INTERNET OF THINGS BASED FALLS DETECTION AND HEART ATTACK DETECTION SYSTEM FOR ADULTS : SMART WEARABLE

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Abstract- In the new era of communications and technology the Internet of Things (IoT) connects devices, sensors, appliances, people, and things. The IoT can help to enhance the living style of the humans in wider area. Most importantly IoT devices will help to safe guard the living beings ever than before. Most of the elders wish to live independently at homes. Some activity in their daily life is prone to have some accidents, such as falls and heart-attacks. Falls can make people in fatal conditions, even death. Also, Heart attack is a global leading cause of death for both gender of elders and the occurrence is higher than other incidences, the research will target to the adults who are suffering from illness and reduce the death rate of heart attack and reduce the bad effects of fallings early as possible.

The research was conducted within applied research paradigm. The intention was to develop an IoT Based SMART Wearable device. The accelerometer uses to detect the falls and GSM based wearable device is use for the notation purpose. The System will generate automatic call as an alert will be sent to family members with the location. This research also can distinguish condition of people between falls and activity doing daily works. When the system starts monitoring and as soon as patient heart beat goes above or lower a certain limit, the system sends an alert to the elder which then transmits this over the internet and alerts the doctors as well as family member. This helps to determine the problem earlier to reduce the death rate of heart attack.

Keywords- Internet of Things, Wearable device, HIS

I. INTRODUCTION

In the novel span of communication and technology, the explosive evolution of electronic devices, smart phones and tablets can be used for physical or wireless communication has become an indispensable tool for day to day life. The next generation of the connected world is run with the Internet of Things (IoT) that associate devices, sensors, appliances, vehicles, and other "things." Objects or objects may include radio frequency identification (RFID) tags, cell phones, sensors, actuators, and so on. The value of the Internet of Things, make it easy to connect anything, access it anytime, anywhere, and effectively access any service and information about any object. Besides, its outspread the benefits of the Internet through remote control capabilities, data sharing, and continuous connections. Consuming embedded sensors that always open and collect data, and are assured to local and universal networks.

At present, heart disease is the leading cause of death in the elderly. Usually, people with heart disease live at home and ask for medical care when they feel sick. However, they often feel sick at the end of the illness and the disease is ubiquitous. This means that the patient's physical condition should be monitored by the doctor and the doctor will decide when to provide medical care based on the patient's real-time status. A key part of this universal healthcare model is the real-time monitoring system. Using the Internet of Things (IoT) approach, you can monitor important people's functions, no matter where they are and what they are doing. In addition, data collection Ed can be sent to remote physicians at low cost,

which ensures that these experts are constantly aware of the patient's physical condition in real time.

Furthermore, fall of an elderly always lead to serious health issues as the failure of their physical ability. Fracture is the most typical injury in fall of an elderly and there is also a certain possibility to get coma, brain trauma, and paralysis. At most fall situations, the fall process is the main source of injury due to the high impact. However sometimes the late medical salvage could worsen the situation. That means the quicker the salvage comes, the less risk the elderly will face. Progress of technology brings more possibilities to help us protect the elderly. Wearable monitoring devices make it possible with realizing low power components. MEMS (microelectro mechanical systems) sensors have simplified the design and implementation of sensor system. Location based service (LBS) makes it more convenient to trace the elderly in health observing. Beside these, mobile computing makes remote health monitoring easier to apprehend. Several kinds of fall detection methods have been developed or applied in our lifetime. Most of the Systems are for indoor environment, but they are hard to realize in outdoor environment. Motion sensor-based method is also commonly used. Accelerometer could provide motion information directly. The sensor measurements or their proper fusion could be used to extricate a real fall.

In this paper, the author proposed an IoT-based monitoring system and heart attack detection system for pervasive heart diseases healthcare and IoT-based falls detection system for elders.

II. LITERATURE REVIEW

A. Emergency Medical System

(VICENTE et al., 2013) have shown that using ED affords prospect to avoid suffering from care as an alternative to the choices of healthcare substitutes. Furthermore, it is absolutely essential to the ambulance personnel support which influence the elderly patient's caring, consequently enabling her/him to participate in healthcare to the highest possible degree. This is actually accomplished through persistently asking for the elderly person's experiences of health, illness, and suffering.

