterate on the mobile app in order to ensuring it abides with human computer interaction and the modularity of system design and its extensibility

Project Aims and Objectives

To create the system, I will be using a number of programming languages and hardware to construct a fully operational beacons node and IOS app that responds to the beacon's transmitted data. For IOS development I will be using Objective C and swift. On backend infrastructure I will be running python, MariaDB for remote database access and bash scripts for automation. The hardware used in development of a beacon node is Raspberry Pi version 2 and Bluetooth 4.0 USB Module.

Objectives

The main objectives for my application is to reach its aims are as follows:

- Construction of low voltage Bluetooth beacons that transmit information to mobile devices.
- Design and develop an algorithm that computes the proximity between a transmitting beacon and mobile device.
- Design and develop a web platform that allows users set desired behaviour to specific beacon when in proximal range of its user.
- Design and implement a mobile user application that responds to a beacon's characteristics when the phone enters in the beacon's proximal range
- Test the developed system using a representative synthetic data sets, and evaluate how the system responds to it.
- Evaluate the usability of the developed application, by testing it out in focus groups.
- Collect feedback from testing in order to support the study of how to use beacons to provide Location-based targeted advertisement to nearby users.

Assumptions

For this application to work, it is assumed that the IOS application is going to be developed for use on very recent phones and for latest version of IOS (Version 9.0) Furthermore it is assumed that the phone will have Bluetooth connectivity and user will have a network connection to use the application's remote database as it relies on this data to display product information, whether it be via Wi-Fi or mobile data.

Core Functionality (Essential Options)

- Application must be able to locate and calculate the distance of the nearest beacons.
 - This method relies on the assumption the user is on the app somewhere within a reasonable distance of a nearby beacon's proximity range, if not no proximity driven events will be triggered.
- Application should be able interact with nearby beacons and display selected notifications/product information when the user is in defined proximal range.
 - This method relies on the assumption the user is within a reasonable distance of a nearby beacon's proximity range, if not no proximity driven events will be triggered.
 - The method relies on the assumption, if there is an edge case when multiple signal/distance from a beacons are the same, we display all of their information in an appropriate manor.
- The software and hardware infrastructure will be created in a modular fashion thus providing greater extensibility for the project in a later date.

- Each of the beacon node should work a fault tolerant structure.
- Easy to Use Interface, the mobile application's user interface will need to be as intuitive as possible to ensure it is easy to use for its user.
 - This means having a logical navigation system in place to allow them to transition between different screens sensibly and with ease in order to view different pieces of information when in range to a specific beacon.
 - The chosen design of the interface abides with human computer interaction principles.

Advanced Functionality (Desirable Options)

- Create a web platform that can be used to program each of the beacon nodes and its desired interaction.
 - The desired interaction can be in the form of nearby notifications or screen changes with relevant information.
- To get the application to collect user proximal data, as this information will allow us to deduce what areas are most popular and create a user travel log, which contains which path the user took and how long they stayed in a specific area for.

System Software Design & Architecture

Throughout the development of the application design and development, I will keep all parts of the application consistent as much possible while trying to keep good usability and accessibility while trying to maximise efficiency. The software and hardware infrastructure will be developed in a modular fashion so it providing greater extensibility for the project in a later date. I will also try to follow the best coding practices and document all sections of my code.

Ethics

Referring to the Ethical guidelines set out by Cardiff University (Spasic, 2015) I have concluded that that I do not need to seek Ethical Approval. During my project I will not be conducting any interviews and any data I use will either be my own personal data or fabricated test data. The proximal data that I am collecting is sensitive and valuable, if I was approaching this project in a commercial and production environment, then I will need to follow the guidelines set out by their respected authorities. I feel that the scope of the project does not warrant the need for me to seek ethical approval. However, as the project progresses this may change, therefore I will be reviewing the ethical guidelines throughout my project.

Work Plan

In addition to everything on the work plan detailed below, I will be meeting my supervisor Dr Alia Abdelmoty on a weekly basis to discuss plans for next week in addition to progress made earlier. In terms of software development cycle, I will be using agile development with sprints as I feel my product will benefit from a new product development (NPD) and it allows me to set specific targets to reach by sprints at any time, while reducing risks.

Week 1 - 30/01/17 Background Research & Initial Plan

- Creating the Initial Plan
- Meet with supervisor
- Complete background research to assist with system requirements and functionalities
 - Test and investigate some similar technologies and their trades offs.
 - Research on low voltage beacon data transmission and background knowledge about the implementation of beacon technology in Raspberry Pi and IOS framework that interact with beacon data.
- Milestone: Submit the Initial Plan, Complete background research and Meet with Supervisor

Week 2: 06/02/17 Learning IOS, Further Background Research & Risk Assessment

- Source the hardware that is required to create the low voltage Bluetooth beacons.
- Conduct further research on the selected hardware and start to prototype a basic proximity algorithm.
- Learn IOS development thoroughly via the official IOS programming course and start to test out the Bluetooth transmission from the Raspberry Pi.
- Create a risk assessment to see if any problems occur and provide feasible solutions
- Identify the social, legal and ethical issues with the system to be created
- Draw up the system and software architecture
- Meet with supervisor
- Milestone: Complete risk assessment, identify social, legal and ethical issues and be fluent with the IOS SDK and be confident implementing an android application and the hardware development of the system. Also discover/create a reasonable pseudo - solution to calculating proximity between of emitting beacon and phone.

