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IOT based Vehicle Tracking & Vehicular Emergency System- A Case Study and Review

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ABSTRACT: In this article we have discussed and analyse Internet of Things (IOT) based vehicle tracking and vehicular emergency system which consists basic blocks and algorithms used in proposed system. The article explains the modelling and working of different units of the system such that vehicle and ambulance unit, the traffic unit and server unit. In this article we have also discussed the basic components and their functions such that IOT and their different layers, microcontroller(ATMEGA 16A) and its architecture, accelerometer sensor (ADXL 355) and its pin diagram, RFID reader and its working, GSM and GPS systems and LCD display and its interfacing with microcontroller.

KEYWORDS: IOT, Vehicle tracking system, ATMEGA 16A, ADXL 355, RFID Reader, GSM, GPS

I.INTRODUCTION

The Internet of Things (IOT) is an arrangement of interrelated computing gadgets, mechanical and digital machines, objects, animals or individuals that are given one kind of an identifiers and the capacity to exchange information over a system without requiring human-to-human or human-to-PC communication. IOT is a new concept that has evolved from the convergence of wireless technologies. Wireless communication is the transfer of information or signal between two or more points that are not connected by an electrical conductor. In IOT devices equipped with Wi-Fi allow the machine-to-machine communication. Using this from of industrial machines to wearable or wireless devices, using built-in sensors to gather data and take action on that data across a network. The sensor and actuator can be setup in different place but they are working together over an internet network. Using IOT technique a vehicle tracking system (VTS) can be built. A vehicle tracking system combines the use of automatic vehicle location of individual vehicles with software that collects these fleet data for a comprehensive picture of vehicle locations. Modern vehicle tracking systems commonly use GPS technology for locating the vehicle, but other types of automatic vehicle location technology can also be used. Vehicle information can be viewed on electronic maps via internet with specialized software. The history of vehicle tracking dates to the beginning of GPS technology in 1978. In the early years, the technology was not yet operational, due to an insufficient number of satellites orbiting the earth. On Jan. 17, 1994, after years of gradual growth, the final of the first 24 satellites was launched, and the GPS system was considered fully operational. Early GPS was designed primarily only for military but in 1996, President Bill Clinton determined that the system would be an asset to civilians as well as the military. This policy change made GPS technology available to the average individual, including fleet managers, who could see the benefit of using the technology to keep tabs on their vehicles. In the early days of fleet tracking, in order to properly track a fleet, each vehicle had to be enabled with a costly GPS device. The company was required to pay a typically high monthly fee to use the satellite tracking system. While helpful, these early systems were difficult to implement, costly to use and sometimes inconvenient for drivers and fleet management alike. Thus it took several 5years for the concept to catch on. In the earliest days, only large, wealthy fleets took advantage of the technology. The modern fleet tracking system provides the necessary data to fleet managers allowing them to run their operations more efficiently. Reports on driver behavior, vehicle performance and fuel use all make it easier for the fleet manager to cut costs and increase efficiencies. These systems go beyond simple reporting of each vehicle’s location, offering fleet managers a wealth of information about their vehicles and their drivers. In many countries this VTS is available. There are some company like GP, ROBI provides Vehicle Tracking Service (VTS) which has some common features like tracking the vehicle using satellite GPS & GSM communication.

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But there is no system which can detect accident and also give the service of VTS. Here comes car safe project which can detect location of a car, and if there is any accident occur it can communicate automatically to the nearest police station, hospital and owner to reduce instant loss or damage.

IOT: The Internet of things (IOT) is the between systems administration of physical gadgets, vehicles, structures, and different things installed with hardware, programming, sensors, actuators, and system availability which empower these items to gather and exchange data. The IOT enables items to be detected or controlled remotely across existing system infrastructure creating open doors for more straightforward of the physical world into computer-based systems and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. Only IOT can connect physical world to the web.

