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Patient Monitoring Systems Using Beacons

Abhishek Katiyar [1], Sunil Koul[2], Nishant Chandak[3], Karan Ghadage[4] and Amit Sonawane[5]
[1,2,3,4,5] Information Technology, SPPU, MIT AOE Pune India

[1]katiyarabhishekh@it.mitaoe.ac.in, [2]sunilkoul1911@gmail.com, [3]chandaknishant@gmail.com,[4]karan900555@gmail.com,
[5]assonawane@it.maepune.ac.in

Corresponding Author: Abhishek Katiyar

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Abstract

Health today has become a significant part of this inter connected world, where doctors and patients are daily mobile users. So, modern health-care needs to find a better way to adopt digital world in health-care which includes real-time, fast and efficient ways of storing and accessing patients' data. For this purpose, beacons which are small Bluetooth devices that broadcast a near-constant radio signal that help to automate internal operations at hospitals, by granting digital access to information, and expedite the process of meeting and helping patients. The broadcasted signals are fed to any smart device as a pop-up message to make doctors aware about the current health information, date of admission, reports and disease and emergency actions to be taken, by simply entering into the region covered under beacons. With constantly changing plans it becomes very difficult for doctors and nurses to move fast and rapidly. Doctors and nurses can save their time running from one patient to the other can spend the time working on their main objectives instead of looking into physical patient files, which however will be provided digitally by beacons in real-time. Beacons once installed near every possible desk can notify hospital staff and nurses about their schedules and provide them real access to information such as patients' prescriptions, important work etc. on their smart devices. Moreover, it becomes easy for low-risk admitted patients to follow their daily routine as prescribed by just a single pop-up message on mobile devices. The use of beacons not only reduces time but also the involvement of nurses and other staff and leads to better health-care security and data compliance practices.
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Keywords: *iBeacons, Eddystone, Hospitals, Bluetooth low energy (BLE).*

I. INTRODUCTION (HEADING 1)

The topic "Beacons in hospitals" focuses on how efficiently its administration and staff is working. World is changing with the lightning speed and using old traditional ways of working in any field will fail to cope up with this speed, hence implementing beacons in hospitals will not only enhance the speed but also the quality. Beacons in Hospitals is a project that will help to automate internal processes at hospitals by providing digital access to information and ease the process of meeting and helping patients using Beacons.

A beacon is a Bluetooth radio transmitter. It continuously transmits a signal which the other devices sense. A beacon continuously broadcasts a radio signal which is a combination of a number and a letter. It sends this signals continuously at a regular interval. Any smartphone with Bluetooth facility locates a beacon once it is in range just like how boats locate a lighthouse to know their position. Bluetooth provides the infrastructure for the entire beacon ecosystem it's a standard for sending the data over short distances, a wireless technology not so dissimilar from Wi-Fi, as a result beacon hardware is simple. BLE stands for "Bluetooth low energy" it is a power efficient version of Bluetooth. BLE enabled beacons to run on tiny coin cell batteries it consumes less energy than the traditional Bluetooth. BLE is a concept of IOT which follows traits of advanced technology along with long lifespan.

This system provides a digital platform for doctors and nurses enabling them to work fast and efficiently in a busy Hospital. This System allows Doctors to retrieve all medical history of a patient as soon as Doctor enters patient's room. Doctors and nurses get their duty schedule using this system. This system keeps records of patients without hectic task of managing files.

II. LITERATURE SURVEY

A lot of research has been done in the field of Beacon and Wi-Fi technology.

Zhouchi Li, Yang Vang, KavehPahlavan proposed a system for baby tracking in hospitals using iBeacons technology in a conference held on 23rd march 2016. They proposed that for baby tracking iBeacon technology could be used as iBeacons broadcasts signal after every small interval. Even so this technology would be more reliable than RFID. In this paper they also proposed to develop a new application which would take data from iBeacon and then derive the iBeacon path loss model for line of sight situation in a closed room environment on basis of RSS analysis. After the feasibility analysis they concluded their work with a brief discussion on the ease of using iBeacons for locating and tracking newborns and how it is more advantageous over RFID in places like hospitals. [1]

