Accident Detection by using Smartphone Sensors and Rescue Alert System on Expressway

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Introduction

❑Road accidents - One of the major disruptive issues.

❑Key factors to reduce the risk of accidents
  - hazard info and in time rescue procedures.

❑Increase fatality rate
  - unidentified location and delay inform to rescue services.

❑1853 cases in 2008 to 4688 in 2016
  - (accidents was in excess of doubled within 8 years)

❑To get timely efficient response for
  - saving precious lives of accident victims and
  - reducing level of accident mortalities rate as lower as possible.

Introduction (cont'd)

- Smartphones fixed with powerful detection sensors
  - contemplated as accident data and
  - convey to prompt response rescue services.

- To validate status of accident by values received from accelerometer and gyroscope sensors by using Motion Sensing Method with GIS and GPS technologies.

- Difference Angle Method is opted to obtain more accurate direction angel.

- Object Detection in Fence Algorithm will assist victims to receive the medical assistance in timely manner.
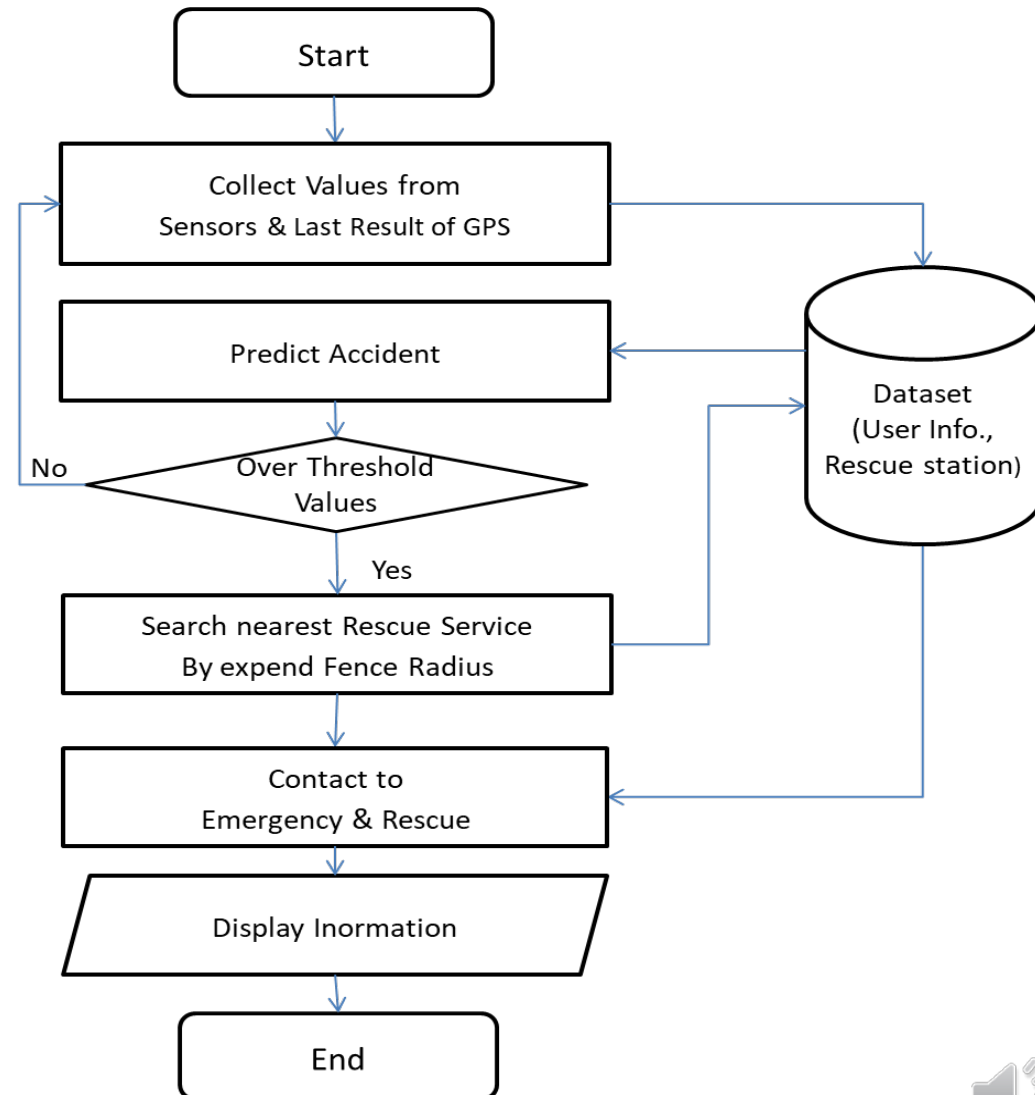
Accident detection

