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Effectiveness of IoT with Reference To Patient Waiting Time

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Abstract— In this research work, the patient administration system of a hospital using manual and IoT methods are compared with authenticated sample data. The software which is developed for this IoT Environment is user-friendly, reduces the time and minimizes the cost. Patient waiting time for hospital services is identified as one of the key measurement of a responsive health care system. So, this study addresses the issue of long patient waiting time in the outpatient department (OPD). Outpatient administration always takes a long waiting time for a treatment that has a short time of consultation by the physician. Queuing theory formulas are used to predict the waiting time of the patient. The main goal of this research is focused on how the IoT method can able to reduce patient waiting time.

***Keywords*—**IoT, Healthcare , Waiting time, Queuing theory, Patient

I. Introduction

Nowadays, people do a huge number of communications using computer systems and mobile systems through internet connections with more delay. In this communication human involvement is more. So, this form of communication is known as human-to-human communication using devices. But in future, the devices will be connected automatically with out human's intervention. This reduces lot of human time. In future machines will talk to other machines and give the result to the user without human involvement. This is called Internet of Things (IoT). The term "Internet of Things" was coined by Kevin Ashton in 1999.The aim of IoT is to create a better world for human beings using a common infrastructure to conjugate everything in our world. This will make us to control of these objects and keep letting us about their state [1].

The Internet of Things sometimes referred to as the Internet of Objects, will change everything including ourselves. The Internet has an impact on education, communication, business, science, government, and humanity. Enormous numbers of devises are participating in this technology [2] [3].

The Internet of Things is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. In IoT the semantic origin of the expression is composed by two words "Internet" and "Thing", where "Internet" can be defined as "The world-wide network of interconnected computer networks, based on a standard communication protocol, while "Thing" is "an object not precisely identifiable" Therefore, semantically, "Internet of Things" means "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" [4]. This online network of physical objects is accomplished through the use of RFID tags and other types of sensors. Implanting these tags inside a physical object gives it the power to be monitored and controlled remotely through the Internet. This eliminates the need for humans to constantly enter and monitor data. Instead, objects can work directly with each other, without the need for a person to link those together [5].

Applications of IoT [6][7]

The improvement of a number of applications of IoT has been made possible because of the potentials supplied by means of this discipline. Best a small variety of these applications had been made available to the society. There are some domain names and environments in which the programs of IoT can improve our lives. The packages of IoT may be categorized into following application regions: healthcare, pharmaceutical, agriculture, logistics, Insurance, manufacturing, smart environment for business services and Media & Entertainment.

Healthcare

Healthcare applications are one of the major fields of IoT. The new breed of low-cost, low-power communication devices have made it possible for the everyday objects to be part of the networks making Internet of Things. Similar advancements are made in electronic healthcare solutions, especially in wearable sensors and HealthCare Record (HCR) databases and formats. IoT technology offer many blessings in the healthcare domain that may be grouped as group of workers tracking and patients monitoring, identity of healthcare personnel and authentication, sensing and accumulating information

Pharmaceutical

A medication temperature monitoring app uses sensors to detect if the medication's temperature has gone outside of the acceptable range and ensures medical supplies still meet quality standards upon delivery. The handling temperatures are medications, vaccines for examples, is critical to their effectiveness. IoT based smart applications can be used to not monitor that medications are kept within the proper handling temperature range, but also to remind patients when it is time to take their medication.

Agriculture

There are numerous IoT applications in farming such as collecting data on temperature, rainfall, humidity, wind speed, pest infestation, and soil content. This data can be used to automate farming techniques, take informed decisions to improve quality and quantity, minimize risk and waste, and reduce effort required to manage crops. For example, farmers can now monitor soil temperature and moisture from afar, and even apply IoT-acquired data to precision fertilization programs.

Logistics

An equipment tracking app provides an airline's engineers with a live view of the locations of each piece of maintenance equipment. By increasing the efficiency of engineers, this IoT application is not only generating significant cost savings and process improvements, but also impacting the customer experience in the end through more reliable, on-time flights.

