Accident Detection with Location and Victim Information Transmission Using Raspberry Pi

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***Abstract*--- The important reason for loss of life in accidents is due to the delayed transmission of location and victim information to the concerned authorities. The proposed system concerns on overcoming these issues by implementing IOT in the existing accident alert system. An effective solution is formulated by embedding a series of sensors, GPS transceiver and a RFID receiver in Raspberry Pi. Initially, a centralized server has been set up with adequate medical information of people for easier retrieval in case of accidents. This system is configured with an auto-mailing module to send the necessary information in case of an accident.**

***Index terms*: Internet of Things, Raspberry Pi, accelerometer, GPS, accident identification, RFID.**

I.Introduction

The Internet of Things is defined as a fast-growing network of Physical devices (which has a unique identifier) interconnected with some devices via Internet. These Physical devices communicate with the rooted devices by collecting and exchanging data without human interaction. Internet of Things has grown rapidly in the past few years due to increased efficiency, user friendly nature, and simple control which save time and money. An accident in mass transportation vehicle leads to high rate of life loss, mainly due to lack of information transmission about accident occurrence and knowledge about its location and the victim's information. If Internet of Things is implemented for automatic accident detection and transmission of location and victim's information to the authorized personnel then, the survival rate of accident victims would be considerably increased.

This Paper implements Internet of Things using Raspberry Pi embedded with Global Positioning System, Electronic Health Record Reader, and Sensors. Initially, the medical records of the People are stored, maintained in the cloud and retrieved in case of accidents. This paper discusses Raspberry Pi as a currently exploring way to provide Electronic Health Record of accident victims and GPS location of the vehicle to the nearby hospitals through internet, providing a remedy to the increased time consumption to identify accidents and to begin treatment to the accidental victims.

This idea is achieved by tracking the vehicle continuously through Global Positioning System, transmitting accident information to hospitals in case of accidents which would be detected by the Sensors. The Unique ID of the Electronic Health Record of the people present in the mass transportation vehicle is stored in the Raspberry Pi in a text file format. The Accident occurrence is intimated to the nearby hospital (Found by the Region based search done by Global Positioning System) by the mailing unit where the accident location and the text file (which has the unique id of passengers) are attached. Once the mail is received, the authorized personnel intimate the ambulance and provide them with the accident location. Then, the Authorized Personnel retrieves the required record information from the cloud and processes it for the victim details. Finally, the Personnel send an SMS about the accident occurrence with the hospital address to the victim's emergency contacts.

II.Background

The retrieval of EHR and location of accident through GPS involves the understanding of smartcards, sensors, GPS system and Raspberry Pi and cloud.

A. *Raspberry Pi*

Raspberry pi is a small single board computer, which is in a size of a credit card that can be connected to any external electronic device for multiple purposes. The various available models of Raspberry Pi are the Pi 3 Model B, the Pi 2 Model B, the Pi 1 Model B+, the Pi 1 Model A+ and the Pi Zero. The Model A+ is the low-cost variant of the Raspberry Pi. It has 512MB RAM (as of August 2016: earlier models have 256MB), one USB port, 40 GPIO pins, and no Ethernet port. The Model B+ is the final revision of the original Raspberry Pi. It has 512MB RAM, four USB ports, 40 GPIO pins, and an Ethernet port. In February 2015, it was superseded by the Pi 2 Model B, the second generation of the Raspberry Pi. The Pi 2 shares many specs with the Pi 1 B+, but it uses a 900MHz quad-core ARM Cortex-A7 CPU and has 1GB RAM. The Pi 2 is completely compatible with first generation boards. The Pi Zero is half the size of a Model A+, with a 1 GHz single-core CPU and 512MB RAM, and mini-HDMI and USB On-The-Go ports.

The model used in this paper is Raspberry pi 3 model B. This model is designed with 1.2 GHz quad core multiprocessor with 1GB RAM. It uses ARMv8-(32/64 bit) architecture. It has CPU/GPU Broadcom which is set to run when the power supply is produced. It can be powered by a micro USB or by GPIO header. The MicroSDHC acts as an On-Board storage, the board has an SD slot at the top. It has 4 USB Ports, an audio jack, a HDMI out, a camera CSI. The Ethernet 802.11n wireless acts as an On-Board network, which is present next to the USB ports. The images of the operating systems can be written onto the SD card and can be run on the raspberry pi. It has 40 GPIO pins from which external devices can be connected to the Raspberry Pi. The number of pins can be extended by connecting the GPIO port to the bread board. The GPIO pins has 2 power pins of 5V, 2 power pins of 3V, 8 ground pins, and other input output ports. The USB Ports are used to connect the peripherals.