Methodology of System

Two main Process:
- Collecting with data processing and
- Connecting to the nearest rescue services.

❑ Values received from Accelerometer, Gyroscope, GPS.

❑ Predicts when exceeding threshold value.

❑ Search location by using GPS values.

❑ Creates polygon in which accident location and search closest rescue service.

❑ Finally, system will send alert with user and vehicle information as well as accident location to rescue service if it finds closest one from accident location.

Start

Collect Values from Sensors & Last Result of GPS

Predict Accident

Over Threshold Values

No

Yes

Dataset (User Info., Rescue station)

Search nearest Rescue Service By expend Fence Radius

Contact to Emergency & Rescue

Display Inormation

End

Sever side's Workflows

❑ Emphasized to collect and process the data including the users' information, incident information and contact of rescue services.

User side's Workflows

❑ Act as the projection of the prediction.

More accurate prediction

❑ Sensor projected data such as false alarm rate; fatalities of accidents, fixed data are stored in centralized system and communication differences parties, smartphones are play as sensor roles to make prediction.

Predefined Data

On Registration

- Name
- Gender
- Blood Type
- Date of Birth
- Phone no.

- Vehicle Type
- Vehicle no.
- Vehicle Color
- No. of Pessenger
- Emergency contact

Sever side Data

Hazard Dataset

- Geofence Indentification
- Hazard Location

Rescue Service Info.,

- Rescue Service Info.
- Location
- Hotline no.

Realtime Data

Sensors

- Sensors data input to deep learning
- Confirmed Detection data send to sever
- Train dataset

GPS

- Collect Realtime Location
- On suspected Accident will check & confirm
- On confirmed send location to server train dataset

Motion Sensing Method

❑ Considered as a compensating method to enhance data reliability by merging the data from various sensors.

❑ Information can be retrieved from automated sensors data stored in the centralized database.

❑ Data received from multiple sensors will be refined and evaluated to achieve the optimal result.
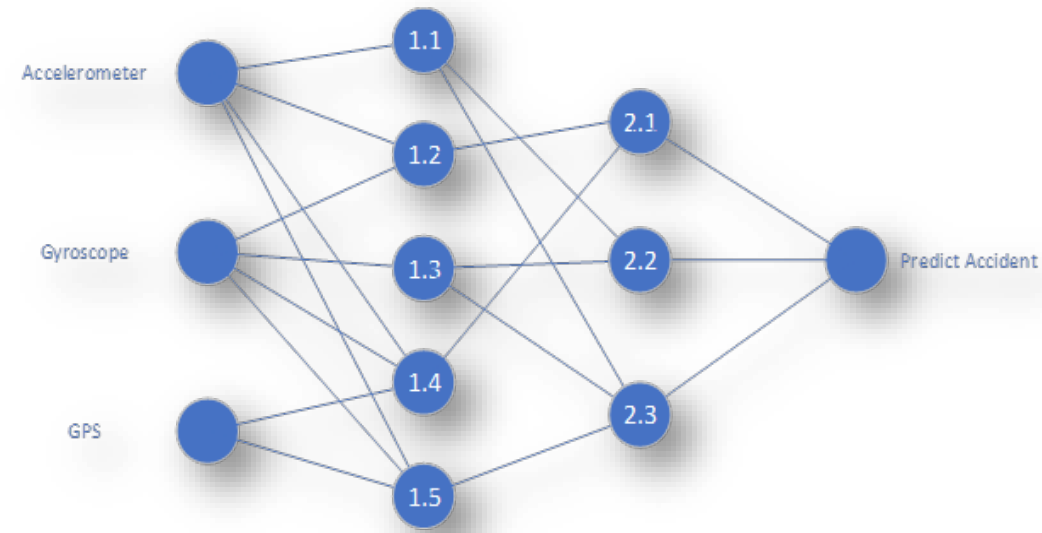
❑ It is crucial to obtain the high-quality input data.