(Wimalaratne et al., 2017) has said even in Sri Lankan EMS Services are still adolescent and country has to developed in many areas to establish as an effective system. Addition to that, the system of Sri Lankan Healthcare should be developed with providing international post graduate specialist training programs for the relevant authorities. The future of the EMS will depend on the recognition of emergency medicine as a primary sphere, public education campaigns for medical safety, and investment in disaster management system such as medical infrastructure.

B. Existing Systems

(Malan et al., 2004) introduced CodeBlue, a wireless infrastructure that is expected to be used in emergency medical care, integrating low-power, wireless vital sign sensors, PDA and PC-class systems. It will improve the ability of first responders to assess patients on site, confirm the seamless transfer of data between caregivers, and facilitate the effective allocation of hospital resources. In addition, due to the dense network of thousands of devices and extremely unstable network conditions, the infrastructure will support reliable temporary data transmission, flexible naming and discovery schemes, and a decentralized security model. This article introduces our architecture and highlights the research challenges addressed by Code Blue development efforts.

Figure 1: (a) mote-based pulse oximeter. (b) The accompanying patient triage application

(Majumder et al., 2017) have done a periodical development in smart home based remote healthcare technologies. Conferring to the author's smart homes that associate with environmental and wearable medical sensors, actuators, and modern communication and information technology. It facilitates continuous and remote monitoring of the health and well-being of older people on a low cost. This system of smart home countenances old people to stay in their comfortable home. Even though it says a smart home it's not more expensive and has limited medical facilities. But the Medical staff can also track the overall health of older people in real time and provide feedback and support from distant facilities.

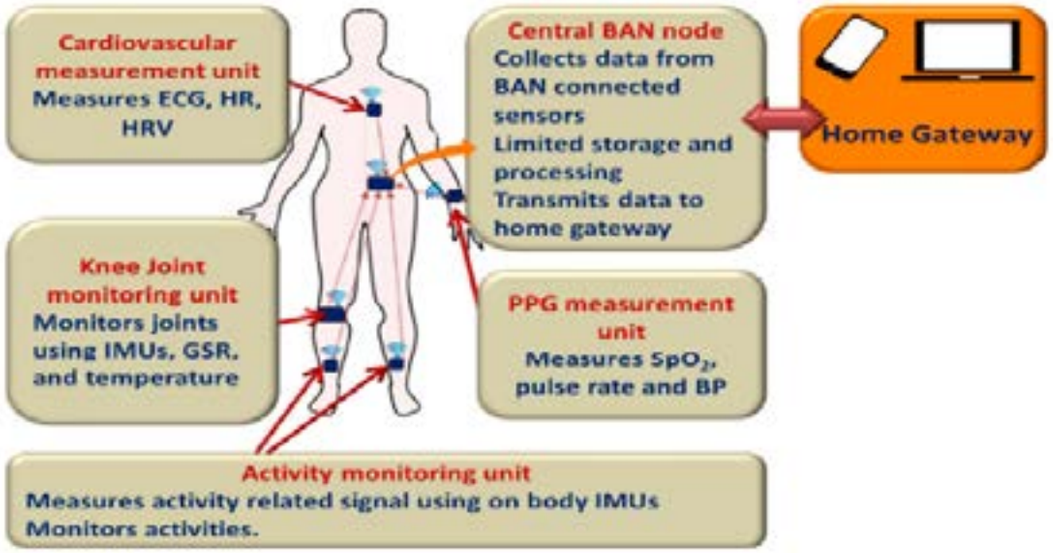

Figure 2: Wireless Body Area Network (WBAN) for wearable medical sensors

In order to achieve all wireless communication sensors and actuators, Standard Protocols for Wireless Sensor Networks (WSN) and Self-Organizing Networks used. Conversely, current protocols considered for WSN do not always apply to WBANs. Figure 2 shows a pictorial representation of a medical WBAN for patient monitoring. Multiple sensors can engaged on clothing or directly on the body, or implanted in tissue, which can facilitate measurement blood pressure, heart rate, blood glucose, EEG, ECG and respiratory rate.

