A Smart EMS Enhancing Prehospital Quality with Cloud Fog Operability

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Abstract

Emergency medical services (EMS) are time critical every second may save life of patient. Current EMS services have some limitations such as limited resources, lack of effective communication with doctors, latency, and poor video technology. Developed EMS system by using hardware which contains raspberry pi 3, sensor temperature and heart rate, fog which deployed on one machine and cloud which deployed on second machine. EMS system is onboard 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. Additionally, videos taken by cameras installed in the ambulance 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— Internet of Things, wireless body area network, Cloud, fog, Emergency medical services, raspberry pi 3.

I. INTRODUCTION

Emergency medical service 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 provide the safety, feasibility and reliability in ambulance. Tele- consultation using an EMS system with cloud fog operability to implement this EMS concept which used 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 wireless body area network such as heart rate sensor and temperature sensor. These sensor data is transmitted using raspberry pi-camera live streaming to doctors, so doctors can prepare before patient 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, ambulance 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 cloud or 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 emergency medical services, such as giving injections or fracture treatment.[2]

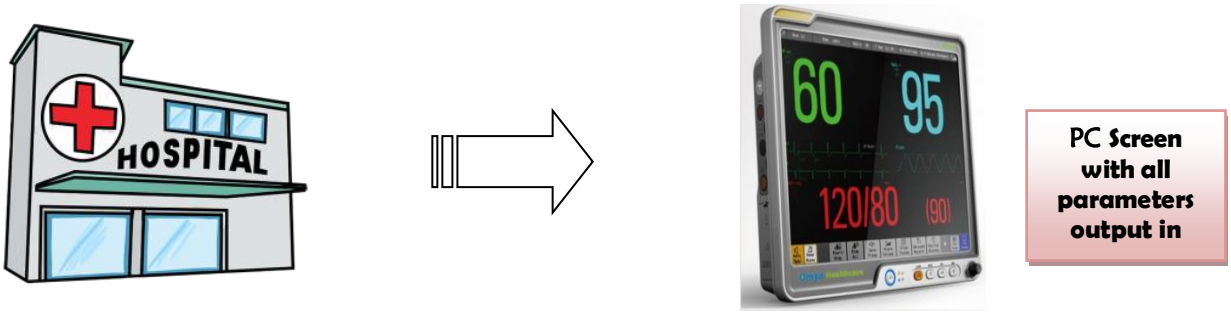

Fig. 1. Hospital unit

a) Ambulance 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, 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 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]