Fig. Sensor-based prediction architecture

Difference Angle Method

- ❑ GPS can provide latitude and longitude values, it cannot indicate angel direction.
- ❑ Difference angel method retrieves GPS values and then, predicts direction based on values.
- ❑ When accident, GPS's latest value is compared with its most recent value.
- ❑ Sensors values exceeds accident threshold set, it obtains GPS value and judges with previous value.
- ❑ In this way, the accident can be validated accurately, and also false alert is able to avoid.

$$\text{Slope1} = \frac{||Y_B - Y_A||}{||X_B - X_A||}$$

$$\text{Slope2} = \frac{||Y_C - Y_B||}{||X_C - X_B||}$$

Angle=arctan (Slope)   when $X_B > X_A$; $Y_B > Y_A$

Angle=180-arctan (Slope) when $X_B < X_A$; $Y_B > Y_A$

Angle=180+arctan (Slope) when $X_B < X_A$; $Y_B < Y_A$

Angle=360-arctan (Slope) when $X_B > X_A$; $Y_B < Y_A$

Difference Angle = Angle(β) - Angle(α)

Є{(0°;180°) Or (-360°;-180°)} "LEFT Turn"

Є{(180°;360°) Or (-180°; 0°)} "RIGHT Turn"

If several turns existed, GPS technology must correctly inform to the system.

Object Detection in Fence Algorithm

❑ Accident confirmed, a polygon fence range of 1,000 square meters will be created.

❑ If cannot be found, will re-create new polygon fence with wider boundaries and search for rescue services.

❑ When service is found, accident alert message including information will be triggered to closest rescue services.

❑ Intention of applying Algorithm is that closest rescue services from accident location can be found and contacted with a minimum time interval.

Geofence

❑ Create virtual geographic boundary of an area.

❑ To mark a location of interest, needs to specify its latitude, longitude and radius.

❑ Latitude, longitude, and radius are provided, it is defined a geofence around the location of interest.

❑ Applied to send information to closest rescue team from geographical location.
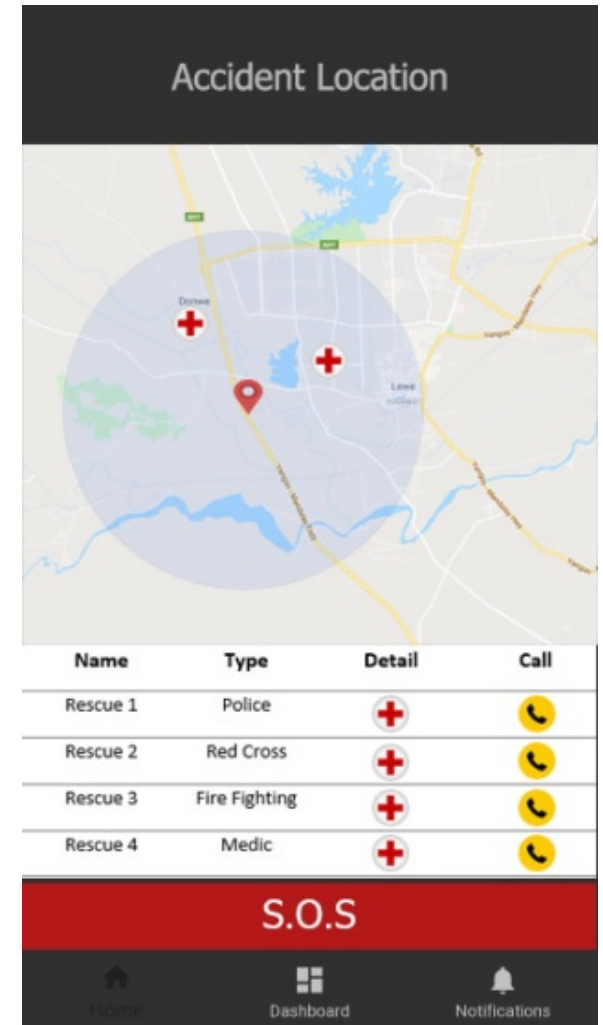
Fig. 2. Information of Rescue Station Location and Accident Detection Location
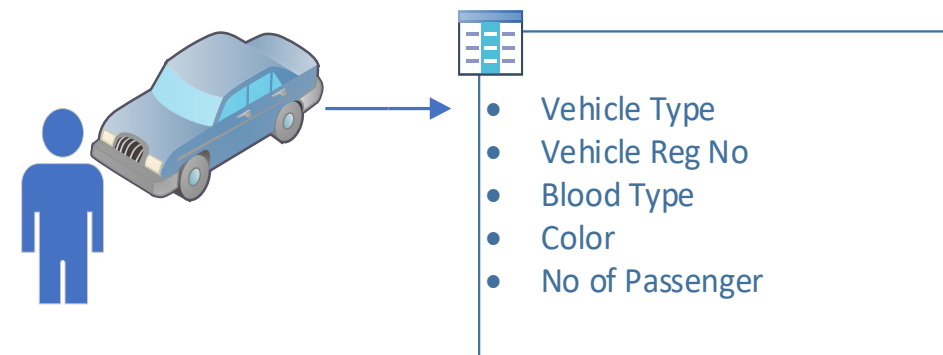
Input information