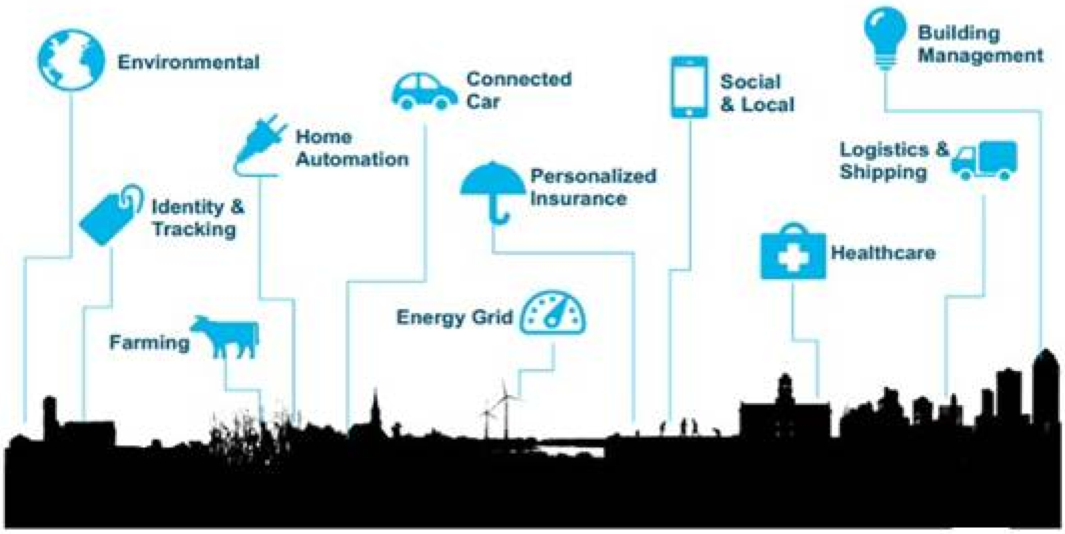

Fig 1: IOT connecting the physical world to the web

The IOT is more than internet connected consumer gadgets. Sooner or later every IT organization will need to create an framework to support it. Energy companies already use networked sensors to measure vibrations in turbines. They feed that data through the network to computing systems that analyses it to predict when machines will need maintenance and when they will fail. Jet engine manufacturers embed sensors that measure temperature, pressure, and other conditions to improve their products. There are different types of Layers present in IOT:

Interface Layer: The first layer of IOT is interface layer. This layer provides the interaction methods between users and application. This section looks how user can easily use the system. This includes three main approaches. Firstly, we need the ability to create web-based front-ends and portals that interact with devices and with the event-processing layer. Secondly, we need the ability to create dashboards that offer views into analytics and event processing. Finally, we need to be able to interact with systems outside this network using machine-to-machine communications (APIs). The recommended approach to building the web front end is to utilize a modular front-end architecture.

Service layer: This layer is used to create and manage services to satisfy user's needs. To do so, it process data deep processing. To make more user friendly application, it provides database with different data and divides work. This is an important layer for three reasons:

1. The ability to support an HTTP server and/or an MQTT broker to talk to the devices;
2. The ability to aggregate and combine communications from different sensing devices and to route communications to a specific device (possibly via GSM/GPRS).
3. The ability to bridge and transform between different protocols that is to offer HTTP based APIs that are mediated into an MQTT message going to the device.

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Networking or Communication Layer: The Networking or Communication layer supports the connectivity of the devices. There are multiple potential protocols for communication between the devices and the cloud. The most well-known three potential protocols are

- HTTP/HTTPS (and REST full approaches on those)
- MQTT
- Constrained application protocol (COAP)

Let's take a quick look at each of these protocols in turn

HTTP is well known, and there are many libraries that support it. Because it is a simple Text based protocol, many small devices such as 8-bit controllers can only partially support the protocol –for example enough code to POST or GET a resource. The larger 32-bit based devices can utilize full HTTP client libraries that properly implement the whole protocol. There are several protocols optimized for IOT use. The two best known are MQTT6 and COAP7. MQTT was invented in 1999 to solve issues in embedded systems and SCADA. It has been through some iterations and the current version is undergoing standardization in the OASIS MQTT Technical Committee.

Sensing Layer: Sensors collect data from the environment or object under measurement and turn it into useful data. This layer covers everything from legacy industrial devices to robotic camera systems, water-level detectors, air quality sensors, accelerometers, and heart rate monitors. And the scope of the IOT is expanding rapidly, thanks in part to low-power wireless sensor network technologies and Power over Ethernet, which enable devices on a wired LAN to operate without the need for an A/C power source.

IOT Platforms and Security: Even with the recent attention given to security for IOT devices, it can be easy to overlook the need for end-to-end security for an IOT platform. Every part of a platform should be analyzed for security prospects. From internet connections to the applications and devices to the transmitted and stored data, there is a potential for an attack vector. Without question, the single most important non-functional requirement of an IOT platform is that it offers robust security.

