IoT Based Healthcare Middleware

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ABSTRACT
In recent times, personal medical information can be of great value in times of crisis. Persistent medical information and history can be lost during transitions or carelessness. The aim of this work is to propose a middleware that shall help transfer medical information of patient to doctors and health care facilities. It is designed to function and work as a bridge between different healthcare services. The functions used by the middleware are driven by means of Internet of things (IoT). On the situation used by us cellular phones and personal computers will be used to exchange and alter information. Each patient's individual social security number (SSN) or any other equivalent identification will be their patient-ID making it a more simple way to organize each patient's unique database which shall be enriched with their medical history from the time they are born. Data will be stored in cloud storage as well as embedded in the patient's device to ensure swift data retrieval. Data will be transferred from one device to another through web applications and mobile applications. The system will significantly decrease the communication gap between patients and doctors while guaranteeing superior data exchange between all parties involved. During emergency, it will first send basic information regarding the patient to the nearest ambulances. Secondly it will alert nearest hospitals, and thirdly, allowing users to send detailed and personal data to a specific doctors to ensure precise and accurate treatment.

CCS CONCEPTS
•Applied computing~Life and medical sciences~Health care information systems

KEYWORDS
Healthcare, Internet of things, health care middleware, Health information exchanges

INTRODUCTION

A test for modern healthcare system in general is not to store data of patient but to ensure an efficient way to exchange data between patients and medical facilities. Efficient communication between each and every parties are difficult to do so even by large hospitals. To access information in timely order is of high importance. Thus we would like to propose a system which uses a middleware to exchange information between all parties while also ensuing each party will have access to information they need whenever necessary. The middleware will use IoT [6] for communicating in between devices making transfer of valuable details faster and safer and also prolong their longevity. Data transfer such as required information, medical information, prescription and results of tests will be done using this procedure of communication. All archives and material about the individual patient will be stored in cloud storage [1] where they will not be exposed to wear and tear had the information been on paper and will be called upon when needed. Each patient will have their respective social security number as patient-ID [4] along with other relevant information about them stored in their profile. This information may vary from their basic identity to continuous cluster of data which may be monitor about the patient [2]. This information is especially helpful in cases of elderly citizens who would normally have an extensive list of medical information susceptible of mismanagement. Information shall be exchanged using web interface and mobile applications. Hospitals, pharmacists and even doctors shall have individual profiles. The proposed middleware will generally work with three kinds of

communication scenarios, each with their individual benefits;

- Patient-doctor
- Patient-pharmacy
- Patient-diagnostic center

During patient doctor communication, patient can give access information along with medical history to the doctor. Afterwards, the doctor can directly send the prescription and dosage needed to the patient's profile making it an easy transaction.

Medication retrieval will be easily applicable for pharmacists through mobile application. They can also retrieve it beforehand for patients. Afterward, the pharmacists can update the information regarding the prescription in a secure manner.

The ending scenario is when a patient adds his prescription and other basic information's to a diagnostic system for medical tests following his visit to the doctor. This shall guarantee a secure and relaxed way for the patient to have a checkup done at a diagnostic center. When outcomes of tests are available for receiving, the patient will be alerted through the profile, thus making procedures more time efficient.

There will also be an emergency scenario where patients will have a few options in case of a real life emergency. During emergency, patients can either contact a health service operator directly or use an application in the system which shall take basic information about the patient and a general idea about the emergency situation and contact the nearest hospital for assistance [5].

During communications, the patient will always have the superior authorization over their personal data and can decide who shall get which data and may limit the visibility of data for said individual. Patient will also have a specific password and login-ID to ensure that the personal medical information will not be seen or exchanged with anyone else without his authority ensuring data protection and security [3] to an extent. This procedure will make the usage of middleware secure and sheltered.