Initially, a Visual Output device is connected to the Pi via HDMI port. The text based input device and the motion based input device are connected to the Pi via USB port. Now the Pi is out-sourced with a power connection and it is indicated by a green LED light on proper connection. Before power connection, the SD card which has the Raspbian image is inserted into the SD card slot. Raspbian image run on Pi is displayed by Visual Output device. The accelerometer sensor, the GPS and the RFID Reader are embedded to the GPIO Ports of Pi with the help of jumper wires, we preferably use female to female (F2F) jumper wires. The Devices are activated and processed to do its dedicated work by program code. The coding is done in Python and the process ran on the Pi.

B. Cloud Storage

Cloud Computing is a general term used to describe a new class of network based computing that takes place over the Internet. Basically, it is a step on from Utility Computing. A collection/group of integrated and networked hardware, software and Internet infrastructure (called a platform). Using the Internet for communication and transport provides hardware, software and networking services to clients. These platforms hide the complexity and details of the underlying infrastructure from users and applications by providing very simple graphical interface or API (Applications Programming Interface).

In addition, the platform provides on demand services that are always on, anywhere, anytime and anyplace. Pay for use and as needed, elastic. Scale up and down in capacity and functionalities. The hardware and software services are available to general public, enterprises, corporations and businesses markets. The major function of a cloud computing system is storing data on the cloud servers, and uses of cache memory technology in the client to fetch the data. Cloud computing is a parallel and distributed computing system, which is combined by a group of virtual machines with internal links. Such systems dynamically offer computing resources from service providers to customers according to their Service level Agreement (SLA). Cloud computing is an umbrella term used to refer to Internet based development and services.

Cloud are transparent to users and applications, they can be built in multiple ways such as branded products, proprietary open source, hardware or software, or just off-the-shelf PCs. In general, they are built on clusters of PC servers and off-the-shelf components plus Open Source software combined with in-house applications and/or system software.

One of the most important features of cloud is the cloud storage. Several large Web companies are now exploiting the fact that they have data storage capacity that can be hired out to others. Allows data stored remotely to be temporarily cached on desktop computers, mobile phones or other Internet-linked devices. Amazon's Elastic Compute Cloud (EC2) and Simple Storage Solution (S3) are well known examples.

The proposed system uses cloud for its storage features. The proposed system requires a private feature cloud with data to be accessed by a public network of hospitals. To connect private and public cloud resources, this model requires a hybrid cloud environment.

C. Electronic Health Record Storage

The use of clinical data for research is a widely anticipated benefit of the electronic health record (EHR). Clinical data stored in structured fields is relatively straightforward to retrieve and use; however, a large proportion of EHR data is “locked” in textual documents. EHR chart notes are typically stored in text files, which include the medical history, physical exam findings, lab reports, radiology reports, operative reports, and discharge summaries. These records contain valuable information about the patient, treatment, and clinical course. This “free text” data is much more difficult to access for secondary purposes. In order to use this data, we must be able to retrieve records accurately and reliably for a desired patient population, usually through the use of natural language processing (NLP). While NLP has been applied to EHR data for decades, the performance of these systems has been variable across the techniques used, as well as the clinical task.

The Health Record of people is stored electronically in the Cloud. The EHR is accessed by RFID tag provided to the individuals. The RFID tag is identified by the RFID reader which is placed at the entrance of the vehicle. The RFID reader is embedded with the Raspberry Pi. The main function of the RFID Reader is to interrogate with the RFID Tag in a wireless form. The Reader has an RF Module which provides both read and write function to the reader. This wireless communication is made possible by using Radio waves which is transferred from the Tag to the Reader. RFID technology uses digital data in an RFID tag, which is made up of integrated circuits containing a tiny antenna for transferring information to an RFID transceiver. The majority of RFID tags contain at least an integrated circuit for modulating and demodulating radio frequency and an antenna for transmitting and receiving signals.