C. Wearable Sensors

(Marschollek et al., 2012) have supposed that ideal sensor systems for health-related parameters. It will be arranged at one point in time and constantly measure and wirelessly report all health-related information. It does not restrict or affect users in any way, nor does it require maintenance. The system similar to the overview of a science fiction novel, but given the effect of technological process. It seems that the system will be reasonable in the not too distant future. This system conflicts with the above requirements and the major problem is energy consumption. Basically it means, that the equipment needs to be charged and repaired frequently. This in turn affects acceptance and compliance. The gap between the harvestable energy and the needs of current sensor systems is still large, but it is shrinking. The demand for service equipment is not only due to energy management but base on the measurement process and the connection between sensors and perceived objects.

(Wolf et al., n.d.), (Koch et al., 2009) have proposed the four axes mobility, connection, measured property and measurement process to organize sensors for health. The related parameters and later improved the scheme (Figure 3).

The presence and availability of wearable sensor systemseasy to deploy and do not burden the patient, if not the main factor impeding the adoption and establishment of health promoting technologies. Currently deployed systems must balance different categories of trade-offs (Marschollek et al., 2012).

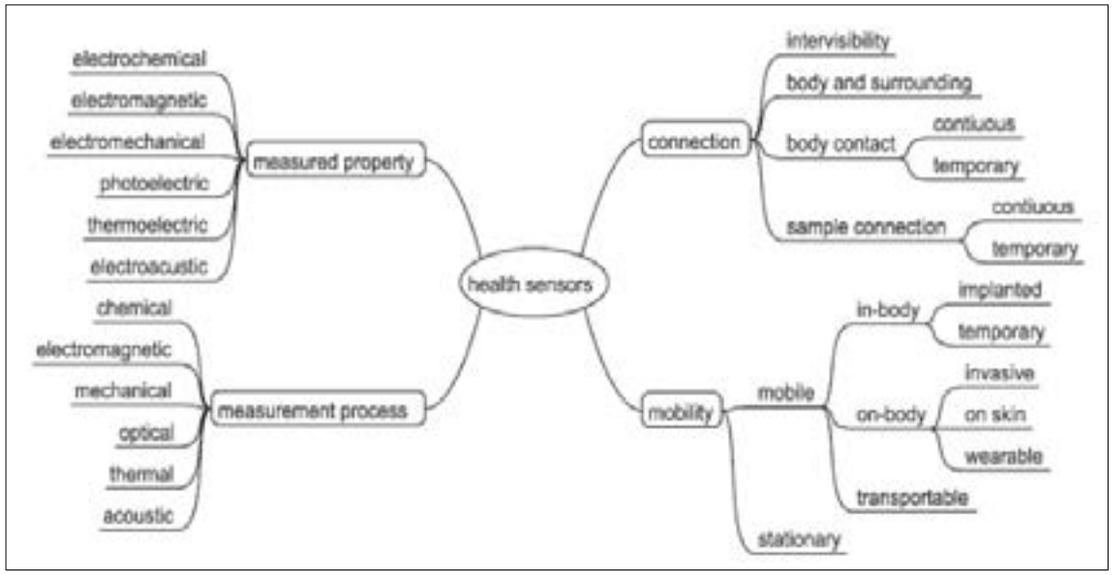

Figure 3: Classification of sensors along four axes: mobility, connection, measured property, and measurement process

(Pan.telopoulos and Bourbakis, 2010) have appraised the current about the development of wearable biosensor systems for health monitoring. Conferring to the biographers, various system implementation methods are associated in the method of identifying the latest technical flaws in current wearable biosensor solutions. this paper displays the architecture of a wearable health monitoring system.(Figure 4).

