ISSN 2348 – 9928
IJAICT Volume 7, Issue 4, April 2020 Doi:10.46532/ijaict-2020014 Published on 05 (4) 2020

INTELLIGENT MEDICAL INFORMATION SYSTEM

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Abstract — Now a days, meeting doctors is quite too frequent. People always meet doctors in order to get treatment for their symptoms. Existing clinic registration systems have to make an appointment with a doctor only when they visit the clinic or hospital and wait in queues for long hours in order to get treatment and everything was tedious too because everything was done manually. So many mistakes could have been made. Therefore, many online appointment systems have been developed in order to book appointments with doctors through mobile application. No priority based appointments and an emergency situation for appointments with doctors is considered. All these aspects are taken into consideration and an online appointment booking system with doctors is especially designed for the Madurai city, Tamil Nadu, India. We will design an android application that tracks the location of a user using particle swarm optimization algorithm and also it displays the details of all the hospitals and clinics in the Madurai district and the available specialists in each stream. This system uses java programming language as interface between the user and doctor and MySQL as the database.

Keywords - Doctor Appointment, Location Awareness, Global Positioning System (GPS), Mobile Application.

I. INTRODUCTION

A person may either visit a doctor at a clinic or a hospital. Basically there is a difference between a hospital and a clinic. A hospital can be a private or public sector building where patients are admitted for treatment. On the other hand, a clinic is a health care hub or it is a place where a doctor analyzes the patients, prescribes medicines and gives the instructions as to how to use the medication. Several [1] Healthcare clinics and hospitals are providing medical services to the patients. A lot of patients daily visits them and are facing problems regarding have to wait for a long time to get doctors' advice and diagnosis result [2]. The administrative staff of the clinic is not able to keep the record details of the patients who have an appointment with the doctor manually. Nowadays people are seeking for a convenient way of being reserved on their appointments. The aim of our project is to create clinic patients handling appointment system that will help doctors in their work and will also help patients to book doctor appointments from their homes [3][4]. It is a centralized web portal and allows doctors to manage their booking timing online. Patients are allowed to book their appointment by making a call to the doctor. These systems are synchronized with reservation system and thus provide a more user friendly experience to patients.

1.1 Overview

The proposed project is a smart appointment booking system for the Madurai district that provides patients or any user an easy way of booking a doctor's appointment online. This is an android based application that overcomes the issue of managing and booking appointments according to user's choice or demands [5][6]. The task sometimes becomes very tedious for the compounder or doctor himself in manually allotting appointments for the users as per their availability. Hence this project offers an effective solution where a user location is tracked first and then based on his location he can view various timing slots available and select the preferred date and time by calling the doctor. This system also allows users to cancel their booking anytime. This mobile application uses MySQL database as the back-end and java programming language as interface between the user and the application[6][7].

1.1.1 Mobile Communication

Mobile communications is a type of data communication that is performed and delivered through mobile devices or simply a Mobile communication is talking, texting or sending data or image files over a wireless network [8][9]. This is a broad term that incorporates all procedures and forms of connecting and communicating between two or more devices using a wireless signal through mobile communication technologies and devices.

Fig 1 : Mobile Communication

1.1.2 Technologies

These technologies are used by our application to use the internet facilities as provided by our providers and also the different emerging technologies used in order to communicate with mobile or handheld devices [10].

Global positioning system (GPS). GPS is a reliable navigational aid available anywhere on the earth, operating in all weather conditions 24 hours a day. It can be used by marine, airborne and land users [11][12]. This technology is used effectively in our system to track the location of a user using particle swarm optimization algorithm.

Infrared – Infrared is a wireless communication technology used for communication over short distances. IR requires line-of-sight because it can transmitted over small range and also penetrates very easily [13][14]. IR-enabled devices can be used to set the standards associated with IrDA. IR technology is used in intrusion detectors, home-entertainment control units, printers, headsets, modems and other peripherals.

Radio Wave Transmission – Radio waves are electromagnetic radiations and are used in order to communicate over shorter frequency range between 300 GHz to 3 KHz. Here the communication takes place between different frequency segments and an audio wave in changed into frequency segment [15].

1G technology - 1G specifications were released in 1990 to be used in GSM. 1G systems are analogue systems such as AMPS that use FDM to divide the bandwidth into specific frequencies that are assigned to individual calls. It continued until 2G technology was introduced.