The RFID System is made up of two parts, one is antenna which is used to receive the Radio wave and another one is the integrated circuit which is used for internal processing, modulating and demodulating the Radio waves and also used for storing data. The RFID Tag varies in terms of frequency based on its operating system. Based on the working of the RFID Systems the Tag is of two types Active and Passive. The Passive tags have no internal power source and are powered by electromagnetic energy transmitted from the RFID Reader. Passive tags can withstand high temperature, is relatively small, range can be extended, cheaper, tags can last a lifetime without a battery. Active tag uses Battery power to continuously transmit the signal, provides the accurate location, high range. Though Active tag has more advantages, it is very expensive. Since, this paper uses RFID System to access only the health records, Passive tags are provided to the individuals.

D. Global Positioning System

The **Global Positioning System** (**GPS**) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver.

The GPS concept is based on *time*. The satellites carry very stable atomic clocks that are synchronized to each other and to ground clocks. Any drift from true time maintained on the ground is corrected daily. Likewise, the satellite locations are monitored precisely. GPS receivers have clocks as well—however, they are not synchronized with true time, and are less stable. GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time. At a minimum, four satellites must be in view of the receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time).

Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS system and implement the next generation of GPS Block IIIA satellites and Next Generation Operational Control System (OCX).

In addition to GPS, other systems are in use or under development. The Russian Global Navigation Satellite System (GLONASS) was developed contemporaneously with GPS, but suffered from incomplete coverage of the globe until the mid-2000s. There are also the planned European Union Galileo positioning system, India's Indian Regional Navigation Satellite System, and the Chinese BeiDou Navigation Satellite System.

Each GPS satellite continually broadcasts a signal (carrier frequency with modulation) that includes:

- A pseudorandom code (sequence of ones and zeros) that is known to the receiver. By time-aligning a receiver-generated version and the receiver-measured version of the code, the time of arrival (TOA) of a defined point in the code sequence, called an epoch, can be found in the receiver clock time scale

- A message that includes the time of transmission (TOT) of the code epoch (in GPS system time scale) and the satellite position at that time

Conceptually, the receiver measures the TOAs (according to its own clock) of four satellite signals. From the TOAs and the TOTs, the receiver forms four time of flight (TOF) values, which are (given the speed of light) approximately equivalent to receiver-satellite range differences. The receiver then computes its three-dimensional position and clock deviation from the four TOFs.

In practice the receiver position (in three dimensional Cartesian coordinates with origin at the earth's centre) and the offset of the receiver clock relative to GPS system time are computed simultaneously, using the navigation equations to process the TOFs.

The receiver's earth-centred solution location is usually converted to latitude, longitude and height relative to an ellipsoidal earth model. The height may then be further converted to height relative the geoids (e.g., EGM96) (essentially, mean sea level). These coordinates may be displayed, e.g. on a moving map display and/or recorded and/or used by some other system (e.g., a vehicle guidance system).

Most receivers have a track algorithm, sometimes called a *tracker*, which combines sets of satellite measurements collected at different times—in effect, taking advantage of the fact that successive receiver positions are usually close to each other. After a set of measurements are processed, the tracker predicts the receiver location corresponding to the next set of satellite measurements. When the new measurements are collected, the receiver uses a weighting scheme to combine the new measurements with the tracker prediction. In general, a tracker can (a) improve receiver position and time accuracy; (b) reject bad measurements, and (c) estimate receiver speed and direction.

The disadvantage of a tracker is that changes in speed or direction can only be computed with a delay, and that derived direction becomes inaccurate when the distance travelled between two position measurements drops below or near the random error of position measurement.

GPS units can use measurements of the Doppler shift of the signals received to compute velocity accurately. More advanced navigation systems use additional sensors like a compass or an inertial navigation system to complement GPS.

E. Sensor

A sensor is a transducer whose purpose is to sense (that is, to detect) some characteristic of its environs. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal; for example, a thermocouple converts temperature to an output voltage. But a mercury-in-glass thermometer is also a sensor; it converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube.

The sensor operating environment must be evaluated to ensure that the sensor's signal range not only covers the vibration amplitude of interest, but also the highest vibration levels present at the measurement point. Exceeding the sensor's amplitude range will cause signal distortion throughout the entire operating frequency range of the sensor. In other words, mechanical shock loading on the sensor or large degrees of machine movement can overload the sensor's response capability. Shaker screens used in materials processing are an example of such an application. The machine can generate high impacts compared to the "normal" working level, but an impact, a step, also causes excitation of the sensor resonance frequencies. The gain is then 10 to 20 dB higher.