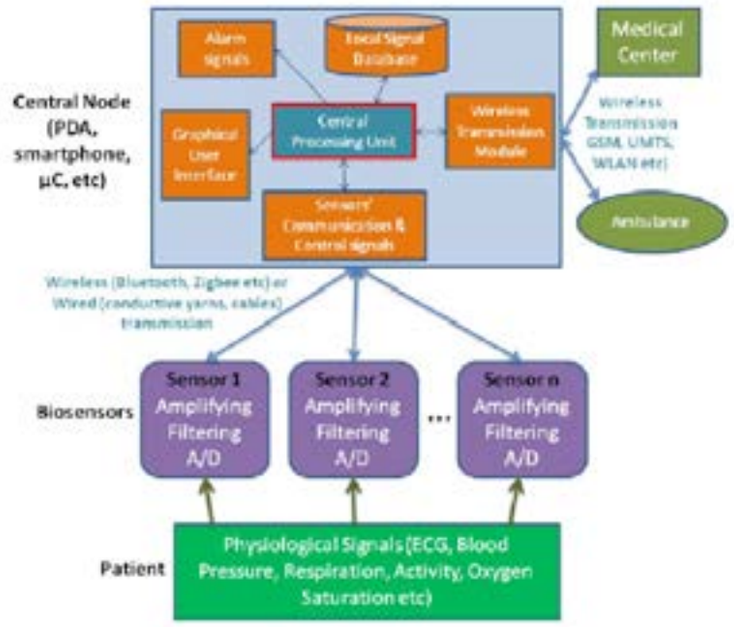

Figure 4 : Architecture of a wearable health-monitoring system

D. Falls Detection Systems

There are several methods for fall detection, such as using a camera, such as Koray Ozcan (Ozcan et al.). Ozcan's research has attached the camera to the body. Therefore, if the direction of the camera changes, it can be concluded that the person has fallen. A very good 86.66% result was obtained from his research. However, some improvements must be considered and many positive errors follow. In addition, accelerometers and gyroscopes are many of the commonly used sensors in today's society. Among them, YanjunLi tried to use an accelerometer sensor (Chen et al.).

His research by using Telos was the chipset that connected to the computer with a wireless connection, but in a small scale. According to that, this detection-fall system is only ideal for indoors.

(Rakhman et al., 2014) has proposed a system utilized a tri-axis accelerometer and gyroscope confined on the smartphones as seen in Figure 5.

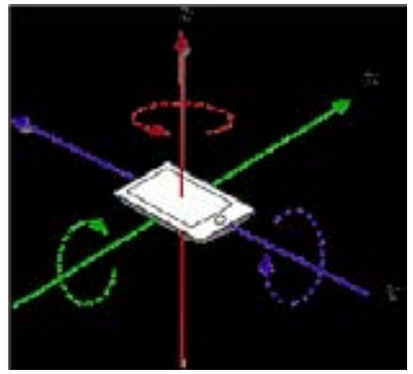

Figure 5: Axis of the gyroscope and accelerometer

(Lan et al., 2009) has presented Smart Fall, which is an automatic fall detection system constructed on subsequence matching, for the Smart Cane system. It uses data from the accelerometers entrenched closely to the handle of the Smart Cane to make implications of current status. (Figure 6)

(Lee et al., n.d.) It is recommended to use the accelerometer of the smartphone to sense the fall detection system of the elderly falling in real time. Mainly its communication spending power in the smartphone to notify the administrator of such an event. The proposed system allows for real-time monitoring of older people who may have fallen. Once the system detects the risk, it uses the smartphone to end the fall and send the location from the smartphone's GPS sensor. Figure 7 shows the real-time location tracking system.

Figure 7 : The real time location tracking system

E. Heart Attack Detection Systems

In a paper presented by Li et al., 2017, an Internet of Things-based heart disease monitoring system is used to popularize health care services. The structure continuously monitors the patient's signs such as blood pressure, electrocardiogram, SpO2 and related environmental indicators. In addition, it offers four different data transfer modes to balance healthcare needs and the need for communication and computing resources. They choose the right equipment to form the sensing layer of the monitoring system. Connectors play an important role in the data transmission of the system. Due to the popularity of smartphones in the system and the openness of the Android platform, the authors focus on using Android smartphones as connectors. The application is responsible for receiving and storing monitoring data from the sensing device via Bluetooth and transmitting the necessary data to give the changed mode of operation. The web-based application was arrested and the doctor could query the monitoring data.

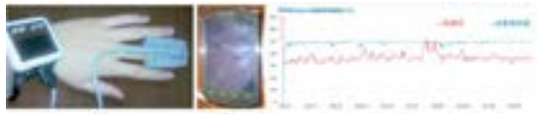

Figure 8 : (a) the SpO2 sensor device; (b) the mobile phone; (c) SpO2 monitoring data.

The figure above shows some of the devices used in the system and examples of monitoring the GUI on the doctor side. Fig. 8(a) is a picture of a sensing device for SpO2 and pulse rate. Figure 3(b) shows the connector in our system, the Android smartphone. Figure 3(c) shows the remote physician's GUI for monitoring patient SpO2 and pulse rate.