2G technology – 2G technology is based on GSM for communication with mobile devices. These second-generation mobile systems are digital and use either TDMA or CDMA method. Digital cellular systems use digital modulation and was launched in the year 1991. It have several advantages over analogue systems, including better utilization of bandwidth, more privacy, and incorporation of error detection and correction.

2.5G technology – This cellular system is combined with General Packet Radio Services (GPRS) and 2G technology. It was introduced to add latest bandwidth technology to the existing 2G generation. It supports higher-data-rate transmission for Web browsing and also supports a new browsing format language called wireless application protocol (WAP). The different upgrade paths include high-speed circuit-switched data (HSCSD), GPRS and EDGE [16][17].

HSCSD increases the available application data rate to 14.4 kbps as compared to 9.6 kbps of GSM. By using four consecutive time slots, HSCSD is able to provide a raw transmission rate of up to 57.6 kbps to individual users.

GPRS supports multi-user network sharing of individual radio channels and time slots. Thus GPRS supports many more users than HSCSD but in a bursty manner. When all the eight time slots of a GSM radio channel are dedicated to GPRS, an individual can achieve as much as 171.2 kbps. But this has not brought any new evolution [18][19].

EDGE introduces a new digital modulation format called 8-PSK (octal phase-shift keying). It allows nine different air interface formats, known as multiple modulation and coding schemes, with varying degree of error control and protection. These formats are automatically and rapidly selectable. Of course, the covering range is smaller in EDGE than in HSCSD or GRPS.

3G technology - To overcome the short-comings of 2G and 2.5G GPRS, 3G has been developed. It uses a wideband wireless network that offers increased clarity in conversations and also for faster internet connections [20][21]. Countries throughout the world are currently determining new radio spectrum bands to accommodate 3G networks. The data is sent through packet switching and voice calls are interpreted through circuit switching.

3.5G system - It supports a higher through-put and speed at packet data rates of 14.4 Mbps, supporting higher data needs of consumers.

4G system - It offers additional features such as IP telephony, ultra broadband Internet access, gaming services and HDTV

streamed multimedia. Flash-OFDM, the 802.16e mobile version of WiMAX can support cellular peak data rates of approx. 100 Mbps for high-mobility communications such as mobile access and up to 1 Gbps for low-mobility communications such as nomadic/local wireless access, using scalable bandwidths of up to 40 MHz. The infrastructure for 4G is only packet-based [22].

5G system - 5G simply stands for fifth generation and refers to the next and newest mobile wireless standard based on the IEEE 802.11ac standard of broadband technology. A formal standard for 5G is yet to be set. According to the Next Generation Mobile Network's 5G white paper, 5G connections must be based on 'user experience, system performance, enhanced services, business models and management & operations'. Previous generations like 3G were a breakthrough in communications[23][24]. 3G receives a signal from the nearest phone tower and is used for phone calls, messaging and data.4G works the same as 3G but with a faster internet connection and a lower latency (the time between cause and effect).

1.3 Protocols

The protocols are used in mobile communication in order to transfer messages with additional security features, confidentiality, authentication, message integrity, accessibility, compression of data and so on.

1.3.1 802.11 For Wi-Fi

Wireless connectivity for is well established with computers and virtually all new laptops contain a Wi-Fi capability. Of the WLAN solutions that are available the IEEE 802.11 standard, often termed Wi-Fi has become the de-facto standard. Wi-Fi is able to compete well with wired systems whose operating speed of systems is around 54 Mbps. Wi-Fi "hotpots" are widespread and in commonly used because of its flexibility and performance. Wi-Fi can be used in laptop computers, hotels, airport lounges, cafes and other places too. 802.11 can also be used for temporary connections in WLAN applications, permanent connections and semi-permanent WLAN connection is used in offices. There are various standards of IEEE 802.11 which cover standards like security aspects, quality of service, etc. Some of the commonly known standards are 802.11a, 802.11b, 802.11g and now 802.11n. Two types of WLAN networks are formed infrastructure networks and ad-hoc networks. The infrastructure application is aimed at office areas or to provide a "hotspot" and serviced by a base station or Access Point (AP) which acts as a controller for the cell. Ad-Hoc network are formed when a number of computers and peripherals are brought together and no Access Point and special algorithms within the protocols are used to enable one of the peripherals to take over the role of master to control the network with the others acting as slaves.