Insurance

An insurance company offers policyholders discounts for wearing Internet-connected Fit bit wristbands. The fitness tracking service is part of the insurer's Vitality program aimed at integrating wellness benefits with life insurance. Through this IoT application, this insurer is creating smart life insurance products and rewarding customers for their positive actions.

Manufacturing

A lighting manufacturer for the horticultural industry built a Smart App that leverages IoT sensors and predictive analytics to perform predictive maintenance and optimize lighting, power consumption and plant photosynthesis. The IoT application transformed their business from a lighting systems manufacturer to a greenhouse optimization as-a-service business.

Business Services

A facility services company uses their multi-device IoT software to enable support personnel to receive alerts about service issues and take immediate action. By aggregating data from thousands of sensors in devices like coffee machines, soap dispensers, paper towel dispensers and mouse traps rather than doing manual checks, the application has significantly cut costs and improved service levels.

Media & Entertainment

An entertainment design and production firm uses sensors in turnstiles of venues to understand the foot traffic of people at events. Their IoT application visualizes the attendee traffic patterns in real time to help sponsors understand the best places to advertise, and to ensure the attendee count stays within the fire code compliance of the venue.

Major Components of IoT [8]

The following are the major components comprising an IoT system

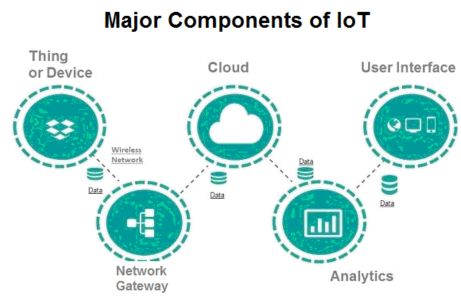

Figure 1: Major Components of IoT

- Thing or Device(Sensors, embedded software and hardware, RFID g)
- Network Harware
- Cloud
- Analytics
- User Interface

Thing or Device

It is a combination of Sensors, embedded software and embedded hardware.

Sensors

According to (IEEE) sensors can be defined as: "An electronic device that produces electrical, optical, or digital data derived from a physical condition or event". Data produced from sensors is then electronically transformed, by another device, into information (output) that is useful in decision making done by "intelligent" devices or individuals (people).

Types of Sensors

Active Sensors

Active sensor emits its own EM (Electromagnetic) energy which is transmitted towards the earth and receives energy reflected from the earth. The received EM energy is used for measurement purpose. Examples of active sensors are communication satellite, earth observation satellite (e.g. RADARSAT-1), LISS-1 etc.

Passive Sensors

Passive Sensors are devices that do not drive or transmit power or signals. Passive sensors do not control electricity directly and do not require external power sources to accomplish control of an electrical signal. Examples of passive Sensor components are resistors (R), capacitors (C), inductors (L), transformers, antennas,

Selection of sensors

The selection of sensors greatly impacted by many factors, including

- ❖ Purpose (Temperature, Motion, Bio…etc.).
- ❖ Accuracy.
- ❖ Reliability.
- ❖ Range.
- ❖ Resolution.
- ❖ Level of Intelligence (dealing with noise and interference).

The driving forces for using sensors in IoT today are new trends in technology that made sensors cheaper, smarter and smaller.

Challenges facing IoT sensors:

- ❖ Power consumption.
- ❖ Security.
- ❖ Interoperability.
- ❖ Embedded Hardware

Embedded software and embedded hardware. [9]

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it in to an output - activating a motor, turning on an LED, publishing something online. The functions of board can be done by sending a set of instructions to the microcontroller on the board. To set the instructions the user should use the Arduino programming language and the Arduino Software (IDE). The Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments.

Features of Arduino board

Inexpensive

Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less.

Cross-platform

The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

Simple, clear programming environment

The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

Open source and extensible software

The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based.

Open source and extensible hardware

The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

Different Types of Arduino Boards [10]

The list of Arduino boards includes the following such as. Arduino Uno (R3), LilyPad Arduino, Red Board, Arduino Mega (R3), Arduino Leonardo.

