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Real-Time Monitoring and Detection of "Heart Attack" Using Wireless Sensors and IoT

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ABSTRACT

Continuous growing interest in IoT applications particularly for a smart city setting has attracted many researchers. E-health applications in IoT networks are the newest area of interest in this research field.The medical urgent situation service is one of the most important need of the human being in case any type of the diseases or the attacks. An idea to get the action or the urgent situation service for the heart attacks by sensing and sending the required information to the nearby hospitals and the listed people using smart watches or smart phones and with the location using GPS. Real-time Heart Attack Mobile Detection Service through voice control and gesture control using smart watches. This aims to improve response time of emergency aid for heart attack patients. In this paper, we propose the capability to monitor the patient present at their workplace, home, hospital, and where ever the patient wishes to be. However the capability of the system brings in new complexity of locating and tracking the patient.

Keywords: Internet of Things (IoT), GPS, Wearable Sensors, Real-time Monitoring

I. INTRODUCTION

The Internet of things (IoT) is the network of physical devices, vehicles, home, appliances, and embedded with electronics, software, sensors, ac tuators which enable these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure. Creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies as smart grids, intelligent transportation and smart cities.

Opportunities pertaining to the incorporation of sensors within the recently released popular smart watches for e-health IoT services are main contributions of this paper. Smart watches are equipped with various sensors such as gyroscopes, accelerometers, Global Positioning System (GPS), and heart rate monitors. The latter three sensors are of interest with relation to the e-health IoT service that this paper proposes.

The emerging wireless sensor technology provides the capability to continuously sense, process and transmit the required signals to a control station. This capability can be used for real-time monitoring of cardiovascular patients, which will reduce the effects of diseases.

This work proposes a wireless sensor network design for real-time monitoring and detection cardiovascular disease. This system incorporates wireless sensor network technology with other wireless technologies such as cellular network, wireless LAN, and broadband network, for efficient and fast delivery of health alerts. This proposed system consists of a wearable wireless sensor system, control system, heterogeneous wireless network system, two phase real-time data analysis and visualization system, and the warning system.

Section II describes the related work. Section III discusses architecture for detecting heart attack. Section IV describes the implementation and validation. Section V describes the results. Section VI describes conclusion and future work.

II. RELATED WORK

A home-based mobile cardiac monitoring solution is described in [1], which incorporates a design of an integrated electrocardiogram (ECG) beat detector, supported by the PDA version of Personal Health Information management System (PHIMS) and Facilitated Accurate Referral Management System (FARMS) through wireless network. This system is designed to use in a home environment whereas the proposed system is capable to be used for continuous monitoring of the patients at different environments such as home, hospital, work place, and practically anywhere.

Kala John Kappiarukudil et.al [2] proposed a real-time wireless sensor network system for monitoring and detecting any upcoming cardiovascular disease. The system has the capability to monitor multiple patients at a time, to deliver remote diagnosis and prescriptions, and also for providing fast and effective warnings to doctors, relatives, and the hospital.

Mario Gerla et.al [3] proposed the urban fleet of vehicles is evolving from a collection of sensor platforms to the Internet of Autonomous Vehicles. This article claims that the Vehicular Cloud, the equivalent of Internet Cloud for vehicles, will be the core system environment that makes the evolution possible and that the autonomous driving will be the major beneficiary in the cloud architecture.

Ian Ku et.al [6] described several different operational modes and the services that can be provided. The feasibility of a Software- Defined VANET by comparing SDN-based routing with traditional MANET/VANET routing protocols. It definesHow fallback mechanism is a key feature that must be provided to apply the SDN concept into mobile wireless scenarios, and transmission power adjustment as one of the possible services that can be provided by Software-Defined VANET.

Robert Richer et.al [10] work presents a novel wearable system that is capable of measuring the user's cardiac functions throughout the day, from a one-time heart rate measurement to a continuous ECG monitoring. The core features of the smartphone application were combined with the possibilities of wearable devices like Google Glass and smart watches based on Android Wear.

Mohammed Ghazal et.al [12] proposed system focuses on delivering real-time service request updates to clients' smartphones in the form of audio and visual feedback. The system in its core is a queue management system with real-time updates to smartphones. It improves the quality of the waited time on location by providing a means of entertainment through streamed TV audio, downloaded magazines, and newspapers.