1.3.2 IrDA - Infrared Data Association

Infrared data communication is playing an important role in wireless data communication due to the popularity of laptop computers, personal digital assistants (PDAs), digital cameras, mobile telephones, pagers, and other devices. IrDA (Infrared Data Association) is an industry-sponsored organization set up in 1993 to create international standards for the hardware and software used in infrared communication links. It is a special form of radio transmission. It has focused ray of light in the infrared frequency spectrum, measured in terahertz, or trillions of hertz (cycles per second). It is modulated with information and sent from a transmitter to a receiver over a relatively short distance. Infrared radiation (IR) is the same technology used to control a TV set with a remote control. Infrared communication involves a transceiver (a combination transmitter and receiver) in both devices that communicate. IR can be also be used for somewhat longer interconnections and is a possibility for interconnections within local area networks [25][26]. The maximum effective distance is somewhat under 1.5 miles and the maximum projected bandwidth is 16 megabits per second. IR is it is sensitive to fog and other atmospheric conditions because it is line-of-sight light transmission.

1.3.3 WAP (Wireless Access Protocol)

WAP (Wireless Access Protocol) is a specification for a set of communication protocols to standardize the wireless devices, such as cellular telephones and radio transceivers that are used for Internet access, including e-mail, the World Wide Web, newsgroups, and instant messaging. Different manufacturers used different technologies in the past while in the future, WAP will be used in devices and service systems. WAP pages can be delivered using Wireless Markup Language (WML).

1.3.4 820.16 WiMAX

WiMAX technology is a broadband wireless data communications technology. It is based around the IEE 802.16 standard of Wireless Metropolitan Area Networks (WMANs). It provides high speed data over a wide area. WiMAX is abbreviated as Worldwide Interoperability for Microwave Access .It is a technology for point to multipoint wireless networking. It can be used in mobile applications by users on the move. The key technologies used by WiMAX are Orthogonal Frequency Division Multiplex (OFDM) and

Multiple Input Multiple Output (MIMO) to provide the high speed data rates. WiMAX technology supports traffic based on transport technologies ranging from Ethernet, Internet Protocol (IP) and Asynchronous Transfer Mode (ATM), this Forum also certify the IP-related elements of the 802.16 products. The focus is on IP operations is the main protocol used. The different versions of WiMAX are 802.16d and 802.16e. WiMAX technology is now being deployed and emerging in many areas and also it is posing threats to other areas of the industry.

1.4 Challenges

1.4.1 Network challenges

Since mobile communication is a wireless technology, so disconnection is susceptible. We could provide resources to handle those disconnections very effectively and efficiently. Round-trip RPC delays can be used in order to reduce disconnections by operating asynchronously in WANs. Caching techniques could be used to enhance the performance of weakly-connected and disconnected operation, but preserving cache coherence under weak connectivity can be expensive. This problem can be solved by maintaining cache coherence at multiple levels of granularity and by the use of callbacks.

1.4.2 Privacy challenges

Privacy and privacy rights for users relate to the collection, use, disclosure, storage, and destruction of personal data. Mobile computing allows users to share information, data, applications, and software over networks. This allows users to access data and applications wherever they can connect online and use various mobile devices to access their data and information. Inherent to cloud computing are privacy concerns as service providers will have access to all the data, and could accidentally or deliberately disclose it or use it for unauthorized purposes. The utilization of mobile devices in a cloud computing environment exacerbates these privacy concerns. So our application will provide a high degree of security to our personal data when any mobile devices, such as smartphones and tablets, are used with equipment of WI-FI, Bluetooth and GPS capabilities

1.4.3 Congestion

When many users are trying to use the frequency bands, it creates a collision of messages in the channels. All the messages will collide to each other and huge traffic is created. Thus, no users can use the frequency bands effectively and efficiently. Thus, our application would provide communication even if there is low frequency bands [4].

1.5 Applications

1.5.1 Remote health monitoring

Our system helps to monitor the people's timely treatment on their requirement basis. It also allows people to continue to stay at home rather than in expensive healthcare facilities such as hospitals or nursing homes. It thus provides an efficient and cost-effective alternative to on-site clinical monitoring [5].

1.5.2 Telemedicine

This concept can be used in case of any emergency situations. It is the use of telecommunication and information technology to provide clinical health care from a distance. It has been used to overcome distance barriers and to improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care. This technology permit communications between patient and medical staff with both convenience and fidelity, as well as the transmission of medical, imaging and health informatics data from one site to another.

1.5.3 M-Commerce

M-commerce is a technology that is used in our system to save lives of patients and also takes care of the patient by operating on the devices by other staff members of the hospital very efficiently even from long distances. It could be used with only one trained person who is trained with personal digital assistant (PDAs) and with one kind of mobile equipment since it is a wireless technology [6].