Arduino Uno (R3)

The Uno is a huge option for your initial Arduino. It consists of 14-digital I/O pins, where 6-pins can be used as PWM (pulse width modulation outputs), 6-analog inputs, a reset button, a power jack, a USB connection and more. It includes everything required to hold up the microcontroller; simply attach it to a PC with the help of a USB cable and give the supply to get started with a AC-to-DC adapter or battery. The Arduino Uno (R3) diagram is shown below in Figure.2.

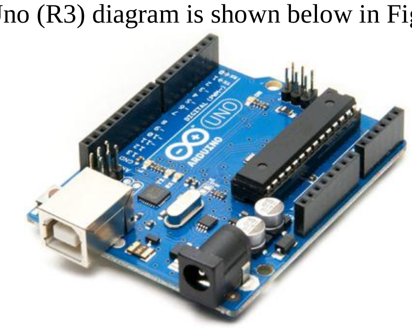

Figure 2 : Arduino Uno (R3)

Lily Pad Arduino Board

The Lily Pad Arduino board is a wearable e-textile technology expanded by Leah "Buechley" and considerately designed by "Leah and Spark Fun". Each board was imaginatively designed with huge connecting pads & a smooth back to let them to be sewn into clothing using conductive thread. This Arduino also comprises of I/O, power, and also sensor boards which are built especially for e-textiles. These are even washable!

Red Board Arduino Board

The Red Board Arduino board can be programmed using a Mini-B USB cable using the Arduino IDE. It will work on Windows 8 without having to modify your security settings. It is more constant due to the USB or FTDI chip we used and also it is entirely flat on the back. Creating it is very simple to utilize in the project design. Just plug the board; select the menu option to choose an Arduino UNO and upload the program.

Arduino Mega (R3) Board

The Arduino Mega is similar to the UNO's big brother. It includes lots of digital I/O pins (from that, 14-pins can be used as PWM o/ps), 6-analog inputs, a reset button, a power jack, a USB connection and a reset button. It includes everything required to hold up the microcontroller; simply attach it to a PC with the help of a USB cable and give the supply to get started with a AC-to-DC adapter or battery. The huge number of pins make this Arduino board very helpful for designing the projects that need a bunch of digital i/ps or o/ps like lots buttons.

Arduino Leonardo Board

The first development board of an Arduino is the Leonardo board. This board uses one microcontroller along with the USB. That means, it can be very simple and cheap also. Because this board handles USB directly, program libraries are obtainable which let the Arduino board to follow a keyboard of the computer, mouse, etc.

The Arduino Shields

Additionally, Arduino shields are pre built circuit boards used to connect to a number of Arduino boards. These shields fit on the top of the Arduino compatible boards to provide an additional capabilities like connecting to the internet, motor controlling, providing wireless communication, LCD screen controlling, etc. The different types of an Arduino shields are Wireless Shields, The GSM Shield, The Ethernet Shield, and the Proto Shields.

Disadvantages

It is not very powerful when compared with Raspberry Pi.
Need to program using either Arduino or C/C++.
Connecting to the internet is slightly difficult, but not impossible

Raspberry Pi [11]

Raspberry Pi board is a fully functional computer or full-fledged credit card sized. It has all the trappings of a computer, with a dedicated memory, processor, and a graphics card for output through HDMI. It even runs a specially designed version of the Linux operating system and it is easy to install in most Linux software, and used the Raspberry Pi as a functioning video game emulator or media streamer with a bit of effort.

Advantages

[1]. It is very easy to connect to the internet.
[2]. Entire Linux software stack is available.
[3]. Can be programmed using a variety of programming languages.

Disadvantages

[1]. Accessing hardware is not a real-time. If the CPU is busy, then interfacing with the hardware can be delayed.
[2]. Does not have enough power to drive inductive loads.
[3]. There is no inbuilt Analog to Digital converter available.
[4]. The hardware design is not open source. Even though it is not a big deal, for some people it might a deal breaker.