Based on piezoelectric technology various physical quantities can be measured; the most common is acceleration. This paper uses ADXL345 sensor.

This sensor is a digital output sensor. It consists of a micro-machined structure on a silicon wafer. The structure is suspended by polysilicon springs which allow it to deflect smoothly in any direction when subject to acceleration in the X, Y and/or Z axis. Deflection causes a change in capacitance between fixed plates and plates attached to the suspended structure. This change in capacitance on each axis is converted to an output voltage proportional to the acceleration on that axis.I2C is a serial protocol for two-wire interface. This Sensor uses I2C to communicate with its control unit. It supports two interrupts. Calibration is the major part of the acceleration sensor, for calibrating the sensor with the gravitational force the sensor output for each axis precisely noted and aligned with the axis of gravitational pull. Accident occurs when a vehicle tilts or rolls-over with respect to any of these three angles.

The tilt of the vehicles within the three angles is calculated by arctan equations.

$$\theta = arctan\left(\frac{x}{\sqrt{z^2 + y^2}}\right)$$

The rollover can be calculated with the following equation:

$$Roll = arctan\left(\frac{y}{\sqrt{z^2 + x^2}}\right)$$

The pitch can be calculated with the following equation:

$$Pitch = arctan\left(\frac{x}{\sqrt{z^2 + y^2}}\right)$$

III. Accident Detection And Medical Record Retreival Of Victims From Cloud

The proposed project focuses on the reduction of time taken to gather the basic records of the accidental victims, by automatically intimating it to the hospitals in case of accidents and reducing the time taken to begin the treatment to the victims thereby improving the survival rate. This is achieved by connecting the Global Positioning System, accelerometer sensor and cloud storage to the Raspberry Pi 3 model B microcontroller. In the proposed project, Raspberry Pi 3 is used with the Raspian Operating System image loaded in the microSD card. The input operations are done by the USB Keyboard and USB Mouse connected to the Raspberry Pi and the output operations are done by the monitor connected by the HDMI cable. The given project involves the use of Raspberry Pi, Global Positioning System, Accelerometer sensor (ADXL345), Radio Frequency transceiver, cloud storage.

On successful implementation of the project, the lives of many people could be saved by quicker identification of accidents and locating it through Global Positioning System. The occurrence of accident is detected with an abnormal accelerometer output and is intimated to hospitals and ambulances closest to the location of accident at a faster rate through an automated mailing system.

The hospitals are located by a region based search done by the GPS receiver. The mail is sent with attachments including the location coordinates and the UIDs of the RFID tags designated to the victims prewritten to the text file stored in Raspberry Pi. The victim's medical data uploaded in cloud storage can be accessed by the use of UID list of victims received in mail. On successful completion of travel, the passenger details are erased from the cloud. In case of accident, the GPS location and encryption key for files are sent to the concerned authorized personnel.

Architecture

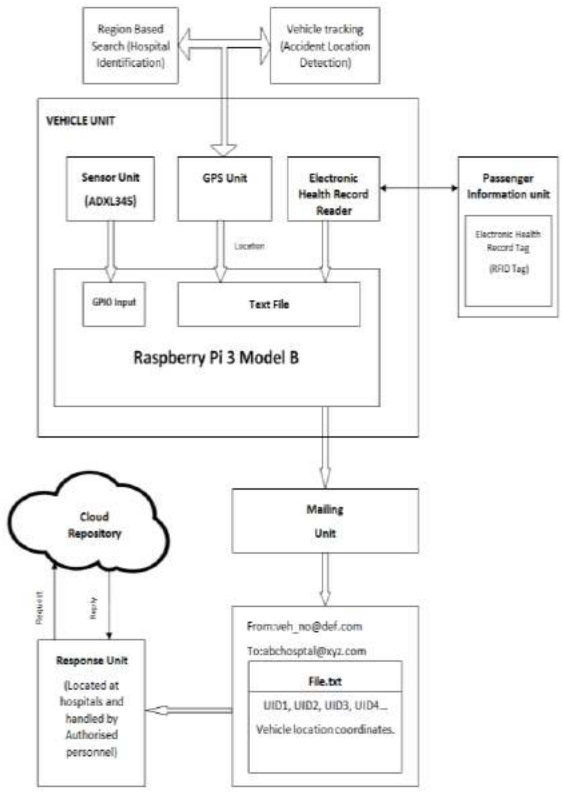

Fig.1. Architecture of the Proposed System

a) *Medical Data Uploading Section:*

Each user is provided with a RFID tag and this tag is used to access the records stored in cloud for updating of information. The medical records of the users are stored in the hybrid cloud. Each record in the cloud is given a primary key equivalent to the UID of the RFID tag provided to the user.