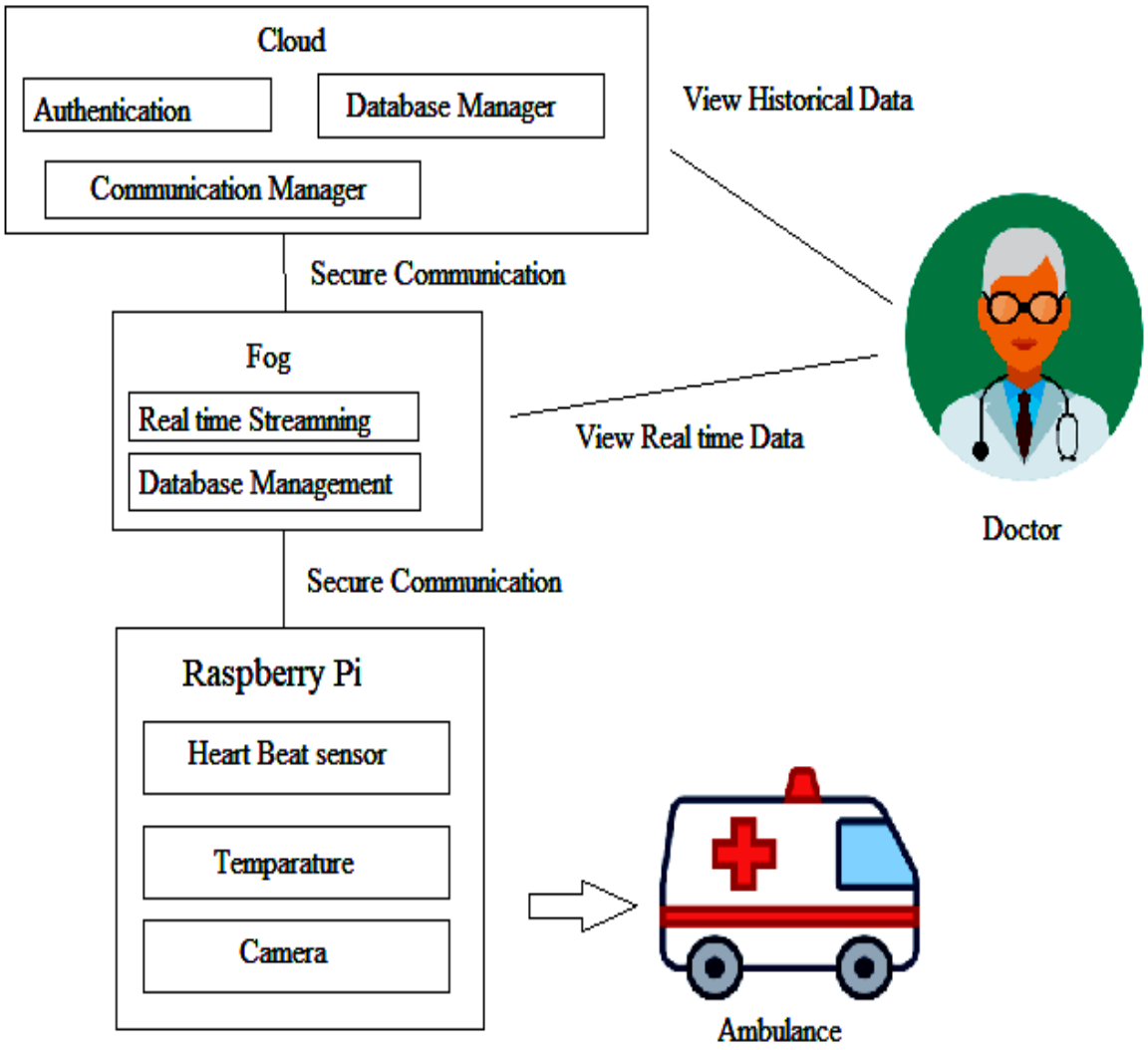

Fig. 2. Ambulance unit

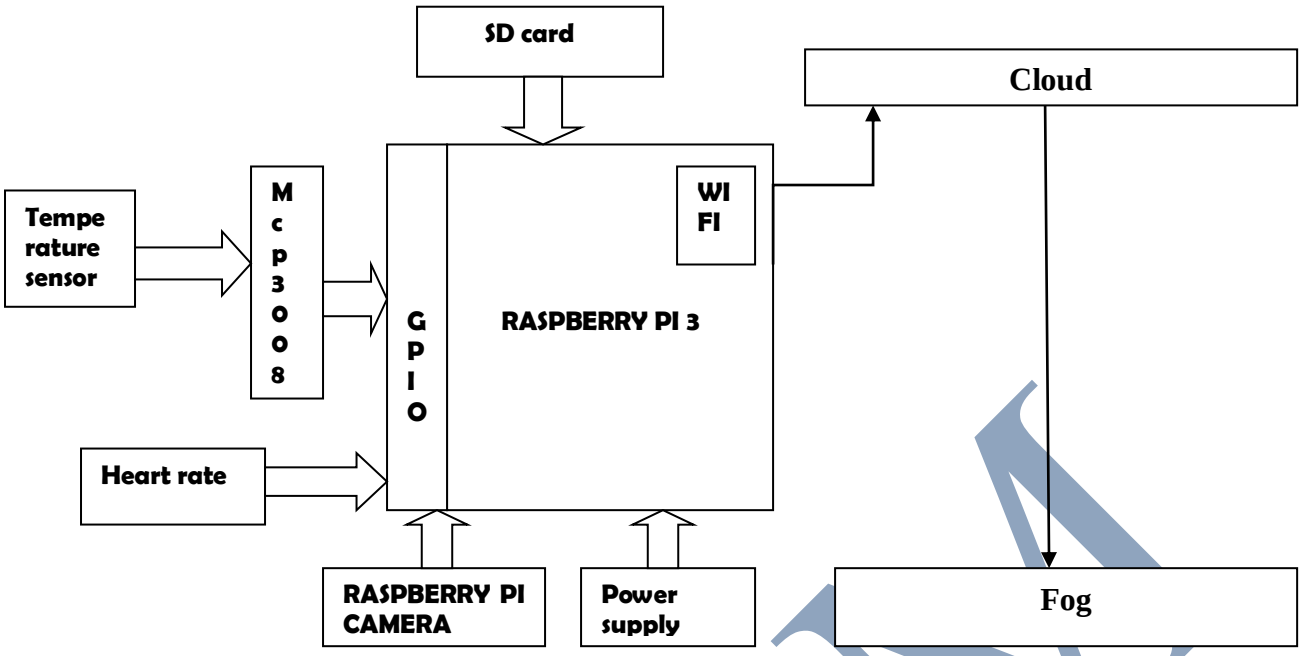

Fig. 3. Process flow of EMS

The Raspberry Pi 3 has an identical form factor to the previous Pi 2 and Pi 1 Model and has complete compatibility with them. Components of raspberry are depicted in fig. 4, 5, and 6. [7]

a) 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 is stored in SD card.