II. RELATED WORK

The proposed middleware relies on IoT to provide efficient communication between the stakeholders. Many recent studies done on the role that IoT based existing cloud platforms, wearables, hardware, and network technologies play on healthcare, shows that there is a huge advantage of using it. One study [6] has shown the understanding of IoT in healthcare and how it will bring competence in the field. The interaction between devices to devices will substantially decrease human error in many ways and lead to a more precise result in the applications. They have seen that 100% of all wearable uses Bluetooth Low Energy as a core technology for data transfer while the system designed implies on using Bluetooth, as well as other ways for data transfer such as NTF and p2p for more effectiveness. In [9] they have described how middleware and IoT can be used together in harmony and how networks are done using them. The design of m-Health monitoring system discussed by [1] which proposed an architecture in three layers where in multilayer they have ensure data protection and privacy of patient where the data's are isolated from each other to protect patient's privacy. Patient's data privacy is also a concern for this proposed middleware. Another study [4] has used IoT and sensors to perform personal diagnostics in addition to monitor and collect their biological data. A Pocket Ambulance application [5] used scenarios in which a patient was in health care emergency to show how GPS in cellular phones are used to track the user patients and how a user friendly application might be helpful in times of emergency. This middleware is compelled by the projects mentioned above in many ways but unlike them, this project is focused on taking the route of data transfer and management instead of data monitoring.

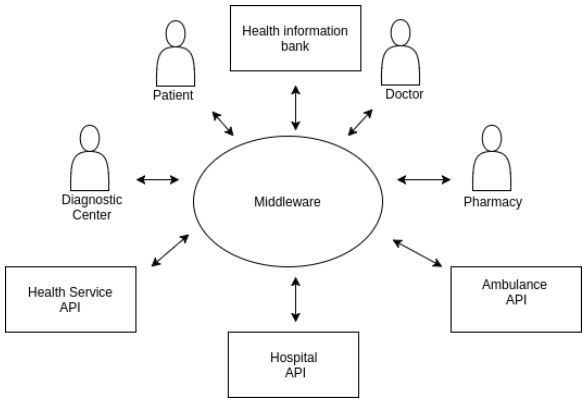

Figure 1: Overview of the healthcare middleware.

III. MIDDLEWARE ARCHITECTURE

The proposed middleware is based on health information bank, hospital API, ambulance API & other medical services. The middleware enables healthcare facilities to be more organized by connecting patients, doctors, hospitals and pharmacies on a single platform through IoT services. The platform allows communication of end-

to-end and maintains the medical data of patients more easily. The middleware communicates with some main modules and APIs which are as follows: patient module, doctor module, pharmacy module, diagnostic center module, health service API, ambulance service API and hospital service API and health information bank API.

REGULAR SCENARIO

The middleware is responsible for handling three different types of communication in regular scenario. Patient-doctor, patient-pharmacy and patient-diagnostic center communication. Users of the system, patient, doctor, pharmacy, diagnostic center have to be registered & verified.

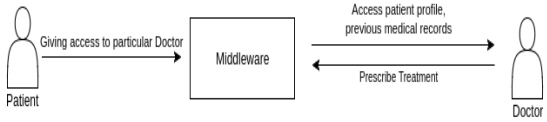

Figure 2: Patient Doctor Communication.

In the Patient-Doctor communication the doctor can access patient's health profile, previous medical history after getting permission from the patient. The permission can be given directly from patient's mobile application via Wifi p2p or the web interface. After getting permission the Doctor's mobile app requests for patient information to the middleware. The middleware fetches the health information from the health information bank and delivered it to the doctor's mobile app. By the same process the doctor can add new prescription in the patient's health profile. In the prescription doctor can add medicine names, amounts, suggestions & diagnostic test names if needed.

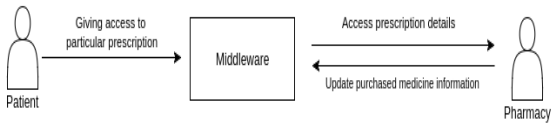

Figure 3: Patient Pharmacy Communication.

The communication between patient and pharmacy will be through a mobile application. A patient application sends prescription id though Wi-Fi P2P. The pharmacy mobile application use this unique prescription id to request to the middleware. The middleware fetches the information from the health information bank and delivered it back to the pharmacy app, to view prescription details.The medicine purchase information will be added to the patient's profile by Pharmacy through the application or web interface of the system.

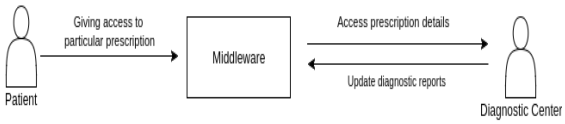

Figure 4: Patient Diagnostic Center Communication

In the Patient-Diagnostic Center communication, patient provides access to a particular prescription by sending the prescription-ID from the application to the diagnostic center's application through a Wi-Fi P2P connection. Based on the acceptance of the diagnostic center, the diagnostic center can view the patient's selected prescription and can add reports to any particular patient's profile.