II.I LITERATURE REVIEW AND MOTIVATIONS

Manasi Patil et al., suggested a better traffic management system using Raspberry pi and RFID technology. The vehicle has a raspberry pi controller fixed in it which is interfaced with sensors like gas sensor, temperature sensor and shock sensor. These sensors are fixed at a predetermined value before accident. When an accident occurs, the value of one of the sensor changes and a message to a predefined number (of the ambulance) is sent through GSM. The GPS module which is also interfaced with the controller also sends the location of the vehicle. When the message is received by the ambulance, a clear route has to be provided to the ambulance. The ambulance has a controller ARM which is interfaced with the RFID tag sends electromagnetic waves. When an ambulance reaches the traffic signal the RFID reader which is placed on the joints detect the electromagnetic waves of the tag. If the traffic signal is red, then the readers goes through the database in fraction of seconds and turn the red light green. And automatically in such condition the RFID on opposite joints turn the opposite signal red. This provides a clear route to the ambulance. [1].V.Sagar Reddy et al., developed an accelerometer based System for driver safety. The system has the advantage of tracking or identifying vehicles location just by sending a SMS or email to the authorized person. The system is designed by using Raspberry Pi (ARM11) for fast access to accelerometer for event detection. Is there any event is occurs the message sent to the authorized person so they can take immediate action to save the lives and reduce the damages. Images captured by the camera on the vehicle are emailed to the concerned person (for example the owner of the vehicle) along with the type of accident and the time of the accident. [2].Sri Krishna Chaitanya Varma et al., proposed an Automatic Vehicle Accident Detection and Messaging System Using GPS and GSM Modems. AT89C52 microcontroller is used in the system. When the system is switched on, LED is ON indicating that power is supplied to the circuit. When the IR sensors that are used sense any obstacle, they send interrupt to microcontroller. The GPS receives the location of the vehicle that met with an accident and gives the information back. This information is sent to a mobile number as a message. This message is received using GSM modem present in the circuit. The message gives the information of longitude and latitude values. Using these values the position ofthe vehicle can be estimated [3].Apurva Mane et al., described the methods for vehicle collision detection and remote alarm device using Arduino. Key features of this design include real-time vehicle monitoring by sending its information regarding position (longitude, latitude), time, and angle to the monitoring station and to the user/owners mobile that should help them to get medical help if accident or the theft occurs. Also user/owner has an access to get real-time position of a vehicle in real time. Whenever accident

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occurs, MEMS and vibration sensor detects and sends the signals to microcontroller, by using GPS particular locations where accident has occurred is found, then GSM sends message to authorized members. [4].

Motivations: Road accidents and traffic congestion are the major problems in urban areas. Currently there is no technology for accident detection. Also due to the delay in reaching of the ambulance to the accident location and the traffic congestion in between accident location and hospital increases the chances of the death of victim. There is a need of introducing a system to reduce the loss of life due to accidents and the time taken by the ambulance to reach the hospital. To overcome the drawback of existing system we will implement the new system in which there is an automatic detection of accident through sensors provided in the vehicle. A main server unit houses the database of all hospitals in the city. A GPS and GSM module in the concerned vehicle will send the location of the accident to the main server which will rush an ambulance from a nearest hospital to the accident spot. Along with this there would be control of traffic light signals in the path of the ambulance using WEB communication. This will minimize the time of ambulance to reach the hospital. A patient monitoring system in the ambulance will send the vital parameters of the patient to the concerned hospital. This system is fully automated, thus it finds the accident spot, controls the traffic lights, helping to reach the hospital in time**.**

III.SYSTEM MODEL

BLOCK DIAGRAM-

The proposed system consists of three main units, which coordinates with each other and makes sure that ambulance reaches the hospital without any time lag.

Thus our system is divided into following three units:

- The Vehicle Unit & The Ambulance Unit
- The Traffic unit
- Main Server

I. VEHICLE UNIT

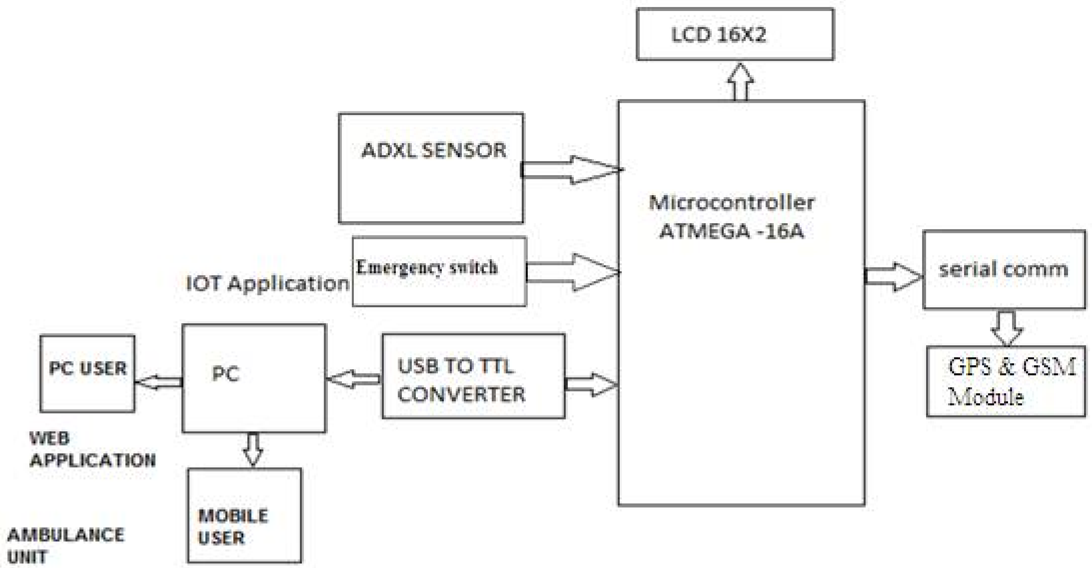

Fig 2: Vehicle & ambulance Unit

The vehicle unit consists of a controller, ADXL sensor, GPS system,. The vehicle unit installed in the vehicle every vehicle should have a vehicle unit. The vehicle unit consists of a controller, MEMS sensor, GPS system. The vehicle

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unit installed in the vehicle senses the accident and sends the location accident the main server. The vibration sensor used in the vehicle will continuously sense for any large scale vibration in the vehicle. The sensed data is given to the controller. GPS module finds out the current position of the vehicle which is the location of the accident and gives that data to the IOT WEB server. The accident location is then conveyed to the main server unit that houses the database of all the nearby hospitals and sends an ambulance to the accident spot. This information to the main server is conveyed by GPS module. The location information is given to ambulance which helps it to reach the accident location immediately to save the casualties The web based tracking system is a system designed using a combination of several modern information and communications technologies. The system comprises of vehicle-mounted tracking devices, a central server system and a web-based application.

1] MICROCONTROLLER ATMEGA 16A

Microcontroller is the heart of this circuit. The microcontroller used is AVR, ATMEGA16 from ATMEL Company. The MOSFET IRF224 will be used as driver for driving DC motor. The sensing of speed for DC motor will be done using optical encoder .The output of sensor will be given as feedback to the microcontroller. For every one rotation of motor one interrupt signal will be send to microcontroller. The required speed can be entered through keypad. LCD 16 X 2 or 20 x4 will be attached to microcontroller. The HMI will be displayed on LCD. The crystal will provide required for the microcontroller. The AVR is a Modified Harvard architecture 8-bit RISC single chip microcontroller (µC) which was developed by Atmel in 1996. The AVR was one of the first microcontroller families to use on-chip flash memory for program storage, as opposed to One-Time Programmable ROM, EPROM, or EEPROM used by other microcontrollers at the time AVRs have been used in various automotive applications such as security, safety, and power train and entertainment systems. Atmel has recently launched a new publication "Atmel Automotive Compilation" to help developers with automotive applications. Some current usages are in BMW, Daimler-Chrysler and TRW. System Semiconductor, Inc produces the M3000 Motor and Motion Control Chip, incorporating an Atmel AVR Core and an Advanced Motion Controller for use in a variety of motion applications. In 2006 Atmel released microcontrollers based on the new, 32-bit, AVR32 architecture. They include SIMD and DSP instructions, along with other audio and video processing features. This 32-bit family of devices is intended to compete with the ARM based processors. Due to lot of features in built it is very cost effective and easy to build a controller.

Technical detail of AVR:

1. High-performance, Low-power AVR® 8-bit Microcontroller
2. Advanced RISC Architecture
3. 131 Powerful Instructions – Most Single-clock Cycle Execution
4. 32 x 8 General Purpose Working Registers
5. On-chip 2-cycle Multiplier
6. Nonvolatile Program and Data Memories
7. 32K Bytes of In-System Self-Programmable Flash
8. Endurance: 10,000 Write/Erase Cycles
9. In-System Programming by On-chip Boot Program
10. 1024 Bytes EEPROM\
11. 2K Byte Internal SRAM

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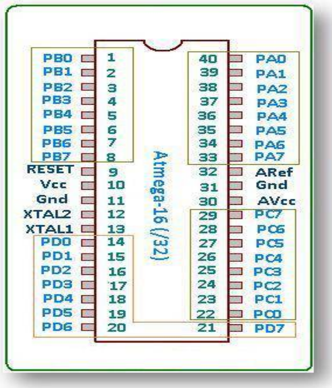

