IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Advanced Telemetry system for Hospital wagon with Fog Cloud Operability

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Abstract- *A hospital Wagon which is a smart ambulance system model that provides health monitoring of patients for remote medical professionals with fog and cloud feature. Sensor nodes records and deliver health status information to other elements of system such as hospital site. Remote decisions can be made in a medical center after receiving inputs generated inside an hospital wagon. Building a distributed real time system can handle all aspects of time critical systems and hide heterogeneity between elements and different types of data. Hospital wagons are time critical every second may save life of patients. Current wagon services have some limitations such as limited resources, lack of effective communication with doctors, latency, and poor video technology. A proposed model for telemetry system for hospital wagon system by using hardware which contains raspberry pi 3, sensors such as temperature and heart rate, fog which deployed on one machine with some bounded area and cloud which deployed on second machine. Wagon will have advanced telemetry system is onboard in an ambulance having life saving capabilities, the vital signs of the wounds (e.g. temperature, heart rate) can be measured and uploaded on fog instantly via a wireless (Wi-Fi) communication network. After one episode completed means patient can be reached to hospital then fog which having real data can upload on cloud for the future investigation. Additionally, videos taken by cameras installed in the hospital wagon can be sent to the hospital in real-time using raspberry pi. Latency issue related to cloud is minimized using cloud fog operability. In fog continually fetch the sensor value and compare with threshold value if values greater the threshold the system can send SMS notification to doctor.*

Keywords—Sensor nodes, Cloud, Fog, Telemetry system, Hospital wagon, Raspberry pi 3

I.INTRODUCTION

For disaster relief operations or emergency medical services (EMS), time is much more than a matter of money—it's a matter of life and death. An ambulance-to-hospital based telemedicine system is the best example of how mobile technology can help save lives, by providing real time patient information to the hospital via wireless communications, enabling remote diagnoses and primary care, and reducing rescue response time. Telemedicine, as defined by the American Telemedicine Association (ATA), is the use of medical information exchanged from one site to another via electronic communications, to improve a patient's clinical health status. Telemedicine includes a growing variety of applications and Services from remote health monitoring to medical education. Among these applications, ambulance-based telemetry system uses the most up-to-date vehicle electronics and mobile communications technology, aimed at providing a significant time advantage, expediting critical treatment and improving patient outcomes.

The telemedicine model applied in these two pilot studies has its origin in the German, physician-based, EMS system: two paramedics (an ambulance's crew in most German EMS) establish, either from a scene or from inside the ambulance, a telemedicine session with an especially trained EMS physician (hereafter called tele-EMS physician), who is located in a remote location (hereafter called teleconsultation center). During the telemedicine session, bidirectional real-time voice communication is the main information channel. Additionally, the Tele-EMS physician receives information from a multitude of sources from the scene of incident and from within the ambulance: amongst others, the biomedical signals acquired by the patient monitoring device.

In the teleconsultation center, two tele-EMS physicians are on call for involved ambulances; a tele-EMS physician supervises only a single ambulance team at once. To collect evidence on the medical and organizational impact resulting from the use of this telemedicine model, the declared goal of our pilot studies was to conduct them in regular EMS operations. Consequently, the telemedicine system must not hinder patient treatment, making usability a major concern; besides, application of telemedicine must not prolong on-scene time intervals significantly, which was already analyzed in former studies.

In addition to usability, organizational aspects and statutory regulations of medical devices are of major importance to the technical system realization. Philips Healthcare (Boeblingen, Germany) joined the research project and supported it by providing off-the-shelf medical devices for patient monitoring (Philips MRx monitoring/defibrillator device) and accompanying software. From a technical perspective, the challenge to incorporate these devices into an integrated telemedicine system—together with additional communication technology and custom software—remained. We have already reported general results from a one-month test phase of this integrated telemedicine system in, where we discuss overall requirements and the performance we achieve with the overall system architecture. Still, we have not yet reported on the solution to the aforementioned integration challenge, which is a major enabler of our study's trail phase and as such may provide valuable insight for future telemedicine projects in emergency medical services.

Telemedicine is currently mainly applied as an in-hospital service, but this technology also holds potential to improve emergency care in the pre-hospital arena. We report on the safety, feasibility and reliability of in-ambulance teleconsultation using a telemedicine system of the third generation.