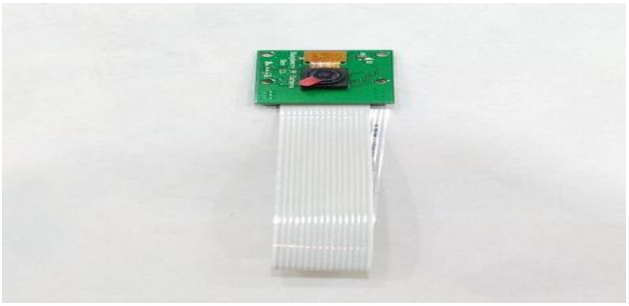

Fig. 4. RASPBERRY PI Camera

b) 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]

Fig. 5. Heart beat sensor

c) Temperature sensor (LM35)

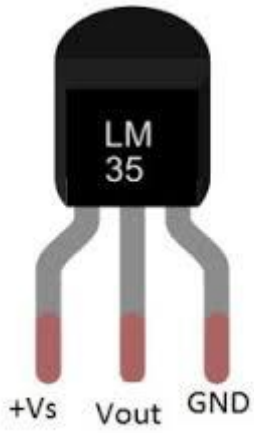

Fig. 6. Temperature sensor (LM35)

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°C in still air.[4]

B) *C*loud – 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]