Mr. Myungin Ji and his teammates Mr.Jooyoung Kim, Juil Jeon and Youngsu Cho proposed a system for positioning accuracy proportional to the number of Beacons used in indoor positioning system in a conference dated 3rdJuly 2015. In today's world a technology that utilizes a BLE Beacon has attracted attention to provide various services. They also proposed a technology which could provide asset tracking with help of beacons. In short they also tried to create awareness or say make people realize the important role that beacons can play in indoor positioning and also they tried to prove a point that beacons would soon spread in the future world. In their paper they first analyzed that beacons have an upper hand in indoor positioning as compared to Wi-Fi because the path loss model of BLE signals was better than that of Wi-Fi signals. To measure the practical path loss model, they set up 4 BLE beacons and 2 Wi-Fi access points .Signals were measured in a given period of time and at a set distance, then calculations and conclusions were made based on the results . [2]

Mr.Elif cay, YelizMert and their teammates Ali ,Bugra and Arif proposed a system for indoor positioning system using beacons in a conference dated 23rd August 2017. Their work aimed to develop a system for tracking and control of elderly or handicapped person in an indoor environment. They have developed both a special box using Arduino board and a mobile application on android to determine the location of target based on Bluetooth low energy signals transmitted by the person and to monitor any event that would cause an alert. Alerts can trigger messages to be sent to local authorities or relatives of the people. Measurements and test results were discussed regarding their performance. It was clear that more research and development was necessary for obtaining the reliable products. [3]

Aries, Achmad, Mike, Prima and I Gede Puja proposed a system for tracking the position of Alzheimer patients using Kalman filter method in a conference dated 10th November 2016. Identification of position can felicitate the tracking targets in certain observation areas. The emergence of Beacon technology which is based on Bluetooth low energy felicitates the tracking target in the building (Indoor environment). In this paper they proposed a tracking system for Alzheimer patients using Beacon technology as a wireless communication medium and Kalman method as data estimator. The results showed that the system was been able to track the patient more accurately, in which most optimal position track results were obtained when the process noise 0.1 and noise measurement 0.01 with the average percentage of error only 7.01 % of the actual position. [4]

Dohy, San-jun, Jaeweon and Dojun proposed an advanced generation of BLE beacon solution for enhanced personalization. They introduced next generation BLE Beacon solution named as S-beacon which opens new business opportunities by globally interconnecting smart phone users with next generation personalization services. S-beacon is a BLE based technology which works well on smart phones and wearable devices to indicate the user's presence accompanied with personal recommendations and useful data which is a key factor for enhancing personalized services. [5] This paper discussed its enhanced BLE based proximity, optimized resource consumption and manageability of beacon devices. They envisioned that the S-beacon solution is well suited for wide range of business sector such as Retail store, public place, hotel, hospitals and homes.

Pavel Kriz, Filip Maly and Thomas Kozel published a paper having article id 2083094 on the topic of Improvising indoor localization using Bluetooth Low Energy Beacons. In this paper they proposed a solution for locating people and mobile devices using BLE Beacons inside a Building. [6]

Wun-ye, Yi-shin and their team proposed a study of the indoor positioning based on smart variable technologies. They designed a BLE device including a reference tag based indoor position algorithm to solve different situations including location determining, route guidelines and tracking in this study. It cannot only help the visitors or patients to understand the position but also provide a system for medical staff to monitor the safety of patient and new born babies in the hospital. This device is tiny enough to be embedded into visitor's wrist band, babies foot band and patient's clothes. It is composed of a single control unit, single sensing unit and wireless connection system. The overall control and memorization status of the device is the responsibility of Signal Control Unitwhich is operated by an ultra-low power MCU and an EPROM memory check. To capture the accelerometer a single sensing unit is used containing motion tracking sensor. The wireless connection unit is a combination of a beacon and a Bluetooth module to send data package as a Bluetooth low energy sender. The indoor location based services system is integrated with a smart beacon and Wi-Fi gateway. Here, beacon acts as a client and Wi-Fi gateway as a server. The Received signal strength indicator of Bluetooth low energy signals to determine whether the beacon owner is in a particular range or not. It is possible that there may be two or more Wi-Fi gateways for receiving the same beacons signal at a time, we add a reference beacon to

each Wi-Fi gateway to reduce the error rate of determining beacon location. The studies reveal that there is only 5% error rate for determining the position of devices. [7]

III. System Architecture

The figure below shows the architecture of the proposed system.