Sidheeque et al.) provides a system that uses sensors to detect a person's heart rate using heartbeat detection even when the person is at home. The sensor is connected to the microcontroller, allowing heart rate readings to be checked and transmitted over the Internet. Users can set high and low levels of heartbeat limits. After setting these limits. After the system begins monitoring, once the patient's heartbeat exceeds a certain limit, the system sends an alert to the controller, which then sends the alert over the Internet and warns the doctor and the associated user. In addition, the system will warn that the heartbeat is low. The system also displays the patient's real-time heart rate whenever the user logs in for monitoring. As a result, the person concerned can monitor the heart rate and can immediately get an alarm for a heart attack from the patient and save the patient on time.

In this paper, (Ashrafuzzaman et al.) proposes a system that can detect heart rate using only a camera (Fig. 9) and a commercially available smartphone and using a mobile stethoscope (Fig. 10) to record heart sounds. There are heart attacks and other heart-related diseases. Fuzzy logic is abandoned here, it is part of data mining, and data mining is an expert solution to human diseases. In this technique, the user does not need specific hardware, and he/she can perform measurements almost anywhere in any environment.

III. METHODOLOGY

The research was conducted within applied research paradigm. The intention was to develop an IoT Based SMART Wearable Falls Detection and Heart Attack Detection System which help to reduce the death rates of our adults to and generate automatic call as an alert will be sent to family members with the location if any emergency situation. The research was done focus on a home environment as in the initial stage.

Figure 9:Holding index finger on camera lens

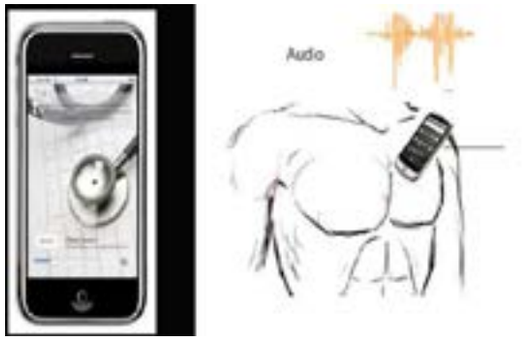

Figure 10: Mobile Stethoscope & Human body with Mobile Stethoscope

A. Falls Detection System

The architecture of the developed system is described in Figure 11. A wearable device is placed on human's hand. The system can detect the elderly's falling by acceleration analysis. Then it will get the elderly's geographic position and send fall alarm short message to guardian(Figure 12). So the elderly who has fallen can get timely help to minimize the negative influence. The authors have added another feature to this device. If the elderly person gets any emergency situation he/she can press the SOS button which authors have added to the device. It sends a call to the guardian.

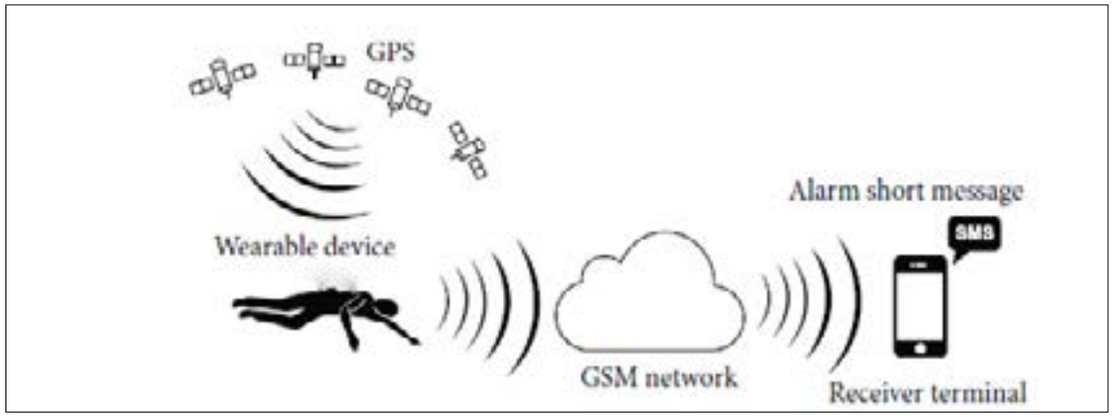

Figure 11: System Architecture

Figure 12: Fall alarm SMS which contains fall location URL

In here authors mainly use sim908 to get the GPS service, GSM function (Figure 13) and accelerometer ADXL345 to get the acceleration. (Figure 14)

