LITERATURE REVIEW

Kevin Dunne   K00232599

Jekaterina Pavlenko   K00224431

Christopher Costelloe K00233369

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1. Introduction

This literature review will cover the different technologies that the projects need to have researched and some that might be used or implemented in the upcoming project. The technologies involved are Azure for the projects database and web hosting needs, Bluetooth Beacon, NFC & QR Code Technology for the hardware needs etc. The main target of usage will be colleges, hospitals, airports & so on. Buildings where people usually most struggle to orientate themselves in. The research will be how indoor GPS was implemented and where it has been used before. The main goal will be to achieve not just cheap & cheerful version of indoor GPS system for people, but also make it precise & efficient one as much as possible by using mix of technologies mentioned above. The goal is to prevent people from getting lost, where the application/system is supported & to help people to find the best way to their destination with less stress & on time.

2. Pre-existing Technologies

The first thing that was researched was about the different companies that have implemented or are planning to implement indoor GPS navigation and companies who are doing research and are inventing new tools to make implementing this technology easier.

The first company that researched was researched was Infsoft which was one of the leading indoor GPS navigation companies around, the research that was done helped explain and understand exactly how this company was using their software in conjunction with hardware to map out their warehouses. (Infsoft.com, 2019)

The hardware that was used was a Bluetooth beacon to setup positions inside a building injunction with Wi-Fi to have a constant signal which they can use, they have also created Infsoft Locator Nodes and Infsoft Locator Tags which actually allow them to track people and assets in real time in any of their buildings. (Infsoft.com, 2019)

The most interesting aspect of indoor navigation is the absolutely amazing amount of versatility it offers different people and companies through tracking different machines, packages, people in factories and collecting analytical data to help optimise their system and work output, one of the most surprising things that was discovered about this was how it is possible to track different customers inside a shop that has a specific layout to see how much each person spent at one zone or what path they

choose to take. Information like this has an immense value to business owners because it can help them optimise their store to make more money. (Infsoft.com, 2019)

One of the most important factors in indoor GPS navigation that was researched was their essential need for reliance, one important factor that was researched showcases what would happen if multiple vehicles that were all automated and guided by an indoor GPS navigation system were not efficient and caused different vehicles to run into each other causing untold amounts of damage. This is a very real and serious situation and has the potential to be quite dangerous for people as well, because of congestion in buildings or vehicles moving around that had incorrect sensors that might crash into a person. All these factors must be taken into account when designing a system like this.

GiPStech is another leading indoor navigation technology company that has been paving the way for a variety of new advancements involving indoor navigation, this company has created a new way of creating an indoor navigation system by using an infrastructure free which involves the use of no Bluetooth beacons, this is a massive step forward in indoor navigation because most companies use standard or specialized beacons as the focal point of their entire indoor navigation system and because the next generation of indoor GPS navigation seems to be moving away from this and just using Wi-Fi signals and the geomagnetic signals that were already installed in the location as the data sources to accurately pinpoint the location inside the building. (GiPStech, 2019)

3. Upcoming Technologies

The constant advancement of indoor GPS navigation technology has been steadily increasing as the incredible importance of this technology grows increasing more essential in everyday life, they benefits this technology offers is incredible and because it is used in so many applications which nearly all ask for or require a GPS location, the need for a more sophisticated GPS location based software has been steadily increasing which has seen a variety of companies around the world invest heavily into sophisticated and low tech solutions such as Google, Apple and Infsoft.

The future of indoor GPS navigation is constantly changing and evolving and one of the biggest reason for this push is customer convenience, the customer wants to find

the way around a building quickly and easily but this can be enhanced by connecting navigation apps with different retail shops inside a shopping centre for example, the next logical step is for a person who is looking for an item online then to connect that to their GPS navigation application and be delivered a real time path inside a building to that item, this is the future of indoor navigation, the technology to delivery this does not exist in just one form but many forms such as Bluetooth navigation in conjunction with real time location technology all of these will come together in the future to deliver this incredible accurate technology. (Directionsmag.com, 2019)

4. Web Hosting

The web hosting companies that were researched were Amazon Web Services and Azure Hosting, the first company that was researched was Amazon Web Services which during the research had discovered offered a free 12 month subscriptions on multiple different services such as database, web hosting etc. which the project need for a variety of roles.

The first thing that was looked at were the differences between the 2 different services just to check did either have any large negative service that would impact the project and the research concluded that both companies offered quite similar services with negligible differences.