RFID [12]

Radio frequency identification (RFID) is a wireless technology capable of automatic and unambiguous identification without line of sight by extracting a unique identifier from microelectronic tags attached to objects. The RFID is a technology that uses radio waves to transfer data from an electronic tag, called RFID tag attached to an object, through a reader for the purpose of identifying and tracking the object. The RFID is already used to track and trace the victims in a disaster situation. Data can be collected in real time and be immediately available to emergency personnel and saves time by the RFID. Radio frequency identification (RFID) systems have been successfully applied in areas of manufacturing, supply chain, agriculture, transportation, healthcare, and services to name a few.

Working Principle of RFID

The most RFID systems consist of tags that are attached to the objects to be identified. Each tag has its own "read only" or "rewrite" internal memory depending on the type and application. A typical configuration of this memory is to store product information, such as an object's unique ID manufactured date, etc. The RFID reader generates magnetic fields that enable the RFID system to locate objects (via the tags) that are within its range. The high-frequency electromagnetic energy and query signal generated by the reader triggers the tags to reply to the query; the query frequency could be up to 50 times per second. As a result communication between the main components of the system i.e. tags and readers are established. As a result large quantities of data are generated. Supply chain industries control this problem by using filters that are routed to the backend information systems. In other words, in order to control this problem, software such as Savant is used. This software acts as a buffer between the IT and the RFID reader.

Components of an RFID system

The RFID system consists of various components which are integrated in a manner defined in the above section. This allows the RFID system to deduct the objects (tag) and perform various operations on it. The integration of the RFID components enables the implementation of an RFID solution. The RFID system consists of following five components:[14]

1. Tag (attached to an object, unique identification).
2. Antenna (tag detector, creates magnetic field).
3. Reader (receiver of tag information, manipulator).
4. Communication infrastructure (enable reader/RFID to work through IT infrastructure).
5. Application software (user database/application/interface).

Three basic types of RFID tag are proposed:

1. Passive RFID Tag
2. Active RFID Tag
3. Semi-Active RFID Tag

The Passive RFID tag is triggered when a user with the RFID tag approaches the antenna of RFID reader. Then, the information recorded in the RFID tag is transmitted through the antenna to the RFID reader. The RFID reader will parse the signal into the digital and computing content. At last, the gained content from RFID tag can be further utilized. Typical applications of passive RFID tag are tickets and guard cards.

An Active RFID Tag indicates that the tag owns a battery and can actively broadcast the information about this tag even there is no RFID reader which inducts this tag. Since there is a battery in the tag, more functions such as temperature sensing, pressure sensing, humidity sensing, etc., are embedded. The information gained from the embedded functions is transmitted actively. When the RFID reader approaches the active RFID tag, the reader can obtain the information. Typical applications of passive RFID tag are wireless sensors.

A Semi-Active RFID Tag seems an RFID tag with an on-off switch. In general, the semi active RFID tag also equips a battery and some embedded functions. For the most part, this RFID tag works as a passive RFID tag. When an RFID reader approaches and inducts the tag, this tag is triggered. After triggered by the reader, this tag turns on the battery and executes the functions. Then, the information from the functions can be translated to the RFID reader. At last, the RFID tag turns off the battery for power saving. In addition to three basic types of RFID tag, the frequency of RFID system used can be classified as LF (low frequency, 125~134KHz), HF (high frequency, 13.56 MHz), and UHF (ultra high frequency, 915MHz).

There are different antenna sizes of these RFID systems. Due to the power and size of RFID antenna, the induction distance between antenna and tag changes. Generally speaking, most RFID applications adopt the suitable frequency according to the required induction distance of the application Table-1.