The healthcare middleware is not responsible for storing any user health information. It is working as a connecting bridge between different health services, modules and devices. To ensure the privacy of the health information while sharing patient's information with doctor through the healthcare app, a token based security implementation is applied. The health information bank system generates a long unique character set as a token for each patient. The patient app sends the token to the doctor's app with the patient ID while giving access. The doctor's mobile application request to the middleware with the unique token & id to change privacy status maintained in the health information bank database. After verifying authentic request the middleware fetch the patient data from health information bank to the doctor's mobile app. Thus a patient's health information cannot be accessed by only knowing patient id as well as the patients who are not connected to the internet, can also use the system.

EMERGENGY SCENARIO

The emergency scenario is based upon three coherent steps. The first is when a user needs to acquire emergency help due to some accident or other serious condition. This can be performed in two ways from the user side. One of the two ways is to register the accident or condition through an application which collects all the necessary information regarding the emergency assistance. Information to be collected includes the current location, type of accident or condition and SSN. The other way is to call the health service for further guidance and assistance. Once the user and the health service are connected, the user will be requested to provide information concerning the assistance. The information collected will contain the type of emergency and the telephone number of the patient

upon availability. If the telephone number can be provided, further details, such as SSN and location, can be obtained using telecommunication API. The emergency condition along with the location, telephone number and SSN if available is sent to the middleware for processing.

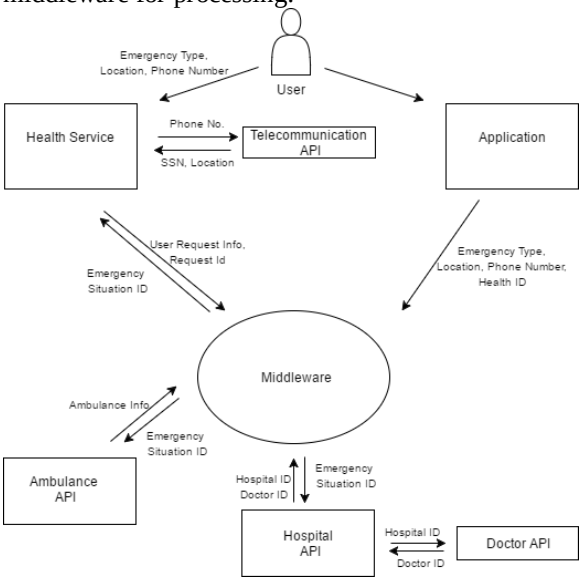

Figure 5: Overview of the emergency scenario handling.

The second step concerns the communication between the middleware and the ambulance API. The middleware provides the generated emergency situation-ID (EID) to the ambulance API. On the other hand, the middleware receives an ambulance-ID from the assigned ambulance which contains information about the location of the ambulance.

The third step concerns the communication between the middleware and the hospital. The middleware provides the generated EID to the hospital. In return, information about the nearest hospital and available doctors will be sent to the middleware, thus assigning these to the particular situation.

IV. CONCLUSION

The proposed middleware facilitates by using IoT to transfer data between users. It addresses some of the miscommunications between doctors and patients which causes many patients being medicated wrongly or even diagnosed improperly.

In the normal scenario, the system shall reduce and save the time needed to diagnose a patient significantly. It also reduces the necessity of time consuming functions of paper and extra hospital staff by making doctors, patients, pharmacists and diagnostic centers use the same medium to communicate and transfer data with each other. By doing so it also reduces the chances of human error due to mismanagement or incorrect reading of results and prescriptions.

The emergency scenario shall trim precious minutes by alerting the doctor and medical center about the emergency, thus giving them enough time to prepare for the patient by either preparing necessary equipment's needed for diagnosing the patient. The medium will also provide help for elder and other people in need for simplified support.

The use of a health information bank was implemented to store data in order to make the system more cost efficient and eco-friendly.

The future of IoT will definitely impact the healthcare sector and this system may be a big step in that direction. Future work on this system will focus on adding wearable monitoring devices to the system, which may predict and diagnose the patient by itself using data received from sensors.

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