International Journal of Engineering & Technology, 7 (1.1) (2018) 252-255

SPC

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Telemedical IoT based technology for emergency health-care

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Abstract

While it is possible to save potential victims during emergencies situations (such as cardiac arrests) using the required healthcare infrastructure around, the greatest challenge lies in setting up of the same. People are not always present at places with readily access to qualified doctors. As a result, there should be a provision to remain in touch with a specialist medical practitioner. This paper presents the methodology of medical content management through internet of things. Transmitting sensory data of the victims to any hospital on time can help save numerous lives across the planet. This mode of human-machine interaction constitutes telemedicine. By embracing information technology and telecommunication, telemedicine provides remote emergency healthcare services outside the regular medical establishments. These systems generate and process an increasing amount of sensory data. It supports real-time processing with the help of a content management system that averts impending life-threatening dangers. By utilizing suitable sensory data inputs, medical practitioners can analyze and convey the appropriate measures to be taken to save the victim. The underlying methodology is extended to various scenarios such as aircrafts, high-buildings and remote villages. Finally, potential for future improvement and the challenges that are currently faced are presented in this paper.

Keywords: *Common Telemedical System; Content Management; Cloud Computing Architecture; IoT.*

1. Introduction

In the present period, it is vital to comprehend the part technology plays in various industrial sectors. Innovation has altered a numerous ventures worldwide through the recent two decades. The beginning of present day innovative headways have had a remarkable effect in the medical field, thus establishing telemedicine as a game-changing approach to serve individuals all through the world. Various levels of the medical industry have embraced this innovation and recognized the long haul benefits related with it. This had prompted the critical increment in usage of telemedicine throughout the most recent decade, in spite of a couple of concerns in regards to its dependability and accuracy.

The main role of telemedicine is to utilize both information technology and telecommunication for providing healthcare services to distant places. It wipes out separation boundaries to enhance access to medicinal administrations for the remote and provincial groups that would otherwise not get access. [2] As such, telemedicine turns into a medium to spare lives amidst circumstances of crisis.

The two terms 'telemedicine' and 'telehealth' are regularly mistaken for each other because of sounding comparable in significance. [3] Nonetheless, there exists a thin obscured line that recognizes them. Telemedicine is all about remote healthcare administrations, while telehealth alludes to remote non-clinical administrations; for example, supplier preparing, authoritative gatherings, and proceeding with medical instruction, etc.

This paper focuses solely on providing emergency telemedical services to victims of cardiac arrests.

In case a person suffers a heart attack, mass volumes of data are continuously delivered by telemedical sensors. Applicable information is required by healthcare professionals at the right place and time. Therefore, the entire bulk of data has to be captured for the adequate conversion, transformation, interpretation and presentation.

As a result, the cloud platform is extensively used for data storage purpose. [8]

During the scenario of heart attacks, the victim has to be monitored so that the appropriate first aid and treatment can be administered appropriately on time. If the victim is in the vicinity of some qualified healthcare professional, the dangerous situation can easily be brought under control. However it is not always possible for patients to be present in such places. Moreover, any kind of neglect in such cases can result in serious casualties. During such emergency cases, the patients can be referred to medical professionals located elsewhere, with the help of the internet. The patient can then easily be monitored and appropriate first aid can be suggested or demonstrated to the inexperienced person for assisting the patient.

This paper considers various different scenarios where remote healthcare (in the case of occurrence of heart stroke) would be required. Some of the areas include in this paper include:

i) in airplanes (during flight)
ii) in high rise buildings
iii) in remote villages

The basic arrangement of giving telemedical medicinal services in such cases is likewise introduced. Subsequently, the extension between the sensors and the human therapeutic staff devouring individualized content is effectively loaded with the assistance of the internet.

2. Implementation

2.1. Sensory data management of telemedical IoT

For the impeccable execution of human services treatment, a productive framework ought to be intended to deal with the content. As the first step, a heart-rate sensor should be established in remote areas in order to receive the input data as and when required. Mass volumes of data can be delivered by this telemedical sensor. Since medicinal services experts require the reasonable data at the pertinent place and time, the bulk health-related data from telemedical appliances is captured for the appropriate conversion, transformation, interpretation and presentation. A feedback link exists between the medical practitioner and the vicinity of victim. Hence, a bridge between the sensory data and the medical practitioners is established through the individualized content management system on the basis of the scenario.

The development of telemedical frameworks should occur in such a way that the machines would be accessible and open from any of the end-user platforms. [7] The GUI (graphical user interface) gives access from PCs, tablets, smart-phones, etc. These devices require the deployment of a telemedical software that connects patients with the doctors.

Storage of each of the patients' medical records can be done within different levels of the cloud architecture. One such usage is called the Infrastructure-as-a-Service (IaaS). An appropriate architecture is provided by Iaas, through which, the medical practitioners can encounter openness, dependability, and accessibility to the given administration. In spite of the fact that there are distinctive administration stages incorporated, countering emergency heart-strokes is the main focus in this case. [6]

For interconnecting all the present information systems in hospitals with telemedical system components, a standard interface is to be setup. [5] It ought to be prepared to manage both-the existent frameworks and rising advances, viz. the Internet of Things (IoT). These IoT instruments gather and forward input sensory data. A pulse sensor is used to continuously display the range of heart-beat values of human beings, in all kind of circumstances. This revolution would positively impact individual lives across the globe.