Figure 13:SIM 908 module

Figure 14: adxl345

B. Heart Attack Detection System

Figure 15 shows the architecture of the IoT-based monitoring system for heart attack detection system for elders. This is a wearable device and When the elderly person checks his/her pulse rate it shows in a c# application in the computer which the device and the application is connected through WIFI. The person has 2 limitations in the pulse rate which is the lower value and the higher value. When the pulse rate comes near to those values it alerts both the guardian and the doctor through an E-mail. So the doctor can come out for some decisions earlier and the doctor can send medicines which the patient should take via E-mail to the guardian and the patient

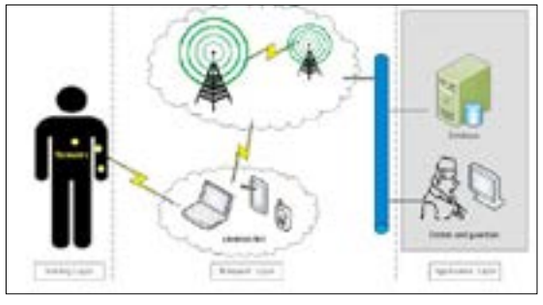

Figure 15 : System Architecture

In here the authors use a pulse rate sensor (Figure 16) for detect the pulse rate and esp8266 WIFI sensor(Figure 17) to connect with the computer.

Figure 16: esp8266

Figure 17: pulse rate sensor

IV. EVALUATION

Summative evaluation was used as the evaluation method to find how the system functions and whether it is up to the expected level to fulfil the users' requirements. At the finalizing stage this evaluation was done to evaluate the product's stability. In summative evaluation, a prototype with most stable build was shown to the user and the feedback was taken to find how far the system is success. The intended target group of the elderly were not employed for testing purposes as a safety measure, since the objective of this project is to design and construct a prototype emergency medical assistance. Therefore, its functionality was tested with the help of colleagues who supported in the testing and evaluation by giving their opinions after using the emergency medical assistance. Several colleagues have given the mobile phones and the computers with the installed C# application with and they were connected to a same Wi-Fi router so the distance from one user to other is low however the when the user initiate the application its worked very accurately and faster than expected. Sometime users send requests same time and its worked fine even that. According to the colleagues used the system they were very satisfied with system. As this project focused on designing and constructing a prototype, comparatively cheap pulse rate sensor and a cheap accelerometer sensor was used. When implementing the actual system, it is recommended to use sensors with high accuracy.

V. CONCLUSION

Increased awareness of the occurrence of falls among the elderly and enrolment of efforts to prevent or diminish such events are highly needed in order to improve the quality of life for elderly people and provide them with convenient fall detection and prevention techniques.

According to the authors, they developed a fall detection system based on a single triaxial accelerometer based wearable device with a SOS button which can use in any emergency situation. The system has low power consumed hardware design which may extend the service time of the wearable device .As normal activity of resting also has similar rotation as falling, it may trigger fall alarm when the body hits ground heavily and alert the relevant people. In future, combining multi-sensing data fusion technology with prediction technologies such as Machine Learning Artificial Intelligence approaches will support developing intelligent fall prevention system based on fall prediction.

A varied of heart attack detection techniques are introduced so far, however they are very expensive and time consuming. Developed a system that measures and detect Human Heartbeat, sends the data to users end by using microcontroller with reasonable cost and great effect. For Human Heartbeat measurement use fingertip, it's in bpm (beats per minute). These calculated rates will have stored in server by transferring through Wi-Fi module via internet. Finally, the stored data in server will be displayed for further analysis by physician or specialist to provide better aid and when the bpm goes to the lower rate and the higher rate it alerts the doctor from the application. From Experimental results, proposed system is user friendly, reliable, economical. Further research work can be carried out for the following issues:

- In Real-time heath monitoring system using ARDUINO can be integrated or implemented in hardware using various types of sensors to detect the human-health conditions of the patients in critical sites continuous Observing of health can be made and the data's will be stored in database.
- In future, a portable Human-Health monitoring system can be designed using Arduino.

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