Week 3: 13/02/17 Creation of Design Flow & System Architecture

- Design flow of user interface and create the mock ups of the front end User Interface and detailing the HCI about how the application functions.
- Complete the system architecture on how the Bluetooth beacons will interact with each other, and start to develop software system where each beacons can transmit meaning full information.
- Begin implementing the front end elements on the IOS application without functionality
- Start development of system

- Setup working environment of the app
- Start development of front & back end
- Start development of API and database design
- Milestone: Complete system architecture & API design, complete flow of app and HCI UI design plan that abides with human computer interaction principles.

Week 4: 20/02/17 Front End Development of the Application and API Design

- Have the interactive aspect of the app and its features implemented
 - Continue front end development
 - Link up all pages
- Continue development of database and API
- Start development of Bluetooth transmission script and deployment on Raspberry Pi.
- Milestone: Have fully working the front end user interface of product information displayed and be able to select between different items in range.

Week 5: 27/02/17 Creation of The Proximity Algorithm

- Begin extended research on proximity algorithm for nearest/strongest signal emitted from the beacons in order to deduce which beacon is closest to the user and reduce background noise from other Bluetooth emitting devices.
 - This may involve first hand research of electrical engineering experts or someone who has more expertise in this domain.
- If there already exists such algorithm, then I will aim to utilise it and modify it according to my needs.
- Start implementation of the algorithm with the hardware.
- Milestone: Discover a feasible solution to calculate the proximity from the transmitted beacon and the user's phone, and start on partial implementation of algorithm on to Raspberry Pi.

Week 6: 06/03/17 Integration of User's Bluetooth Connectivity & Detection On Nearby Beacons

- Use IOS's Swift Framework's API to attain the user's Bluetooth connectivity information from the application.
- Get the application to detect which beacons are in range and how far they away are from the source, and identify each beacon uniquely.
- Milestone: Be able to retrieve the user's proximity information and use this information to accurately calculate how far they are from a beacon in app.

Week 7: 13/03/17 System Automation & Data Logging

- Implement a way to uniquely identify each beacons in range, and use this information to log each beacon's properties in database, so the when the user is in range it will trigger the desired function inside application.
- Write automation scripts for the Raspberry Pi, so that upon boot it will start to broadcast the desired Bluetooth information.

- Supervisor meeting to review progress
- Milestone: Raspberry Pi will run the desired scripts and starts to transmits information to the application upon boot. Be able uniquely identify each active beacons and retrieve it's set properties from remote database from the application. I will be having meeting with the supervisor to ensure I'm on the correct track and doing well to meet all targets and get any help from the problems I am facing.

Week 8: 20/03/17 - Week 9: 27/03/17 Web Platform Development

- Continue development of beacon nodes and application.
- Start development of the web platform, that allows us to set beacons properties
 - Implement properties such as nearby notification & and product display when near a specific beacon range.
- Test beacons with in a controlled area to ensure the set properties are functioning as intended to.
- Collect feedback from the testing, and iterate in product development until achieving the desired output.
- Review meeting with Supervisor.
- Milestone: Development and implementation of proximity driven features in app, test beacons in a controlled area, write up report on web platform development and testing of beacons.

Week 10: 03/04/17

- Supervisor meeting to review progress
- Review the whole product and system infrastructure before entering testing phase, carry out risk analyses and test platform, application and infrastructure in all possible edge cases.
- Refine product iteratively, until desired output is achieved.
- Milestone: the application is ready to enter testing phase, and will be having meeting with my supervisor to ensure I'm on the correct track and doing well to meet all targets and get any help from the problems I am facing.

Week 11: 10/04/17 (Easter Break Starts 8th) Testing Stage 1 & Start on Final Report

- Create test case documents
- Start user testing & unit testing on code
- Start to write up the final report
- Milestone: Complete the test cases, complete user testing and unit testing, write up report for testing, write up report on test case documents

Week 12: 17/04/17 Testing Stage 2 & Final Report

- Supervisor meeting to review progress
- Continue working on the final report
- Should have all core functionality implemented and running as intended to, hopefully most/all of the advanced requirements (If not, continued extended work on this)
- From the testing plan devised ensure all areas and objectives covered are thoroughly tested.
- Testing and evaluation of application in all parts should be finished in this week.

- Milestone: In the meeting with the supervisor to ensure I'm on track and doing well to meet all targets and get guidance if needed

Week 13: 24/04/17 Final Report Writing

- Write up final report
- Contingency time
 - Test and update existing functionalities
 - Add desirable functionality if time is available

Week 14: 01/05/17 (Easter Break Ends 30th)

- Contingency time.
 - Test and update existing functionalities.
- Write up report.
- Milestone: Complete the final report.

Deadline: 05/05/17

- Upload final report

References

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