Advanced telemetry system for hospital wagon systems provide quick response, transportation, video live streaming clip and sensor data transfer with low latency with the help of powerful features of fog computing. Appropriate emergency medical care to the patient provides the safety, feasibility and reliability inside hospital wagon. Tele-consultation using an telemetry system in hospital wagon with cloud fog operability

to implement the emergency medical services concept which will use raspberry pi 3 having inbuilt Wi-Fi,1.2GHz operating frequency, 64 bit ARM Cortex, which help to enhance time sensitive application. Time is much more important than money as it's a matter of life [2].

Patient connected with electronic sensor nodes such as heart rate and temperature sensor. These sensors data as well as raspberry pi-camera live streaming data of the patients will be send to hospital unit, so doctor will be able to see it and prepare OT or procedures required for that particular patients before they comes in hospital and can save life of patient. Live streaming is implemented by RTMP (real time streaming protocol)[4]

Doctor can monitor the live situation of patient by accessing the data from fog (live streaming and sensor values). Fog can deployed on one machine, which authorized by doctor. Fog essentially, a middle layer between the cloud and the hardware to enable more accurate data processing, and storage, which is responsible for reducing the amount of data which needs to be transported to the cloud. Fog computing mainly provides low latency in the network by providing instant response while working with the devices interconnected with each other. [9]

II. ARCHITECTURE

Architecture is divided in three parts, hospital unit, Hospital wagon unit and fog – cloud operability.

A. Hospital unit

At the hospital side, emergency room physicians and doctors can receive and review the incoming data at a desktop PC from fog unit as well as cloud on a mobile device such as a tablet or Smartphone and make preliminary assessments before the arrival of the patient. The ER doctor can also zoom-in to see the wounds, discuss the situation with the emergency medical technicians (EMTs), and instruct the EMTs to administer primary care or Advanced telemetry system in hospital wagon, such as giving injections or fracture treatment.[2]

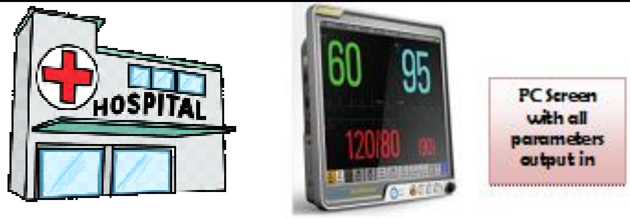

Fig.1 System Overview

B.Hospital wagon unit

The different parameter that has to measure with the help of respective sensors is connected to the GPIO of Raspberry Pi. Raspberry Pi is having on-chip WIFI which will be used for wireless data sending to the Fog machine and Raspberry Pi camera can be interfaced to the CSI interface given on the board itself. So that continuous monitoring of the patients health is recorded and in real time base it is sent to the Fog. Because of this doctor at remote location can monitor the current situation of the patient by accessing the in data from Fog (i.e. Live streaming and current sensor data can be viewed by accessing the data from Fog). All the sensor data will be then available on the cloud [12] with database store with date and time

Hospital wagon unit will send all details to nearby hospitals. so the doctor having authority will be able to see the patients live streaming from wagon to the hospital. It is not necessary he should be present in the hospital he should have device with internet connection that is advantage of IOT in our proposed model