User information

❑ To process for faster and, receive efficient rescue procedure.

❑ Collected upon installing the one-time input.

❑ When fatal accident, victim might need blood, so rescue team can prepare for victim.
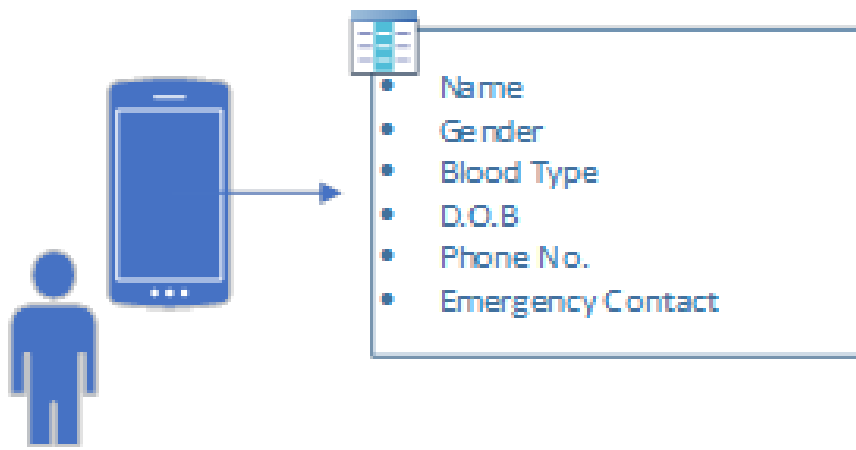
Vehicle information

❑ Required to insert info of vehicle.

❑ Info such as accurate position is provided when user activates accident detection system.

❑ System will be able to access data before informing rescue teams.

- Name
- Gender
- Blood Type
- D.O.B
- Phone No.
- Emergency Contact

- Vehicle Type
- Vehicle Reg No
- Blood Type
- Color
- No of Passenger

Train Dataset

Accident Detection Dataset

❑ Need to retrieve and evaluate status of accident.

❑ Confirmed, latest calibration sensors data is delivered to main system to create the updated dataset automatically.

❑ Decide upon received values from built-in sensors, whether accident may occur or not.

Rescue Service Dataset

❑ Rescue services such as contacts of ambulance service, fire stations, police stations and so on.

❑ Accident confirmed, nearby rescue services will be informed after automatically adding details of last GPS.