III. PROPOSED WORK

The proposed system is capable for real-time, continuous monitoring of cardio vascular disease, detecting life threatening heart attacks, and disseminates the alert to the nearby vechicles. The currently available wearable cardiac monitoring system requires connectivity to either cellular network or wireless network to disseminate the alert. But in the current scenario, cellular or wireless network is not available continuously. Due to this non-availability of the network connectivity, alert dissemination will be delayed, increasing the risk of the patient. Even if the cellular network is unavailable, the proposed system is capable to disseminate the alert to the patient through his smart watches high beep alarms.

The architecture of this proposed system consists of sensors for detection of heart attacks that may occur while you are driving. A wearable wireless sensor system is designed to continuously monitoring the patients through smartwatches or smartcars. The fastest alert will be issued to nearby vehicles, relatives, and hospitals using the proposed data processing algorithm implemented in the patients cars.

The proposed system is provides the capability to monitor the patient present at their workplace, home, hospital, and where ever the patient wishes to be. However the capability of the system brings in new complexity of locating and tracking the patient. The proposed system provides the solution for locating the patient in real-time, that will enhance the capability of the system in providing the required health care with minimum delay.

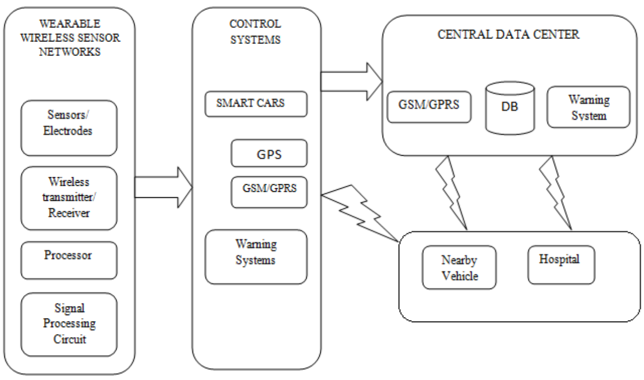

Figure 1. Architecture Of Proposed System

A. Wearable Wireless Sensor System - The wearable wireless sensor system is used to continuously sense the ECG of a patient. WWSS consists of lead chest electrodes, blood pressure sensors, respiratory sensors, interfacing and signal processing circuit, and the transmitter. Electrical signals initiated from the heart are captured by the lead chest electrodes, amplified and filtered using the interfacing and signal processing circuit. These ECG signals are transmitted to the mobile phone using Bluetooth technology.

B. Mobile Control System (MCS) - The signals transmitted from the WWSS are received by the patient's mobile phone. This mobile phone act as the control system, which process the ECG signals, generate the initial warning, and transmit the data and warning to the nearby vehicle, relative, and patient's mobile phone, and also to the specified hospital. The warning message with warning alarm will be send by the GSM/GPRS module of the mobile phone. In order to locate the position of the patient, his location, from the GPS module in the mobile phone, and the time stamp will be sent along with each data packet transmission. Time stamp can also be used for determining the event continuum.

C) Warning System (WS) - The warning system is integrated in the mobile control station and also in the central data center (CDC). The mobile control system provides the fastest warning, whereas the central data center will provide extensive warning about any prospective cardiovascular disease. The warning alarm can be either a message or a special music stored in the music library of the concerned person's mobile phone, or a combined technique.

IV. IMPLEMENTATION AND VARIATIONS

Real time monitoring heart attack employs various sensors for detection of heart attacks that may occur while you are driving or in a car. We propose two models; each utilising a particular sensor for convenience of the user and enhanced accuracy of the system. The proposed methods has two models, voice controlled and gesture controlled, are implemented through the utilisation of smart cars.

Voice controlled RHAMDS model is based on the use of voice commands feature that smart cars have. In this model, a certain unique word is identified for the initiation of the e-health IoT service As such, the smart cars carries out continuous real-time monitoring of voice commands.

The recognition of the identified and programmed voice command for the heart attack incident alarm, both GPS co-ordinates of the smart cars monitored locally. However, upon a match one of the smart cars GPS co-ordinates, the server communicates with the RSUs to send the command for an automatic car flash to commence for the respective identified smart car. The car is then controlled to auto park to the nearest emergency lane whereas the nearest hospital is notified of the location for an enhanced ambulance response time.