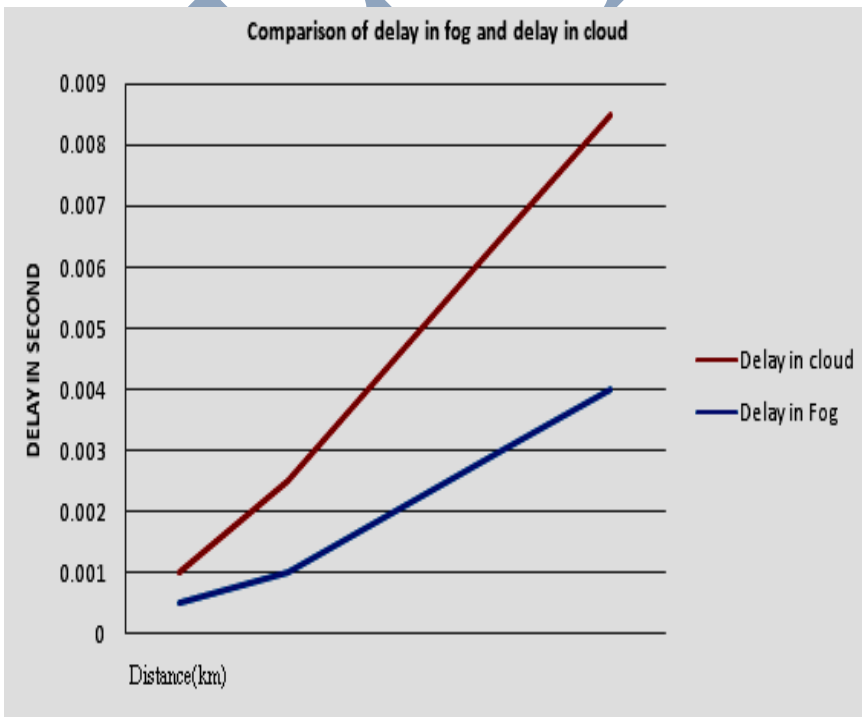

Fig. 7 Comparison of delay in fog and delay in cloud .

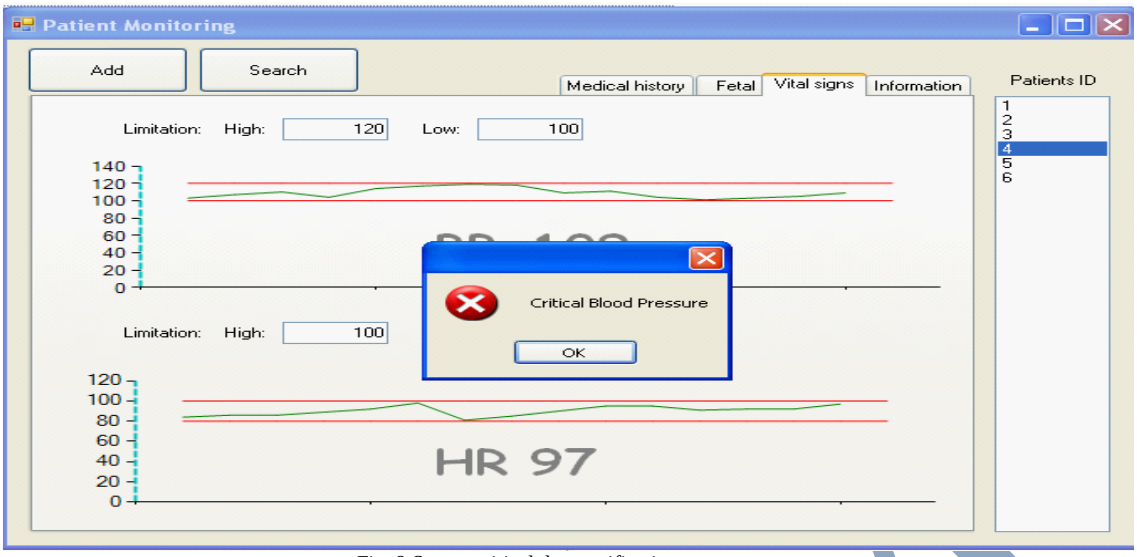

Fig. 8.Sensor critical data notification.

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[8]

The emergency and trauma physicians can also triage cases remotely, and start to prepare a surgery team if needed, prior to the patient's arrival. If they find that the available medical resources of the hospital are insufficient for the situation, they can refer the case to an alternative medical care center, to save time. The EMS system must be integrated with the hospital's patient information system, so ambulance technicians and hospital physicians and nurses can retrieve patients' medical history as required, to expedite medical decisions.[1]