Azure hosting is the main hosting company that the project will be using for the database and web hosting needs in the application, the research that was done helped conclude that students actually have a free 12 month subscription because the college created students accounts with Microsoft which allows the students to use all Microsoft applications which include Azure, which is an incredible benefit to the project because of the wide array of options it offers and with it being free this has also allowed the project more flexibility because it can now save money by not needing to use other hosting applications which depending on the company are either lower quality hosting sites or reliable and good hosting companies which charge an extraordinary amount of money which the project could not afford.

The reason Azure Hosting was chosen compared to Amazon Webserver which also offer very good services is because the research that was undertaken lead to the

conclusion that Azure offered the best mix of these services compared to the other hosting companies.

- Availability
- Azure Software Development Kit
- Scalability and flexibility
- Stability
- Recovery
- Integration Tools

The Azure application allows the use of a variety of different development environments such as eclipse, visual studio, NetBeans, mySQL and many more, this offers the project an immense amount of flexibility because all these applications have a variety of tools which can be used for great effect in the project, the Azure web hosting technology require .net framework experience which is problematic because it is not taught, the benefits of being able to using other IDEs is because azure is cross platform friendly it accepts a variety of different types which negates the need to know .net framework which is an immense benefit for the project.

The azure application can be used in conjunction with GitHub to pull new code from the project repositories and used to update both the web front and database back end of the project which offers a flexible and stable backup and upload centre.

Azure hosting had a nice mix of all these features and even more that helped realise that this is the best choice for the project (TechRepublic, 2019)

5. Bluetooth Beacon Technology

Bluetooth Technology was begun in 1989 by Dr. Nils Rydbeck and Dr. Johan Ullman. First goal was to make wireless headsets. After that each generation of Bluetooth was adding new features to it.

Bluetooth Beacons is hardware data transmitters at short-wavelength radio waves, from 2.4 to 2.485 GHz, between two and more devices that are near and performing actions when a device is close to the beacon. This technology usually used to determine physical location & to respond as a location-based action to a device. Bluetooth Beacons come in variety of forms, from coin-size cell to USB stick.

The idea how Bluetooth beacon works:

1. Information broadcasted from a beacon
2. Phone receives information and sends to backend systems
3. Analytics backend systems receive and process the data
4. Notification is delivered over network to mobile application

From Bluetooth 4.0 version, it is possible one-way communication, when Bluetooth device just transfer the data, but not listen for it. Also, it works with less impact on the battery life and with good extended precision.

Bluetooth Beacons come with variety of powering design as well: battery powered, which the project is going to use, & USB powered, which are good for a long-term installation option. As the project is going to use battery powered beacons then the manufacturer specifications related to power consumption, interval transmit power, also must be in count approximate frequency of usage and think by what kind of phones, it might be use. Battery powered beacons life range is about from 1 month to 2 years.

There is two most popular version of this technology – 4.2 and 5. Bluetooth 5 improved version, of course, with more speed, which is 2 times higher than at 4.2 - 2 Mbps against 1 Mbps & with more range, which is 4 times higher – till 40 metres indoor range. Power consumptions of Bluetooth is less than previous version & battery life is longer. Also, capacity of message larger, 255 bytes against 31 bytes.

The project plan is to use about 2-3 beacons per building, just as checkpoints of user's location.

Mobile Device support – Android and iOS do not do it natively and a generic application is needed for that.

Other usage of the beacons is location-based advertising, healthcare (in-home monitoring), customer data collecting for improving customer loyalty with special offers, payments accepting etc.

6. NFC Tag Technology

NFC tags (abbreviation for Near Field Communication) are basically, small stickers, of round or square shape and the size of the coin, with integrated circuit that able to store data and transfer it between NFC-enabled devices such as smartphones and

tablets. In wireless world, NFC's closest relative is RFID, which stands for Radio Frequency Identification. NFC readers work at ~10 cm of maximum range.

NFC tags are passive, because they don't have any power source. They take power from the device that reads them by using magnetic induction. When reader-device gets close enough to an NFC tag, it energizes the tag and then transfer the data from the tag. There is always some power lost during the transmission, but it is usually still enough to power the NFC tag. They 'steal' a bit a power battery of the phone to kick in, basically.