1.5.4 E-commerce

Using this e-commerce technology, any user can do payments of any products like pharmaceuticals in hospitals very easily. E-commerce involves transactions and the exchange of information among vendors, hospitals, insurance agencies, state and federal regulators, and doctors' offices [7].

II. LITERATURE SURVEY

2.1 Online Clinic Appointment System for AM Town

The online clinic Appointment Scheduling and Reservation offered health professionals a more efficient and convenient way for patients to reserve appointments in the clinic which is highly favored by clinics, doctors, dentists and their staff as it saves them substantial time from scheduling appointments and allows them to allocate resources to other, more pertinent areas. It was a web based application which covers all aspects of management and operations of clinics. The website covered Admin profile, Doctors profile, Patients profile, online appointments, Patient treatment reports, Prescription report,

billings, and Clinical tests. Users can perform search by doctor specialty, gender, and day and/or doctor name and can also view doctors' profile and their specialty information. The registered user can choose and book an appointment or reschedule or cancel their appointment at their flexible time and date. In this system, patient have to sign up and login by entering login credentials. Even Patient can check appointment details, treatment details and prescription details. This system increased new patient traffic, saved staff time because no manual work was done and also allowed clinic's staffs to control and maintain patient's information through a computerized process [1].

2.2 Mr.Doc: A Doctor Appointment Application System

As we were too busy with our life, we avoid taking medical appointments in person to maintain a proper health care. So the main idea of that project was to provide ease and comfort to patients while taking appointment from doctors and it also resolves the problems that the patients has to face while making an appointment. The android application Mr.Doc was built for the country Pakistan which acts as a client whereas the database containing the doctor's details, patient's details and appointment details is maintained by a website that acts as a server [8].

2.3 Enhancing Patient Appointments Scheduling that Uses Mobile Technology

Appointment scheduling systems were utilized mainly by specialty care clinics to manage access to service providers as well as by hospitals to schedule patient appointments. In Tanzania, patients have experienced some challenges to meet an appropriate specialist doctor when they are in need. The doctors' availability was critical whenever any patients needed to see a specialist doctor for treatment. So this system provides appropriate technology techniques to enhance appointment scheduling. Thus, a mobile based application scheduling system for managing patient appointments [9].

2.4 Application of Intelligent Agents in Hospital Appointment Scheduling System

This agent based systems had been developed for the hospital service and also for searching and fixing appointment over mobile phones which gives a direct reply to the user. However, no facility like priority based appointment of patients had been developed and also the appointment does not take into consideration emergency situations and the scheduling report is only for general patient appointment only. Taking these aspects into consideration, they had developed an intelligent agent based system towards negotiating and collaborating with the agents of doctors and the hospital for the appropriate appointment time for the patient which would take the above factors into consideration. In addition, the meetings of the junior staff like the duty doctor and nurse with the chief doctor regarding patients would also carried out again while taking into consideration the medical condition of the patient admitted and so on. These agents developed functions based on fuzzy preference rules, to make a proper decision regarding making an appointment for patient and other hospital staff , which is very unique and first of its kind. The system validated uses ANDROID 2.2 and JADE-LEAP, for providing a robust, user friendly solution for the patient and doctor [10].

III. PROPOSED SYSTEM

3.1 System Architecture

Our proposed Intelligent Medical Information System is composed of five modules (Fig - 2): a Login Module, Location Tracking, a Display of streams and specialists module, an Appointment module and a Reminder module.