On accident occurrence, a mail with the UID of passengers in the vehicle in which the accident has occurred is received. The authorized person in the hospital accesses the records stored in cloud with a login id and password provided to the particular hospital. The records are searched with the UID received in the mail.

Every time the user visits a hospital, his medical records in the cloud are updated with new findings. The cloud storage is centralized and acts as one system to find the user's medical history. The storage cloud used is a hybrid cloud since the data are private and has to be accessed by a public network of hospitals from time to time.

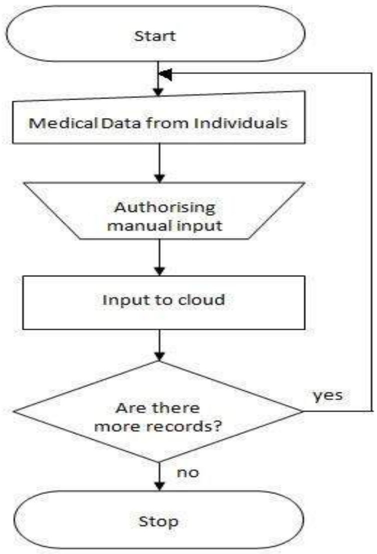

Fig.2. Operation of medical data storage unit

b) Passenger information Section:

The passenger information system is present in the entrance of the vehicle. Once the user enters the vehicle, the UID of the RFID tag is read by the RFID reader and the UID is written in a text file temporarily. Once, the user exits the vehicle, this ensures the end of his/her journey. Further, the UID of medical record of that particular user, stored in the text file is deleted. Else, if an accident occurs, the device receives accident signal from the sensor module and the GPS location calculated and appended to the same text file. On accident occurrence, the text file is sent to the nearby hospital. After successful transmission of data along with the encryption key, the cloud deletes the victim details after an acknowledgement.

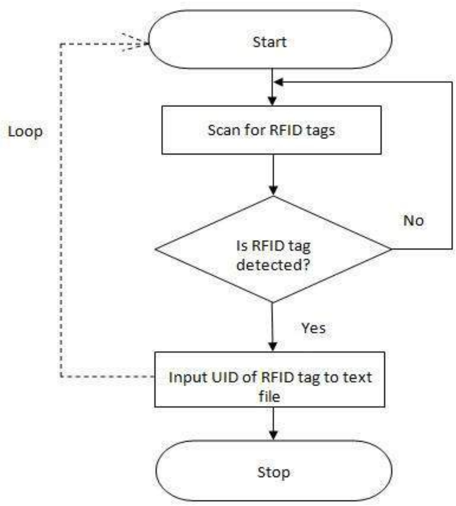

Fig.3. Operation of Passenger information unit

c) Sensor Section:

An accelerometer sensor is connected to the Raspberry Pi microcontroller placed in the vehicle to be tracked for accident. The accelerometer sensor senses the movement of the vehicle in triple axis. The accelerometer used in this system is ADXL345 and it is a digital accelerometer. Hence, this accelerometer produces digital values between and including 0.000 and around 6.000. The three axis values are compared with the threshold values for abnormality. If there is no abnormality, the accelerometer continues to provide output periodically and the output is checked for abnormality. When the value exceeds the threshold value, the sensor module begins the sub process for intimating the accident to other components in the system for further proceedings. The accelerometer sensor continues to work constantly throughout the working of the vehicle.

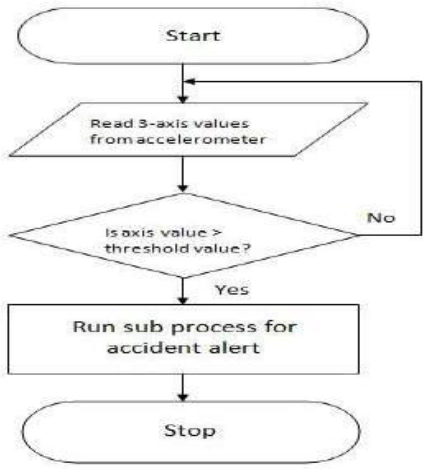

Fig.4. Operation of Accelerometer unit

d) GPS Section:

The GPS receiver is placed in the vehicle for two varied locating purposes.