Table-1

	Low Frequency	High Frequency	Ultra High Frequency
Induction Distance	<2Feet	<3Feet	<10~30Feet
Normal Application	Keyless entry	Smart Card	Electronic Toll Collection
Date Rate	Low←---------------------------→High		
Tag Size	Large ←-------------------------→Small		
Performance near Metal /Liquids	Better←--------------------------→Worse		

Network Hardware

The second step of this implantation is to transmit the signals collected by sensors over networks with all the different components of a typical network including routers, bridges in different topologies, including LAN, MAN and WAN. Connecting the different parts of networks to the sensors can be done by different technologies including Wi-Fi, Bluetooth, Low Power Wi-Fi , Wi-Max, regular Ethernet , Long Term Evolution (LTE) and the recent promising technology of Li-Fi (using light as a medium of communication between the different parts of a typical network including senores). The driving forces for wide spread network adoption in IoT can be summarized as follows. High Data rate,Low Prices of data usage,Virtualization (X – Define Network trends),XaaS concept (SaaS, PaaS, and IaaS),IPv6 deployment. The following are the Challenges facing network implementation in IoT

- ❖The enormous growth in number of connected devices.
- ❖Availability of networks coverage.
- ❖Security.
- ❖Power consumption.

The major components of network hardware are

- ❖ Wireless sensor network
- ❖ Gateway
- ❖ Mobile network

Wireless sensor network(s) (WSN)

A wireless sensor network (WSN) is a network formed by a large number of sensor nodes where each node is equipped with a sensor to detect physical phenomena such as light, heat, pressure, etc. WSNs are regarded as a revolutionary information gathering method to build the information and communication system which will greatly improve the reliability and effi ciency of infrastructure systems. Compared with the wired solution, WSNs feature easier deployment and better fl exibility of devices. With the rapid technological development of sensors, WSNs will become the key technology for IoT.

Gateway

IoT Gateway manages the bidirectional data traffic between different networks and protocols. Another function of gateway is to translate different network protocols and make sure interoperability of the connected devices and sensors. Gateways can be configured to perform pre-processing of the collected data from thousands of sensors locally before transmitting it to the next stage. In some scenarios, it would be necessary due to compatibility of TCP/IP protocol. An Internet of Things (IoT) gateway is a physical device or software program that serves as the connection point between the cloud and controllers, sensors and intelligent devices. All data moving to the cloud, or vice versa, goes through the gateway, which can be either a dedicated hardware appliance or software program. An IoT gateway may also be referred to as an intelligent gateway or a control tier.

Mobile network

To support the further expansion and evolution of the Internet of Things (IoT), the mobile industry has developed and standardised a class of dedicated cellular technologies. These Mobile IoT networks support devices requiring broad coverage, a long battery life and low cost, yet secure, connectivity across both rural and urban locations. Environmental monitoring applications of the IoT typically use sensors to assist in environmental protection by monitoring air or water quality, atmospheric or soil conditions, and can even include areas like monitoring the movements of wildlife and their habitats.

Cloud

Internet of things creates massive data from devices, applications and users which has to be managed in an efficient way. IoT cloud offers tools to collect, process, manage and store huge amount of data in real time. Industries and services can easily access these data remotely and make critical decisions when necessary. Basically, IoT cloud is a sophisticated high performance network of servers optimized to perform high speed data processing of billions of devices, traffic management and deliver accurate analytics.

Analytics

Analytics is the process of converting analog data from billions of smart devices and sensors into useful insights which can be interpreted and used for detailed analysis. Smart analytics solutions are inevitable for IoT system for management and improvement of the entire system. One of the major advantages of an efficient IoT system is real time smart analytics which helps engineers to find out irregularities in the collected data and act fast to prevent an undesired scenario.

User interface

User interfaces are the visible, tangible part of the IoT system which can be accessible by users. Designers will have to make sure a well designed user interface for minimum effort for users and encourage more interactions. Modern technology offers much interactive design to ease complex tasks into simple touch panels controls. Multicolour touch panels have replaced hard switches in our household appliances and the trend is increasing for almost every smart home devices.