Extension of cloud computing to Big Data analytics would help enhance the storage of a huge amount of information.

The challenge is in calling for new methodical and innovative arrangements. Because of the developing healthcare diagnosis efficiency, the general overall telemedical service level can definitely be up-scaled.

Communication of the telemedical IoT equipments generally takes place through the Wi-Fi module. Since these instruments normally have only a limited capacity for storage; so after the exchange of data, the large quantity incoming sensory data should be stored. Cloud constitutes the most suitable storage medium for the incoming telemedical IoT sensory data. It offers scalability of the storage capability that is most appropriate.

The next phase is processing. For the incoming sensory information / data, cloud-based processing of data is the most appropriate solution.

2.2. Telemedical content management

The presentation layer in this telemedical system architecture is optimized as being the sixth layer of the OSI reference model.

Telemedical content is categorized either into the technical or process level.

Technical management of content implies that the telemedical systems have the ability to present data. The best example for this kind of sharing is the application of XML-schemas. XML provides the required structure of data or information. Once the XML-schemes and structures are agreed to by all the hospitals, the systems (that have been adjusted) can flawlessly interchange data.

Since healthcare is process-oriented; therefore presentation capabilities should consider processes. [4]

Since telemedical frameworks have a noteworthy level of intricacy, their data is disseminated on various Systems. With the help of appropriate web services, interchange of data among distributed software (that are interconnected across a decentralized network) is ensured.

Telemedical healthcare models call for customized content management. Clinical information systems generally depend upon inputs giving to the system by the medical staff. The quality of this input (which includes data consistency) influences the support system of computer decision-making. However, the issue pertaining to the obstacle associated with the partial filling of patient data needs to be dealt with.

Fig. 1: Telemedical Interface Model.

2.3. Architecture of cloud service

The complexity of the overall system is continuously increases continuously with the increase in the number of components (present in the system). [1] By evolving as such, integration of the system components becomes imminent. Exchange of information involves 4 levels:

i) Technical exchange of information.
ii) Syntactic exchange of information.
iii) Semantic exchange of information.
iv) Process exchange of information.

The technical level involves machine-to-machine interaction through bit-to-bit transfer of data. It prescribes the protocols that are necessary for flawless data transmission. A secure channel is required for the same.

The syntactic level is about the interpretation of the delivered information by both the systems (sender and receiver). For ensuring perfect interpretation, field sizes and character coding on both sides should be applied in the same manner.

At the process level, harmonization of the sender and recipient institution is to be done to bring about transmitted information in a meaningful manner. Even though each healthcare institution is unique in its own way, there should be harmonized processes for using the interchanged healthcare information meaningfully.

The cloud architecture offers the advantage scalability upon demand. Some of the aspects covered here include memory, storage, capacity of computation and bandwidth of the internet.

The solution for connecting these data in the numerous centers calls for a uniform cloud architecture. Cloud technology will reach its maturity with the evolution of IoT sensory technology. A Common Open Telemedical System is developed so as to fit to the cloud technology (that is presently available commercially). It has the ability to run under varying cloud agglomerations and geographically luxate instances, so that the bulk of incoming information is intercepted to process in each of the respective regions.

In such cases, the cloud-storage provider should also be prepared for challenges (covering aspects such as technology, telecommunication, etc).

One challenge is that, since telemedical instruments have different data representations, their standards do not cover every level of system. The other challenge is about processing the continuous flow of medical data to make it readable by the medical practitioner.

Things get much more complex due to the input IoT sensory devices not having a common medium for the representation of data. This makes the telemedical IoT devices incompatible with one another. The proposed initiative for standardization calls for the interconnection of each the smart IoT devices, alongside the integration of telemedical information.

3. Methodology

This paper considers various different scenarios where remote healthcare (in the case of occurrence of heart stroke) would be required. Some of the areas include in this paper include:

i) In airplanes (during flight).
ii) In high rise buildings.
iii) In remote villages.

During long flights, if a passenger happens to suffer from a cardiac arrest, it is very difficult to land the aircraft all of a sudden. Therefore it becomes difficult to provide immediate treatment to the patient. Because if time is wasted on the landing of the aircraft, it can lead to the unfortunate consequence of loss of human life.

Similarly in the case of high rise buildings (which include offices and housing apartments), bringing the heart stroke victim down all those number of floors and shifting them to a local hospital can be time taking process. Not just such buildings, shifting a patient from a person's home can also be a time consuming process, owing to the traffic problems that are encountered in urban areas. This unnecessary wastage of time can indeed prove fatal.

The same is again in the case of remote villages. With the poor connectivity of roads in many of the remote areas, it becomes very difficult to access healthcare services on time.