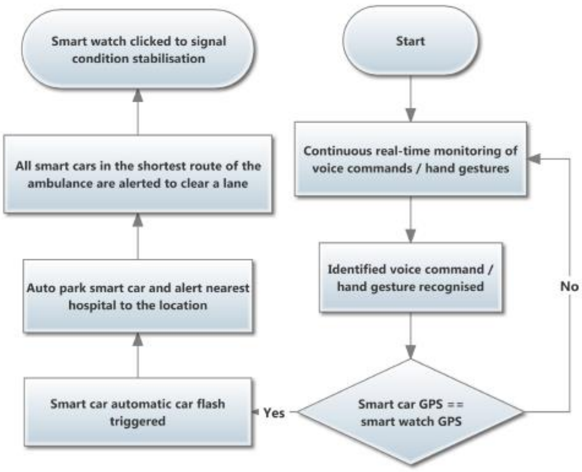

Figure 2. Voice controlled/ Gesture Controlled Variations

Note that when the identified voice command is recognised, the smart watch shows a window that needs to be cleared when the emergency ambulance vehicle arrives. This is performed to signal status stability, i.e. the patient is receiving the appropriate aid, and allow the network to return to its original condition with the aforementioned notified smart cars proceeding with their normal interaction on the road.

This window may also be cleared when the user the voice command in passing conversation in the car through an immediate repeat of it to prevent false alarms to the system. The complete work-flow of the model is shown in figure 2.

Another variation of the model considers real-time heart attack detection both within a vehicular network and outside it. This is taken into consideration by changing the logic that the service provides when the smart watch GPS coordinates do not match any of the smart cars. This indicates that the heart attack emergency is not taking place in a car. As such, the service then directly notifies the nearest hospital of the location. It then proceeds to alert the smart cars within the shortest route to the emergency position to clear the lane and increase the corresponding traffic signal time for the ambulance passage to ensure record response time. This model's variation work-flow is shown in Figure 3.

V. EXPERIMENTAL RESULTS

Upon the detection of a heart attack, i.e. voice or gesture monitoring successfully indicate an event trigger, a notification pops up on the smart watch. On the other hand, nearby cars receive as the network signals the nearest hospital in order for the drivers to clear a lane for clearing a direct route for ensuring the fastest possible ambulance or medical assistance. Nearby cars are calculated by the proposed system network as per their GPS locations in comparison to the car with the heart attack incidence and the nearest hospital route to the spot where the smart car auto parks in.

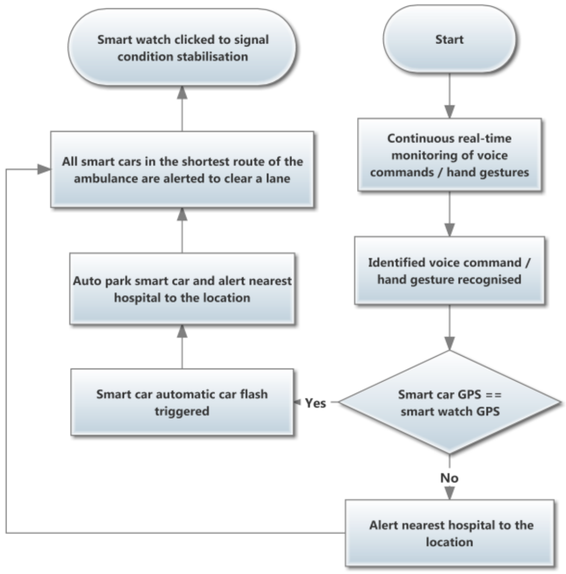

Figure 3. Result for Proposed System

Nearby cars are calculated by the proposed system network as per their GPS locations in comparison to the car with the heart attack incidence and the nearest hospital route to the spot where the smart car auto parks in.

VI. CONCLUSION

An idea to get the action or the urgent situation service for the heart attacks by sensing and sending the required information to the nearby hospitals and the listed people using smart watches or smart phones and with the location using GPS. Real-time Heart Attack Mobile Detection Service through voice control and gesture control using smart watches. This aims to improve response time of emergency aid for heart attack patients. The proposed system is capable for real-time, continuous monitoring of cardio vascular disease, detecting life threatening heart attacks, and disseminates the alert to the nearby vehicle, relatives, and patient. The fastest alert will be issued to nearby vehicles, relatives, and hospitals. The proposed work has been explained with the architecture diagram and the processes involved in it are explained. The proposed system can be evaluated using various performance measures. The future work is to implement and evaluate the proposed system.

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