II. OBJECTIVE OF THIS RESEARCH

The aim of this study is to find ways to optimize the hospital ecosystem for out-patient department (OPD). Time is very important in the treatment of an individual. Even a few microseconds can prove crucial for efficient treatment in case of emergency situations. Form filling and vital checking takes up a lot of time which can in some cases prove fatal for the individual. Therefore, this time has to be conserved and used efficiently to provide optimum recovery. Another point of concern in the hospital environment in the treatment of an individual owes to the human error involved in the process. It is mainly because of the misinterpretation of the health conditions of the patient by the doctor. This may occur due to the lack of medical knowledge of the patient, the language barrier between the patient and the doctor, the human error in the reading and assessment of vitals of the patient in the instrument. The errors in the medical field cause permanent damages and life threatening. The uses of IoT devices which provide machine-machine interaction avoid these crucial errors. This will reduce all forms of human error caused in the hospital environment. Therefore, this research focused the use of IoT decrease the patients' waiting time at the OPD.

III. DATA COLLECTION

The sample data is collected from medical centre in Thanjavur, Tamilnadu, India for this study. The following dataset is given by them for a period of one week. This Table-2 shows the number of persons got appointment during the specific time intervals for a day. The seven days information is given in the following Table -2.

Table 2 . The average number of patients' waiting per hour

Patient ID	Arrival time	Service start Time	Service End Time	Service Waiting Time	Total Waiting Time
OPD01	6:55 AM	7:00 AM	7:03 AM	0:03	0:08
OPD02	7:01 AM	7:04 AM	7:08 AM	0:03	0:06
OPD03	7:03 AM	7:09 AM	7:11 AM	0:01	0:07
OPD04	7:10 AM	7:12 AM	7:15 AM	0:02	0:04
OPD05	7:13 AM	7:16 AM	7:18 AM	0:01	0:04
OPD06	7:15 AM	7:19 AM	7:23 AM	0:03	0:07
OPD07	7:21	7:25	7:30	0:05	0:07

	AM	AM	AM		
OPD08	7:22 AM	7:31 AM	7:35 AM	0:03	0:12
OPD09	7:32 AM	7:36 AM	7:42 AM	0:05	0:09
OPD10	7:40 AM	7:43 AM	7:49 AM	0:05	0:08
OPD11	7:48 AM	7:50 AM	7:55 AM	0:04	0:06
OPD12	7:50 AM	7:56 AM	8:00 AM	0:03	0:09

Table-3: Total Waiting Time in Day1 form 7-8 am

Time Duration	**Number of patient/ day**						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
7-8 am	12	13	11	9	13	11	11
8-9 am	11	11	12	11	13	13	11
3-4 pm	11	11	12	10	11	13	13
4-5 pm	12	11	11	10	11	14	11
5-6 pm	14	15	14	13	14	13	13
6-7 pm	18	17	18	19	19	19	19
7-8 pm	20	19	21	25	21	21	19
8-9 pm	19	18	17	13	17	18	19
9-10 pm	15	15	13	10	14	21	16

The Total Waiting Time in manual method for the 12 persons in Day1 form 7-8 am is in the following Table-3.

IV. METHODOLOGY

The following data flow diagram explains the new patient administrative system. When the patient entered into the room his pre-assigned RFID number is scanned by the RFID reader using tag wore by the patient. RFID is a card which stores the patient's personal information such as his name, age, phone number and medical details such as his blood group, medical history, medical condition required by the doctor for his treatment. The program stored in the Arduino board memory receives this RFID number and gets the patient's information within a fraction of second using the database.

As soon as patient details are retrieved, their past treatment detail is also displayed on the screen. This helps the doctors for their analysis. Now the doctor can enter the new treatment detail which will be used for future reference. This is a flawless method which will optimize the hospital environment to provide better treatment for an individual