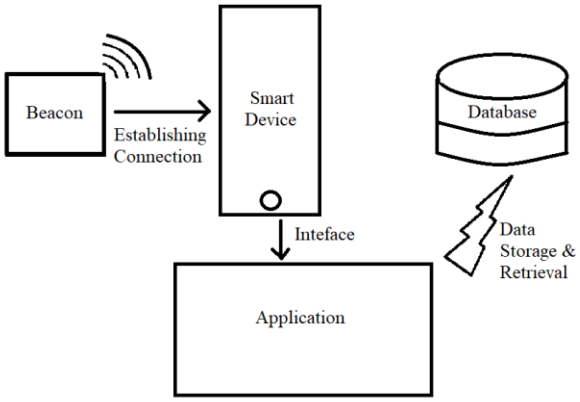

Figure 1: System Architecture

The brief description of the Architecture is as follows:

- Beacons – BLE devices that constantly transmit their UUID up to a range which can be set by the user but has a certain limit.
- Smart Devices – Here the smart devices are mobile phones, tabs, etc. on which the doctor and staff will use the application to check the notification.
- Application – The significant part of the system is an interactive mobile application that is beacon driven which will send pop up notification.
- Database – The storage of records, historical data will all take place in the database. The database could be local hospital server or cloud support could also find its role.

Beacons just act as a trigger to a particular activity in an application. Beacon constantly transmits its UUID. The code for an application is written in such a way that it triggers some activity on receiving a particular ID.

Beacons transmit UUID which is detected by the smart device. Smart device takes action according to the UUID; it might retrieve some information from the database and display it to the user. To use beacons, the user must have compatible app installed in his/her smart device.

In the system the beacons are installed for every patient near to his/her bed. Doctors are supposed to visit these patients physically. On approaching a patient physically application will automatically display the patient's profile. Application installed on the device gets triggered by the beacon to retrieve the medical history of respective patient from the database. Doctors are allowed to write down the prescription, this prescription gets stored in the database. Similarly, other departments like Laboratory, X-ray, MRI, CT-SCAN etc. are allowed to upload the reports related to a patient. All this information is provided to the doctor when he/she approaches the patient.

Apart from this the application is also used for notifying the doctors about their routine. It's the job of the administration to upload to-do list of doctors in the database. When doctor approaches to his/her work stations they will get notified about the routine.

IV. Proposed Solution

System collects information about the treatment of the patients from different departments of the hospital (e.g.: Blood test, Urine tests, X-rays, MRI) and making it available to doctors in real time. System catering needs of doctors by helping them to retrieve reports just by entering the patient's room. System provides a common platform for patients, doctors, administration, staff to work together with high efficiency and speed.

A. *Identify the Problem*

Traditional way of working inside hospital is really inefficient and slow. Handling huge number of patients inside a single hospital is getting difficult. It's a tedious task for doctors to go through every patient's file. This task takes huge time and doctors working less efficient. Similarly maintaining the records and treatment history of every patient in the form of hard copy is troublesome job.

B. *Solution*

Solution for this problem is to use beacons in hospitals. These beacons will allow doctors to retrieve all information related to their patients on their cell phones/ tablets just by entering into patient's room. Beacons will also notify tasks assigned to each doctor and nurse on their smart phones. The system provides common platform for different group of people like doctors, administrators, nurses, patients to work together with high efficiency and fastly.

V. FUTURE SCOPE

Soon beacons will revolutionize the medical industry. Not only medical industry but other sectors like retail, museums, shopping malls etc. will start accepting this technology. Sooner business starts to accept it earlier they will start getting rewards.

In future following modifications can be implemented:

1. Using beacons in the form of wearable devices.
2. To track live location of the patient or doctors.
3. Indoor navigation.

VI. CONCLUSION

The main objective of this thesis was to find existing problems and loopholes and to design a system overcoming the challenges present in the traditional system. The Survey reveals that there are loopholes present in the existing systems and there is a scope of improvement in the existing way of working in different domains. Survey concludes that there is a need of system catering and helping actors involved in the system and making it easy for patients, doctors to access the reports. Survey also concludes that the system making work of several departments in hospital easy and bringing their reports at a common platform eradicates the problem existing in the traditional working of hospitals.

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