Thus, the main objective is to design a telemedical system that works with IoT devices to ensure system integration. The integrated systems would then transport large volumes of data (both structured and unstructured). Crowd-sourcing helps achieve the same.

In a crowd-sourcing architectural model, every actor is simultaneously assumed to be the producer and consumer. The reason is that every actor can utilize the produced data for their own purposes. Actors as consumers, are used during further medical examinations or treatment by the actors. The non-technical actors are placed in two categories- producers and consumers. Users belong to the producers group (since they produce data), whereas the integrated telemedical information system belongs to the consumer group.

Another major lookout within the implementation of the telemedical system is to ensure appropriate data protection. A suitable authentication and authorization mechanism should be adopted within the system. Elimination of the basic authentication takes place by using a randomly generated token for each web request, so as to validate and authorize the user. For basic authentication, the user must login with their user id and password. Upon successfully signing in, a hash that is generated will be received. Hash is the token that should be contained by all the further requests. If anyone attempts to impersonate a user without an appropriate token, the system would refuse. Authorization here can be defined by the permissions that the users assign to the tokens generated. Only by successful authentication (through the possession of a valid token) can the resources in the system be accessed; until the issuer (user) revokes access or the token expires.

OAuth can be used for access to information on websites, without having to share passwords.

There are also other techniques such as separation of patient data from other data, so the intercepted data cannot be mixed up. Every method has its own pros and cons.

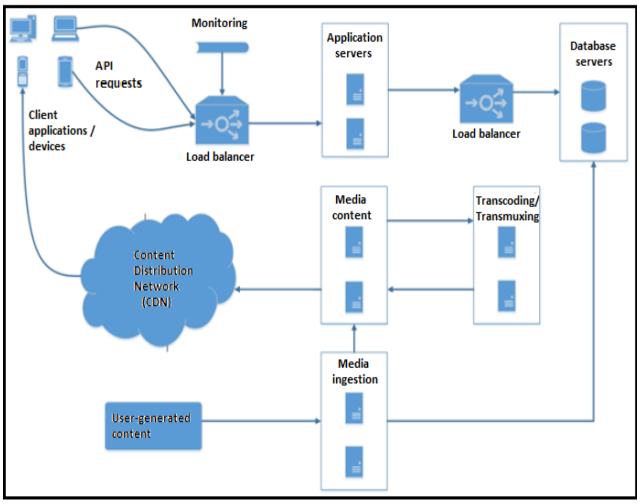

Fig. 2: Cloud Architecture for Telemedical Content.

The system being proposed as a solution should be able to handle impromptu data queries within the common telemedical system. Therefore a suitable industry-wide recognized protocol is necessary to rely upon. The industry already has protocols available, so there is no necessity to build a separate new one. Such standard is the OData (in short for Open Data protocol), which uses HTTP requests in order to GET, PUT, POST and DELETE data. Its purpose is to help integrate the systems and smart-phone applications using the common telemedical system's endpoints with regards to gathering the appropriate data. Accessibility of data that is offered by the common telemedical system should be regulated.

All users (whether personal or technical) are classed under different groups. These user groups differ according to their levels of identification. As per these levels, a single user's access can be controlled either in an individual and general manner. Data stored within the system also differs by two types- sensible and personal data. Not only do the personal health details call for caution, but information such as the GPS coordinates (global positioning system) should also be handled according to the necessary validation procedures.

During the exhaustive exchange of data between the telemedical system and a hospital that has available medical practitioners; whenever a patient is checked, a request for medical examination is received. Then the doctor would be granted access to the previous medical history. The common telemedical system's cloud is designed such that, it stores the large amount of data, where the altering of old data (i.e. historical data) is not permitted. However, there are special processes present for correcting the information that is either incomplete or incorrect.

4. Conclusion

Despite there being continuous institutionalized activities for innovation and data-exchange in IoT, there is no such general arrangement for expansion right now. Transportation of information, interoperability and administration of data/content; all call for a general standard that would be relevant. This prerequisite for the most part applies to the IoT gadgets. As these gadgets as a rule produce essential tactile information through non-existing standards, there arises a need for the synchronization of the entire administration. The general scene gets much more complicated with the joining of the traditional IoT social insurance data framework joining has to be dealt with. The more extraordinary designs in the general administration chain, the greater the quality that has to be managed.

The increase of infiltration of the IoT device market is leading to new prospects for telemedical care. However, these emerging technologies also bring about unmatched challenges that need to be handled. Therefore, standardization becomes mandatory for different devices and architectures to efficiently operate together. By doing so, all the interrupted information can be caught, processed and analyzed at once.

This paper proposes to help victims of emergency situations (particularly heart attacks) through the common telemedical system. This interconnection of interconnecting patients' data to a common telemedical hub would lead to path breaking healthcare data assessment that would rely upon techniques like Big Data Analytics.

Another area of the research, that can continued on lines of the information in this paper; is the cognitive telemedical content management. By collecting significant real- time information, the data should be compared with the patients' past medical records and suitable treatment measures should be generated, without the doctor taking time to analyze. This can further optimize the overall procedure, thereby increasing the probability of survival.

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