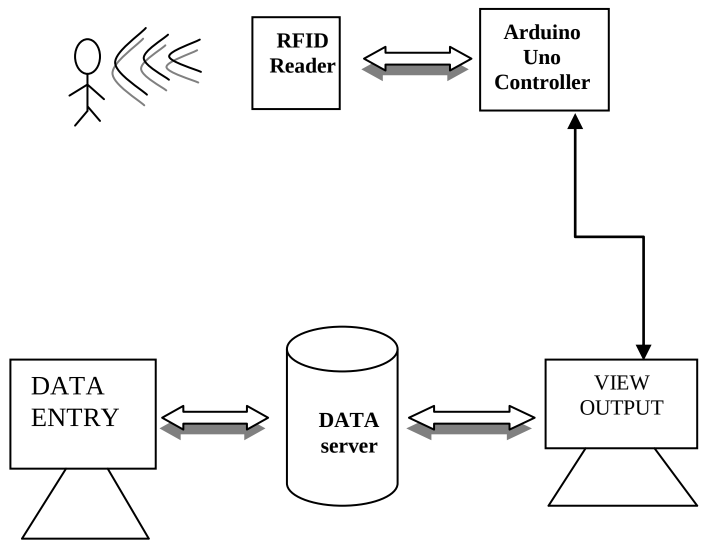

Figure – 3: Data flow diagram – IoT method

The above Figure-3 is explained in the following steps.
Step 1: Check the patient information is already available or not using the Data Base. If the patient information is not available, new RFID Number is assigned and the basic details about the Patient should be entered to store that into the database. If available the system move into the step 2.
Step 2: The RFID Reader Read the patient-Id using the RFID Tag.
Step 3: The RFID Reader transfer the patient-Id into the Arduino controller.
Step 4: The Arduino controller check the patient details in the Data Base Server using patient-Id.
Step 5: The Arduino Controller display the patient's full details on the screen.

V. RESULTS AND DISCUSSION

Using the above Table-3 Total waiting time is calculated using the following formula.

Total Waiting Time for each patient = (Service start Time - Arrival Time)+(Service End Time – Service Start Time)

Example : Total Waiting Time for OPD01 = (7.00 am - 6:55 AM) + (7.03 AM – 7.00 AM)
= 0.05 Minute + 0.03 Minute
=0.08 minute

Similarly, the Total waiting time is calculated for all patients in the duration 7 - 8 am of day1. Then the average total waiting time is calculated for all durations in all days mentioned in Table-2. The following Table-4 shows the consolidated Average waiting time (AWT) for all days in manual method.

Table 4 : Average Total Waiting Time (AWT)

Time Duration	**Number of patient/ day Average service Waiting Time (AWT)**						
Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	**Day 7**
7-8 am	0.07	0.07	0.07	0.06	0.07	0.07	0.07
8-9 am	0.07	0.07	0.07	0.07	0.07	0.07	0.07
3-4 pm	0.06	0.07	0.07	0.06	0.07	0.07	0.07
4-5 pm	0.06	0.07	0.07	0.06	0.07	0.07	0.07
5-6 pm	0.07	0.07	0.07	0.07	0.07	0.07	0.07
6-7 pm	0.08	0.08	0.08	0.09	0.09	0.09	0.09
7-8 pm	0.09	0.09	0.1	0.09	0.1	0.1	0.09
8-9 pm	0.09	0.07	0.08	0.07	0.08	0.08	0.09
9-10 pm	0.07	0.07	0.07	0.06	0.07	0.09	0.08

The Total Waiting Time in IOT method for the 12 persons in Day1 form 7-8 am is in the following Table - 5.

Table 5 : Total Waiting Time in IOT method in Day1 first duration

Patient ID	Arrival time	Service start Time	Service End Time	Service Waiting Time	Total Waiting Time
OPD01	6:55:00 AM	6:55:00 AM	6:55:02 AM	0:00	0:002
OPD02	7:01:00 AM	7:01:00 AM	7:01:02 AM	0:00	0:002
OPD03	7:03:00 AM	7:03:00 AM	7:03:02 AM	0:00	0:002
OPD04	7:10:00 AM	7:10:00 AM	7:10:02 AM	0:00	0:002
OPD05	7:13:00 AM	7:13:00 AM	7:13:02 AM	0:00	0:002
OPD06	7:15:00 AM	7:15:00 AM	7:15:02 AM	0:00	0:002
OPD07	7:21:00 AM	7:21:00 AM	7:21:02 AM	0:00	0:002
OPD08	7:22:00 AM	7:22:00 AM	7:22:02 AM	0:00	0:002
OPD09	7:32:00 AM	7:32:00 AM	7:32:02 AM	0:00	0:002
OPD10	7:40:00 AM	7:40:00 AM	7:40:02 AM	0:00	0:002
OPD11	7:48:00 AM	7:48:00 AM	7:48:02 AM	0:00	0:002
OPD12	7:50:00 AM	7:50:00 AM	7:50:02 AM	0:00	0:002