❑ Constantly updated in servers, thus Geofence can access whenever it is required.
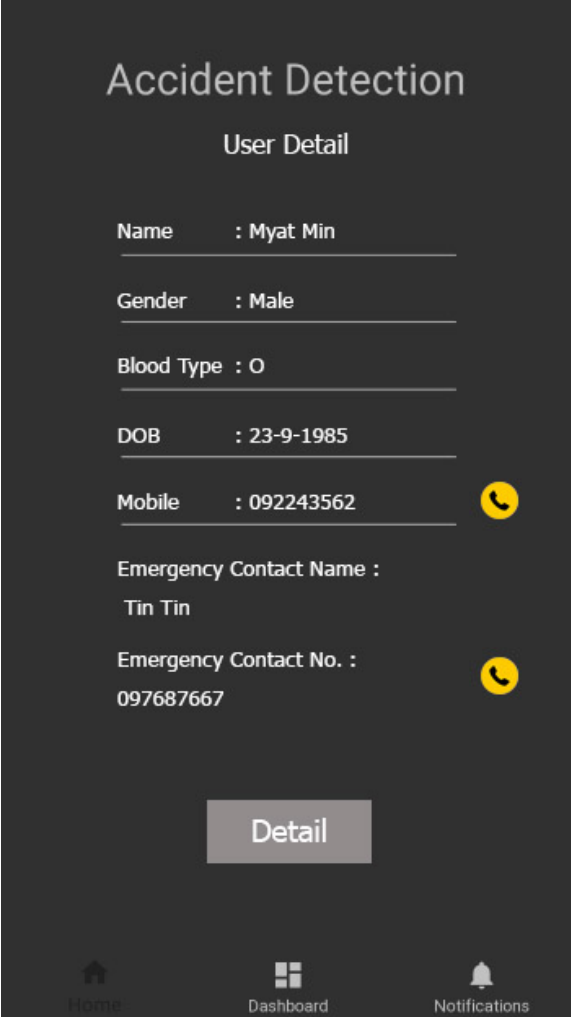
Technologies Usage

❑ Smartphone is affordable and effective.

❑ Android is open-source mobile OS.

❑ Android Studio supports developer all required tools.

❑ Java has set of class libraries that comprise multiple functions.

❑ Geo-fencing creates virtual boundaries.

❑ Google Location API delivers more powerful, high-level framework.

❑ Google Maps Android API is a service allowed to access Maps Server.

❑ Google Directions API calculates distance between starting point and destination.
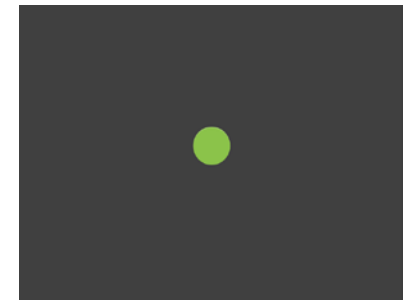
Experiment & Result

❑ Save victims by delivering medical assistances on time.

❑ Predicted based on values received from sensors by system.

❑ With visualization facility of Geo-Fencing, not only discovered for timely response but also to verify nearest rescue services.

❑ By using Motion Sensing Method and Difference Angle Method with Object Detection in Fence Algorithm, received sensors value are accident can be predicted and then closest rescue service as it is crucial to deliver rescue team to victim in timely manner.

❑ Closest rescue contact is spotted, system sends alert message including list of accidents happened around that selected rescue service location.

Fig: Registration of personal data

Experiment & Result (cont'd)

❑ Unique client-server architecture to collect and retain.

❑ Registering about user's data as well as information of vehicle. Request data are needed because required procedures can be prepared such as the correct blood types for the accident victim.

❑ Rescue service, which is nearest to accident location, will receive alert message, data of user including emergency contact.

❑ The latest accident will be shown on top of the list.

Fig: Accident Information

Conclusion

❑ System will be compatible with the various trained dataset.

❑ Well-trained datasets are maintained in systems, user's conditions while using highways are tracked and updated in database perpetually.

❑ Geo-fencing and Google APIs, accident location accurately identified within a short time, closest rescue services and informed to save victims.

❑ System is implemented as user-friendly version.

❑ User is unconscious; system will wait for certain time duration before contacting to nearest rescue unit via Geo-Fencing Technology to prepare required procedures.

❑ Always synchronizes with user's device and even device is switched off, last information is still captured in system to verify data of accident.

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Thank You!