NFC tags can be with different memory capacities. It's possible to store a telephone number or URL (web address), also there is opportunity to add the protection – NFC tags can be locked, once data has been written, it cannot be changed. They can be re-encoded a few times before they are locked forever. During the research, 5 different types of tags were found, with different capacities and data transfer speed:

Type 1 & 2 store from 48 bytes up to 2 kilobytes of data and communication speed is up to 106 Kbit/s. These types of tags can be rewritten several times and also be permanently locked, so no one could apply any changes to data. These tags able to store something short like a website URL – a simple piece of information.

Type 1 is used for read-only applications, business cards etc. Type 2 is more popular, because offers more functionality and has relatively cheap price. Type 2 used for low-value transactions, event tickets, URL redirects etc.

Type 3 stores up to 32 KB and communication speed is up to 212 Kbit/s. It provides a wide range of the functionality, but price is quite high. These types can be written only once and has the lack of security. It used for more complicated applications such as E-tickets, electronic ID, membership cards, etc. It is very widely used in Asia, because it is Japanese innovation.

Type 4 has the same capacity, but speed is up to 424 Kbit/s and offers most of the flexibility and memory but has high price for it. Also, it provides a good security.

Type 5 is used for library books, products and ticketing applications.

It's a quick and efficient way to push any information to your phone. Also, they are very cheap to make, maintain and can be used for wide range of apps.

7. Barcode & QR Code Technology

7.1 Barcodes

"The barcode was invented by Norman Joseph Woodland and Bernard Silver and patented in the US in 1951. The invention was based on Morse code that was extended to thin and thick bars." (En.wikipedia.org, 2019)

"Barcodes became commercially successful when they were used to automate supermarket checkout systems, a task for which they have become almost universal. Their use has spread to many other tasks that are generically referred to as automatic identification and data capture (AIDC)" (En.wikipedia.org, 2019)

"GS1"is a company that provides barcodes to organisations and has a comprehensive list of steps that can be followed to obtain a barcode (see link above). A barcode consists of a prefix of 2 or 3 characters and a company number, which can be assigned to an organisation by GS1 (and other companies). Once these are assigned, then a decision has to be made as to the type of barcode to be used, from a simple code, to one that can contain URL information, from codes to be used at a POS device (must support omni-directional scanning), warehouse (larger size codes for distribution scanning) or healthcare items (omni-direction scanning not required), all require different types of barcodes. (Gs1.org, 2019)

The project will have the capability of be using bar-codes that have been generated by either a web-service or program, The project will be using a variety of options when it comes to enable the generation of barcodes for use within the project / application, to allow the users of the application to identify where they are. (Windows Report | Error-free Tech Life, 2019)

Since the generated barcodes are compliant with current standards, any standard or conventional barcode reader will be able to read the generated barcode, The options that were researched has shown that it is possible to install onto an Android Phone, an App that can read both Barcodes and QR codes, and this can be used to test the readability of the barcodes that have generated. (wikiHow, 2019)

7.2 QR Codes

QR code (abbreviated from Quick Response code) is the trademark for a type of matrix barcode (or two-dimensional barcode) first designed in 1994 for the automotive industry in Japan. A barcode is a machine-readable optical label that contains information about the item to which it is attached. In practice, QR codes often contain data for a locator, identifier, or tracker that points to a website or application. A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently. (En.wikipedia.org, 2019)

QR Codes are now very common and can be found almost anywhere and nearly all smartphones can scan a QR Code and act on the contents of the QR Code. From bringing a user to a site, allowing for payments, for virtual store shopping, website and Wi-Fi network logins to the ability to have QR codes engraved on headstones so that visitors to a gravesite can find out about who was buried there and possibly, information about their life.

Since QR Codes are now so common, it is nearly mandatory for the project to be able to read QR codes as they are very easy to generate, the same websites and applications for barcodes can be used for QR Codes. Users of the project / application may be more familiar with scanning in QR Codes than Barcodes, but the project / application will support both methods, as well as Bluetooth beacons and NFC Tags.

8. Conclusion

The research that has been undertaken for the project has been immense and extremely enlightening, the different ways researched about indoor navigation have been the tip of the iceberg because of the vast ways the different technology can work separately or in conjunction with each other such as using Bluetooth beacons to tri-angulate the users current destination within a meter is ground breaking and this is just using Bluetooth technology without adding in NFC tags to create an stunning acutely map of a building that can monitor a user every foot inside a building.

The constantly advancement of this technology will lead to constant new advancements in the future at the pace it is progressing, the project will utilise these technologies in a cost-effective way to help jumpstart more low-tech solutions to indoor GPS navigation.

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