The following Table - 6 shows the consolidated Average waiting time (AWT) for all days in IOT method

Table – 6: IOT Average Waiting Time

Time Duration	**Number of patient/ day Using IOT Average Waiting Time (IOT AWT**						
Time	Day1	Day2	Day3	Day4	Day5	Day6	Day7
7-8 am	0.002	0.002	0.002	0.002	0.002	0.002	0.002
8-9 am	0.002	0.002	0.002	0.002	0.002	0.002	0.002
3-4 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002
4-5 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002
5-6 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002
6-7 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002
7-8 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002
8-9 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002
9-10 pm	0.002	0.002	0.002	0.002	0.002	0.002	0.002

The following Table-7 shows the difference in between manual method and IOT method in Day 1.
Using the above Table-7 the following Table-8 is created.

Average waiting time Manual method	Average waiting time IoTmethod	Total Time saved in IoT Method
0:07:20	0:00:02	1:05:42

Table-8 Difference in between Manual Method and IoT Method

Time Duration	Difference in between manual method and IOT method in Day 1.		
	Day 1		
Time	Time Take in Manual Method	Time Take in IoT method	Difference or Time Saved
7-8 am	00:07:00	00:00:02	00:06:58
8-9 am	00:07:00	00:00:02	00:06:58
3-4 pm	00:06:00	00:00:02	00:05:58
4-5 pm	00:06:00	00:00:02	00:05:58
5-6 pm	00:07:00	00:00:02	00:06:58
6-7 pm	00:08:00	00:00:02	00:07:58
7-8 pm	00:09:00	00:00:02	00:08:58
8-9 pm	00:09:00	00:00:02	00:08:58
9-10 pm	00:07:00	00:00:02	00:06:58

The above Table-8 proves that if the IOT method is used for Day1, the total saving time is 1:05:42. While implementing IoT method 97% time is saved. If the save time is calculated for the entire week the total save time will be in multiples of the value. The following graph shows effective utilization of time in between Manual and IOT method.

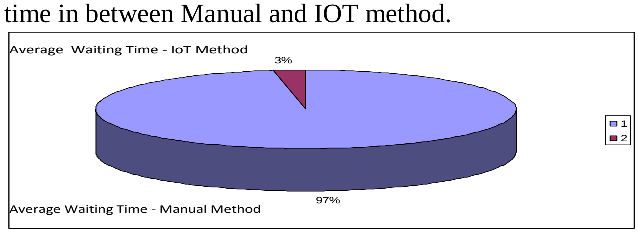

Figure- 4

VI. Conclusion and Future Scope

Time is very important in the treatment of an individual. Even a few microseconds can prove crucial for effective treatment in case of emergency situations. Form filling and vital checking take up a lot of time which can in some cases prove fatal for the individual. Therefore, this time has to be conserved and used efficiently to provide optimum recovery. Another point of concern in the hospital environment in the treatment of an individual owes to the human error involved in the process. It is mainly because of the misinterpretation of the health conditions of the patient by the doctor. This may occur due to the lack of medical knowledge of the patient, the language barrier between the patient and the doctor, the human error in the reading and assessment of vitals of the patient in the instrument. The errors in the medical field cause permanent damages and life-threatening. The uses of IoT devices which provide machine-machine interaction avoid these crucial errors. This will reduce all forms of human error caused in the hospital environment. So, implementation of IoT devices in hospital administration system is essential in near future

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