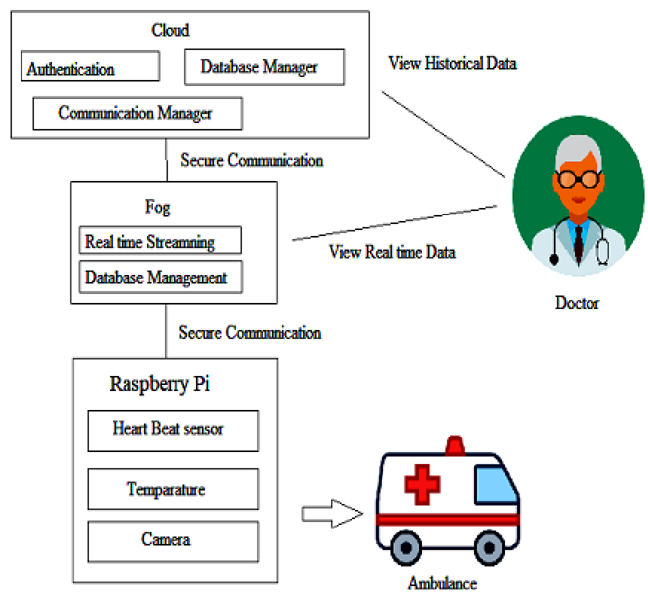

Fig.2 Architecture of the system

C. Complete system

A hospital wagon system made by Hardware which contains raspberry pi 3, sensor i.e. temperature and heart rate, Fog which deployed on one machine and cloud which deployed on one machine.

Telemetry system will be onboard inside hospital wagon having lifesaving capabilities, the vital signs of the wounds (e.g. temperature, heart rate) can be measured and uploaded on fog instantly via a wireless (Wi-Fi) communication network. After one episode completed means patient can be reached to hospital then fog which having real data can upload on cloud.

Additionally, videos taken by cameras installed in the hospital wagon can be sent to the hospital in real-time using raspberry pi. The different parameter that has to measure with the help of respective sensors is connected to the GPIO of Raspberry Pi. Raspberry Pi is having on-chip WIFI which will be used for wireless data sending to the Fog, and Raspberry Pi camera can be interfaced to the CSI interface given on the board itself. So that continuous monitoring of the patients health will be recorded and in real time base it is sent to the Fog. In fog continually fetch the sensor value and compare with threshold value if values greater the threshold the system can send SMS notification to doctor.

Doctors can monitor the live situation of patient by accessing the data from fog (live streaming and sensor values). Fog can deployed on one machine which authorized by doctor. Fog is, essentially, a middle layer between the cloud and the hardware to enable more efficient data processing, analysis and storage, which is achieved by reducing the amount of data which needs to be transported to the cloud. Fog computing mainly provides low latency in the network by providing instant response while working with the devices interconnected with each other.

Here cloud is used for storing the large amount of data. After patient reached to hospital our current episode will be end. Fog can ready to send the patient streaming data and sensor value to cloud. Cloud can fetch these data and store into cloud database. After sending data done, fog can delete the previous data for clearing the space on fog.

Doctor wants to view real time streaming and sensor values of patient then he can view from fog. If he wanted to view previous data of patient then will use cloud. The whole system uses wireless communication technique for communication. Data can be transfer and received securely via Wi-Fi and internet network. Hardware that will be use in proposed model

D.MCP3008

The MCP3008 10-bit Analog-to-Digital Converter (ADC) combines high performance and low power consumption in a small package, making it ideal for embedded control applications. The MCP3008 features a successive approximation register (SAR) architecture and an industry-standard SPI serial interface, allowing 10-bit ADC capability to be added to any PIC® microcontroller. The MCP3008 features 200k samples/second, 8 input channels, low power consumption (5nA typical standby, 425µA typical active), and is available in 16-pin PDIP and SOIC packages. Applications for the MCP3008 include data acquisition, instrumentation and measurement, multi-channel data loggers, industrial PCs, motor control, robotics, industrial automation, smart sensors, portable instrumentation and home medical appliances.

Features:10-bit resolution, Eight single-ended channels, SPI interface,,±1 LSB DNL,±1 LSB INL,200 ksps sample rate at 5V,-40 to +85°C temperature range