Firstly, it is used for tracking the vehicle location. The GPS constantly tracks the vehicle throughout its working. Once, the GPS receives the accident signal from the sensor module, it retrieves the location of the vehicle which underwent the accident and appends it to the text file containing the UID of RFID tags.

Secondly, the GPS unit begins a region based search for the closest hospitals on a radii basis. The search is conducted initially to find hospitals in the first one kilometer radius and later on increased to 2km, 5km radii and so on. The vehicle can also be tracked by the GPS using signals from the smart phones used by passengers inside the vehicle.

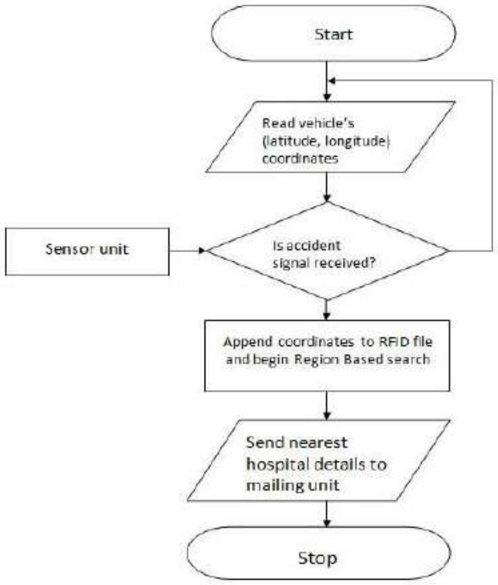

Fig.5. Operation of GPS section

e) Mailing Unit

Once the accident is detected, the sub process for mailing unit is begun. The mailing unit auto-prepares the mail by attaching the text file containing the UID of victims inside the bus and the location of the accident. The sender mail id is the mail id exclusively designated to each vehicle. The receiver mail id is found by extracting the mail id from the profile of the closest hospital found from the region based search done by the GPS receiver after the accident has been detected.

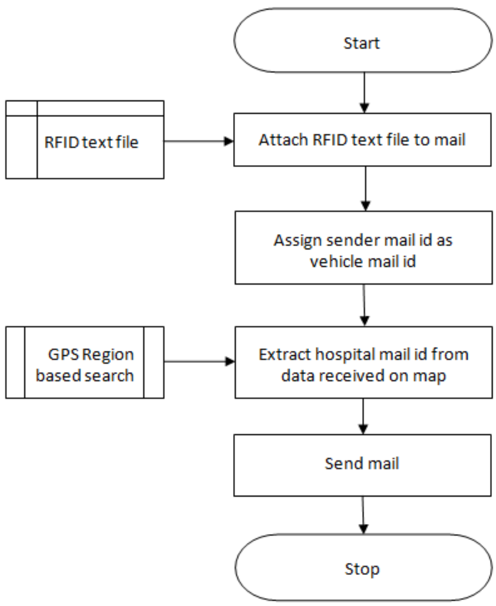

Fig.5. Operation of Mailing unit

Scope for Future Work

The future work focuses to provide a better interface to view shared files, to provide better authentication and allow authorized access to sensitive data, to extend the projected system, so that, it can also be used to send intimation about the accident to the emergency contacts of the accidental victims, to work on avoiding incorrect data transmission and delivery to help a broader range of EHR storage. With this project, the passengers of mass transportation vehicles may get better safety and quicker rescue in case of accidents.

Related Work

Data Value provides users with service to share their data securely over cloud. But it is currently only for computers. Data Guard is another work going on which shares and protects user's data. It preserves data confidentiality and integrity using a middleware technology. It also provides disaster recovery and high availability.

Challenges

The main objective of the proposed project is to provide a convenient and rapid method for retrieval of victim data from the cloud. The major challenges which are to be taken care of are the cost, incorrect retrieval and security of victim data in cloud which is at the stake of getting into wrong hands.

CONCLUSION

The possibility of an accident victim to lose his/her life in present scenario is higher. The implementation of this project lets the authorized personnel to retrieve medical records and GPS location in no time. In turn, this potentially increases the chances of survival of the victims. This project also deals with various issues including security and authentication of the information in addition to the conceptual idea and the implementation. With proper implementation and overcoming the various issues, this would become one of the most important lives saving technological application.

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