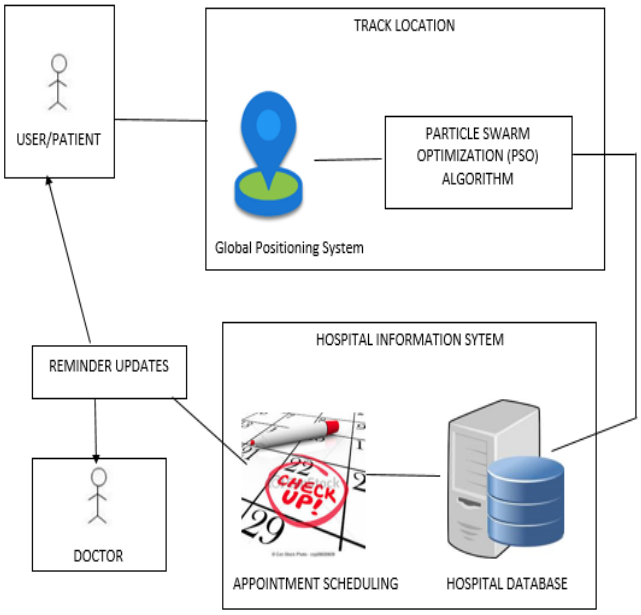

Fig 2 : System Architecture

The Login module provides all the personal details of the user or the patient like name, address, contact number, date of birth and so on. All these details are stored in the database. Location tracking tracks the location of the user using the Global Positioning System (GPS). As soon as the location is tracked, the number of hospitals and clinic in the nearby location is displayed. Based on the hospital or clinic selected, the streams of the specialists will be displayed. Upon the user requirements and the treatment he prefers with the corresponding doctor he

prefers, the user calls to the corresponding doctor. The appointment module confirms the appointment booking with the doctor and if required the booking can be changed by the doctor or the user. Once an appointment is booked, a reminder will be made to both the doctor and the patient who made the appointment.

3.2 Implementation

3.2.1 Login Module

The user will first download and install the application in their mobile device. Once installed, this application will remain into the device permanently until the user deletes it or uninstalls it. The patient will have to register in the application on his first use. After registration, the patient will receive a username and password. For sign up, the user has to fill the given fields that are his personal details, username, email, password, and confirm password and then the user clicks on the signup button to register itself and then all the information provided by the user is saved in the database located on the server. If the user registers successfully then a notification message "successfully registered" is displayed else "unsuccessful registration". Different checks are also maintained while registering the user. If both the passwords are not matched then the user will be notify that the "passwords didn't matched". If email is not valid then the user cannot register itself and a notification will displayed that "email is not valid. The patient has to use this username and password for logging into the app for each time usage. For signing in the user has to provide the registered username and password otherwise if the user enters such a username or password that is not registered then the user will get a notification message that "Sign in failed".

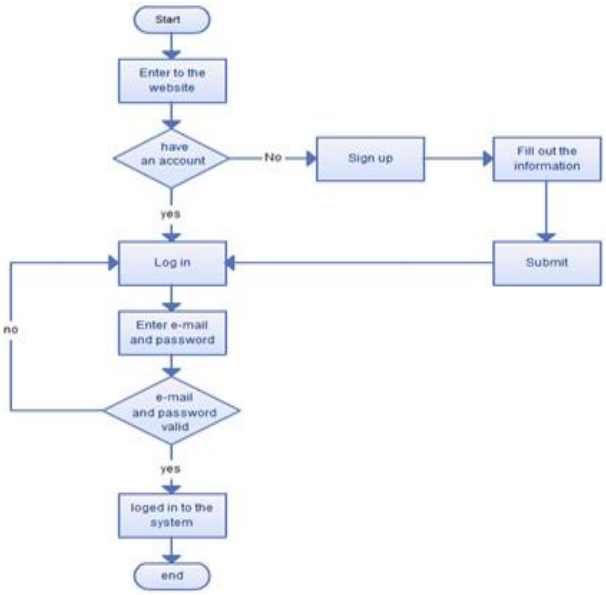

Fig 3 : Login System

3.2.2 Location Tracking

Once the user enters into the application and the mobile device is asked to enable the Global Positioning System (GPS) of that device. A Global Positioning System is a system designed to help navigate on the Earth, in the air, and on water. A GPS receiver shows where it is. It may also show how fast it is moving, which direction it is going, how high it is, and maybe how fast it is going up or down. All GPS receivers have information about places. GPS tracking can be done using particle swarm optimization to search any remote place [11] [12].

The mobile device enables its GPS and Global Navigation Satellite System (GNSS) Network is established and it uses the technologies like 3G or 4G technology to provide the internet connections by different providers. After establishing the network, the internet providers interact with the satellite and track the users' present location through the mobile device. The mobile device tracks the location of the user each and every second and uses the particle swarm optimization to track the location. The location is retrieved by taking the exact value of latitude and longitude value from the database.

Fig 4 : GPS tracking of a remote place

Here, the PSO algorithm works by having a population (called a swarm as the roads) of candidate solutions (called particles as places). These particles are moved around in the search-space. The movements of these particles are guided by their own best known position in the search-space as well as the entire swarm's best known position. When improved positions are being discovered these will then come to guide the movements of the swarm. The process is repeated again and again. By doing so a satisfactory solution will eventually be discovered but not guaranteed correct solution.