III. ALGORITHM

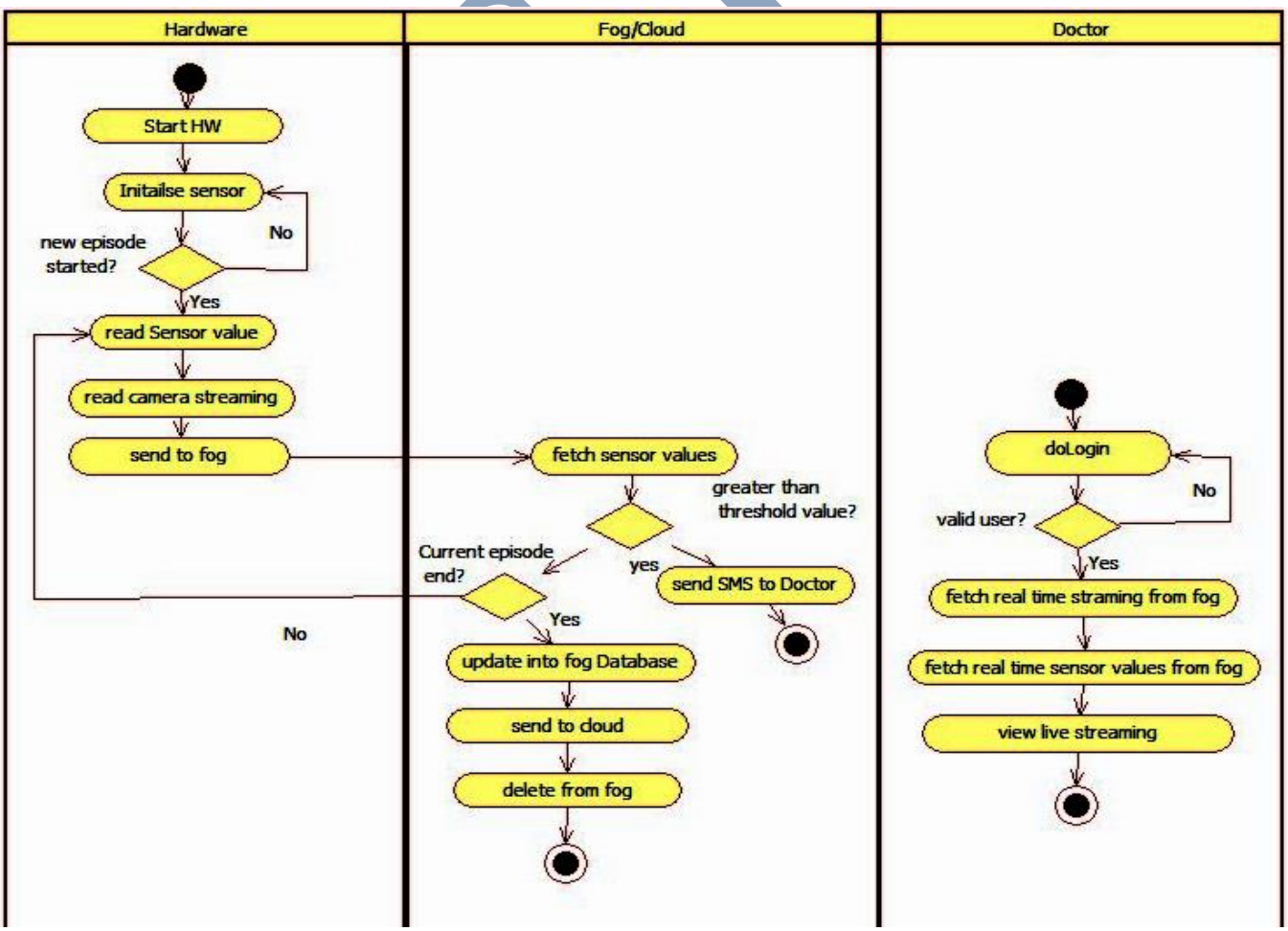

Fig. 9 Algorithm for the EMS system

a) Step of Algorithm

1. Start
2. Initialize all devices like Sensors, Pi Camera, etc.
3. Check input received from respective sensors interfaced to the Raspberry Pi.
3. Check input received from respective sensors interfaced to the Raspberry Pi.
4. Send all the data received from sensors to the Fog server via Wi-Fi connectivity.
5. Send Streaming data received 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 beacause data,processing and application are concentreated in devices at the network edge rather than always on cloud. Fog node decides whether to process the data on own resources or sending to cloud.

V. CONCLUSION

Emergency medical services is developed with raspberry pi 3. Wireless body area network, video technology RTMS live data streaming can save the life of patient. Ems is time critical application so this application is developed with fog so latency is reduced as shown in fig so latency is reduced as shown in fig

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, distance between client and server is one hop not multiple hops.

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