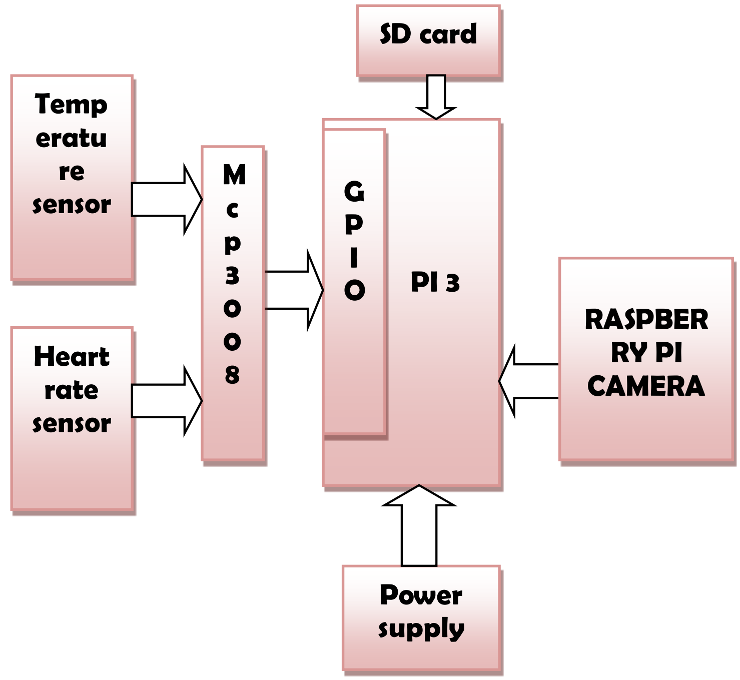

Fig. 3 Block diagram of the proposed system.

E. Raspberry pi camera

This 5MP camera module which has 1080p video and still images and connects directly to your Raspberry Pi. Size of camera is 25x20x10mm. Raspi-config is used to enable camera. Images are stored in SD card.

Fig. 4. Raspberry Pi Camera

F. Heart beat sensor

The working of Heart Beat sensor is based on the principle of photo plethysmography (PPG), which is a non- invasive method of measuring the variation in blood volume in tissues using a light source and a detector. Since the change in blood volume synchronous to the heart beat, this technique can be used to calculate the heart rate.[5] .it's feature includes Work voltage: DC 5V,The output valid signal is high, the light goes out, Sensitivity adjustable (fine tuning),Heart beat detection range, non-directional

Fig. 5 Heart beat Sensor

G. Temperature sensor

LM35DM is a three terminal IC temperature sensor. The sensor output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in o Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 mA from its supply, it has very low self-heating, less than 0.1^{o}C in still air.[4]

Fig. 6 Temperature sensor

H. Cloud – Fog operability

Fog is, essentially, a middle layer between the cloud and the hardware to enable more efficient data processing, analysis and storage, which is achieved by reducing the overburden of huge data. Fog computing provides low latency so it is leading concept in time crucial application .fog is not send data always to cloud fog is placed at near end devices[3]

Fog Computing

Fog computing is a decentralized computing infrastructure in which data, compute, storage and applications are located somewhere between the data source and the cloud. Like edge computing, fog computing brings the advantages and power of the cloud closer to where data is created and acted upon.

While edge devices and sensors are where data is generated and collected, they don't have the compute and storage resources to perform advanced analytics and machine-learning tasks. Though cloud servers have the power to do these, they are often too far away to process the data and respond in a timely manner. In addition, having all endpoints connecting to and sending raw data to the cloud over the internet can have privacy, security and legal implications, especially when dealing with sensitive data subject to regulations in different countries.

It is important to note that fog networking complements -- not replaces -- cloud computing; fogging allows for short-term analytics at the edge, and the cloud performs resource-intensive, longer-term analytics. Popular fog computing applications include smart grid, smart city, smart buildings, vehicle networks and software-defined networks.

Because cloud computing is not viable for many internet-of-things applications, fog computing is often used. Its distributed approach addresses the needs of IoT and industrial IoT, as well as the immense amount of data smart sensors and IoT devices generate, which would be costly and time-consuming to send to the cloud for processing and analysis. Fog computing reduces the bandwidth needed and reduces the back-and-forth communication between sensors and the cloud, which can negatively affect IoT performance.

Cloud Computing

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The name cloud computing was inspired by the cloud symbol that's often used to represent the Internet in flowcharts and diagrams.

A cloud service has three distinct characteristics that differentiate it from traditional web hosting. It is sold on demand, typically by the minute or the hour; it is elastic -- a user can have as much or as little of a service as they want at any given time; and the service is fully managed by the provider (the consumer needs nothing but a personal computer and Internet access). Significant innovations in virtualization and distributed computing, as well as improved access to high-speed Internet, have accelerated interest in cloud computing.

A cloud can be private or public. A public cloud sells services to anyone on the Internet. (Currently, Amazon Web Services is the largest public cloud provider.) A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people. Private or public, the goal of cloud computing is to provide easy, scalable access to computing resources and IT services.