Here, let f: be the cost function which must be minimized. The function takes a candidate solution as an argument in the form of a vector of real numbers and produces a real number as

output which indicates the objective function value of the given candidate solution. The gradient of f is not known. The goal is to find a solution a for which $f(a) \leq f(b)$ for all b in the search-space, which would mean a is the global minimum. Maximization can be performed by considering the function h = -f instead.

Let S be the number of particles in the swarm, each having a position $x_i \in$ n in the search-space and a velocity $v_i \in \mathbb{R}$n. Let pi be the best known position of particle i and let g be the best known position of the entire swarm.

```
for each particle i = 1, ..., S do
  Initialize the particle's position with a uniformly distributed random vector: xi ~ U(blo, bup)
  Initialize the particle's best known position to its initial position: pi ← xi
  if f(pi) < f(g) then
      update the swarm's best known  position: g ← pi
  Initialize the particle's velocity: vi ~ U(-|bup-blo|, |bup-blo|)
while a termination criterion is not met do:
  for each particle i = 1, ..., S do
    for each dimension d = 1, ..., n do
      Pick random numbers: rp, rg ~ U(0,1)
      Update the particle's velocity: vi,d ← ω vi,d + φp rp (pi,d-xi,d) + φg rg (gd-xi,d)
    Update the particle's position: xi ← xi + vi
    if f(xi) < f(pi) then
      Update the particle's best known position: pi ← xi
      if f(pi) < f(g) then
        Update the swarm's best known position: g ← pi
```

Fig 5 : PSO Algorithm to Track User's Location.

The values b_{lo} and b_{up} are the lower and upper boundaries of the search-space respectively. The termination criterion can be the number of iterations performed, or a solution where the adequate objective function value is found. The parameters ω, φp, and φg are selected by the practitioner and it controls the behavior and efficacy of the PSO method.

3.2.3 Display of Streams and Specialists

After the location of the user or patient is tracked, the screen is displayed containing the lists of hospitals nearby the location tracked. After any hospital is clicked the list of doctors in various streams in displayed. The patient can also view the details of the doctors available at the particular hospital. It will also contain the timing details of the doctor along with additional details of the doctor like their specialization, contact numbers.

3.2.4 Appointment Module

Patient can contact the doctor by making a call by clicking on the doctor's phone number. By clicking in the book appointment button, a calendar and different available timing slots of the doctors are displayed on the screen. The patient has to send a request for appointment by selecting a day or time. The central database gets updated accordingly. The user will call the doctor in order to book appointment with the doctor.

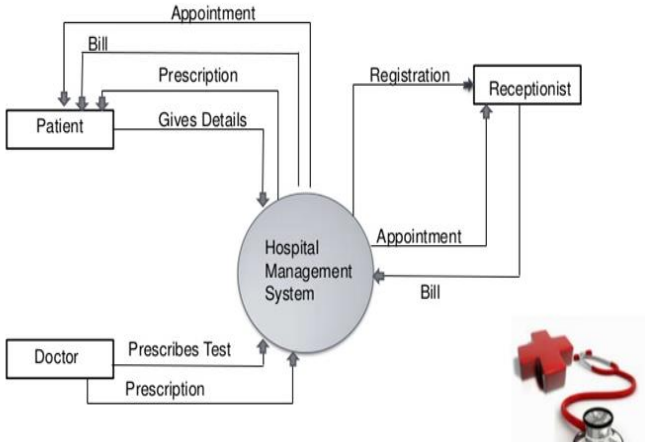

Fig 6 : Booking Appointment with the Doctor.

3.2.5 Reminder Module

This module helps to remind the doctor and the patient that the appointment was booked between them. A message would be provided to both the doctor and the patient before few minutes of that appointment. If the doctor is busy, then the appointment will be rescheduled and the same will be intimated to the patient.

IV. CONCLUSION

Our proposed system has been implemented in android studio for application development and MySQL to store the data as provided by the user in our database. All the tasks are divided into small modules to work efficiently. The data is approached and shared by using APIs between the android application and the server. The proposed system is efficient and has friendly user interface. Addition of pharmaceutical drugs with their price and the availability of drugs in the pharmacy of the same clinic or hospital and also in the nearby pharmacy can be included in the future work. This would help any individual to find the availability of medicine or drugs easily without wasting any time. Some advancement like patient's prescription, patient's medical history can also be included in the near future. Advancements like appointment booking of a user just for fun would be avoided by paying a small amount in the hospital through online transactions to avoid unethical users.

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