Private cloud services are delivered from a business's data center to internal users. This model offers the versatility and convenience of the cloud, while preserving the management, control and security common to local data centers. Internal users may or may not be billed for services through IT chargeback. Common private cloud technologies and vendors include VMware and Open Stack.

In the public cloud model, a third-party cloud service provider delivers the cloud service over the internet. Public cloud services are sold on demand, typically by the minute or hour, though long-term commitments are available for many services. Customers only pay for the CPU cycles, storage or bandwidth they consume. Leading public cloud service providers include Amazon Web Services (AWS), Microsoft Azure, IBM and Google Cloud Platform.

Cloud computing characteristics and benefits

Cloud computing boasts several attractive benefits for businesses and end users. Five of the main benefits of cloud computing are:

•Self-service provisioning: End users can spin up compute resources for almost any type of workload on demand. This eliminates the traditional need for IT administrators to provision and manage compute resources.

•Elasticity: Companies can scale up as computing needs increase and scale down again as demands decrease. This eliminates the need for massive investments in local infrastructure, which may or may not remain active.

•Pay per use: Compute resources are measured at a granular level, enabling users to pay only for the resources and workloads they use.

•Workload resilience: Cloud service providers often implement redundant resources to ensure resilient storage and to keep users' important workloads running -- often across multiple global regions.

•Migration flexibility: Organizations can move certain workloads to or from the cloud -- or to different cloud platforms -- as desired or automatically for better cost savings or to use new services as they emerge.

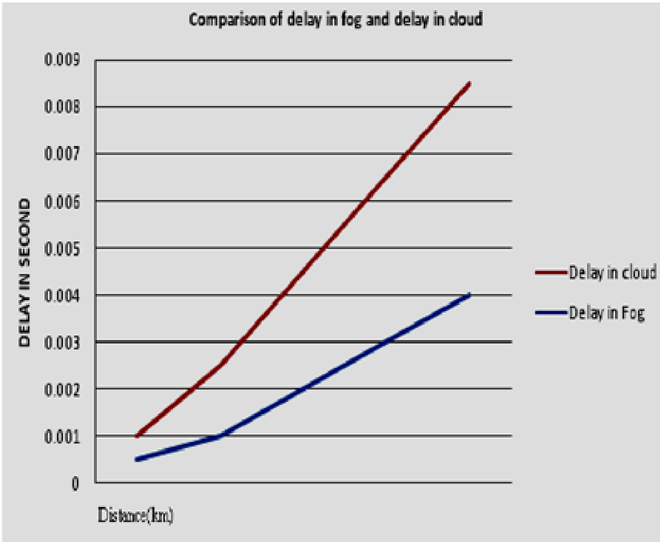

Fig. 7 Delay comparison between cloud and fog

III. ALGORITHM

A. Steps of Algorithm

1. Start
2. Initialize all devices like Sensors, Pi Camera etc
3. Check input receives from respective sensors interfaced to the Raspberry Pi.
3. Check input receives from respective sensors interfaced to the Raspberry Pi.
4. Send all the data receives from sensors to the Fog server via Wi-Fi connectivity.
5. Send Streaming data receive from Raspberry Pi Camera to the Fog Server via Wi-Fi connectivity.
6. If sensor data is greater than threshold value send this data to doctor.
7. If sensor data is less than threshold value and current episode is over then data is send from fog to cloud and data is delete from fog.
8. If current episode is not over then Continue from step 3

IV. RESULTS AND DISCUSSION

Fog computing reduces latency period by 4 ms as per fig 7. This possible because data, processing and application are concentrated in devices at the network edge rather than always on cloud. This will reduce the
Fog node decides whether to process the data on own resources or sending to cloud.

CONCLUSION

Advanced telemetry system for hospital wagon will be develop with raspberry pi 3, sensor nodes, video technology RTMS live data streaming can save the life of patient. Medical service for hospital wagon is time critical application so this application is developed with fog so latency is reduced as shown in fig 6 so latency is reduced as shown in fig 6
Centralized cloud concept have limitations like high latency, network insecurity,network failure ,so remove such limitations we switch towards fog computing. Fog offers faster response, high precision low latency, high flexibility. Cloud feature is added to keep the maximum database for longer duration on the machine for the further investigation

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