Fig 3: Pin configuration of AVR (Atmega16)

Architecture of Atmega16:

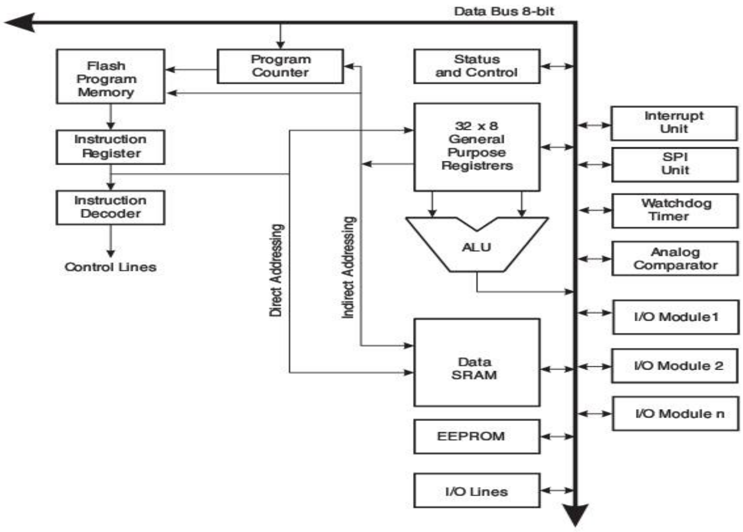

Fig 4: Architecture of AVR

2] ACCELEROMETER SENSOR (ADXL 355)

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

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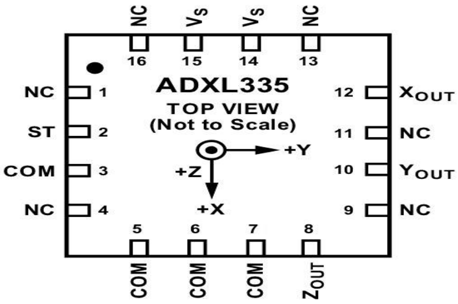

Fig 5: Pin configuration

Pin No.	Mnemonic	Description
1	NC	No connection
2	ST	Self-Test
3	COM	Common
4	NC	No connection
5	COM	Common
6	COM	Common
7	COM	Common
8	Z_{OUT}	Z channel output
9	NC	No connection
10	Y_{OUT}	Y Channel output
11	NC	No connection
12	X_{OUT}	X Channel output
13	NC	No connection
14	VS	Supply voltage (1.8V to3.6V)
15	VS	Supply voltage (1.8V to3.6V)
16	NC	No connection
EP	EXPOSEED PAD	Not internally connection.

Table 1: Pin Function Description

3] GSM: GSM (Global System Mobile) is a digital communication system which has rapidly gained acceptance and market sheared worldwide. Mobile services based on GSM technology were first launched in Finland.

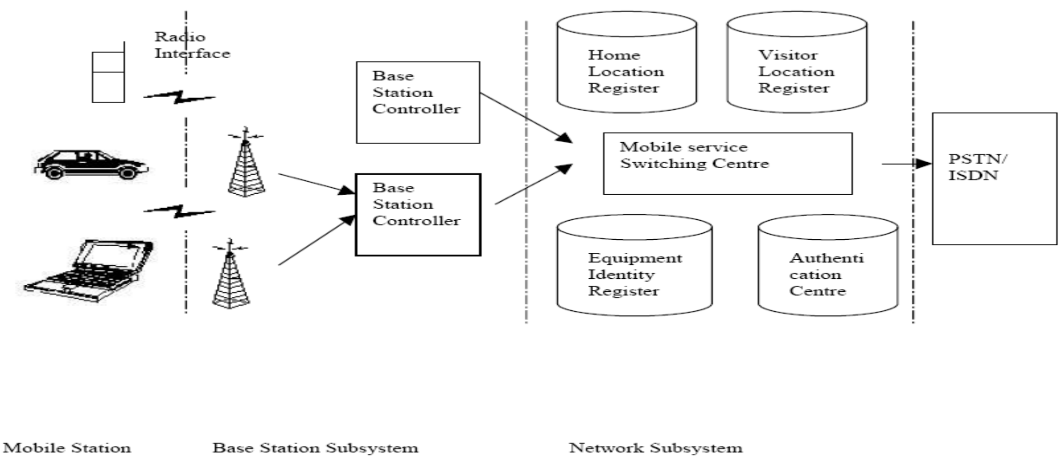

Fig 6: Architecture of GSM

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The GSM network can be divided into three parts.

- Mobile Station
- Base Station
- Network Subsystem

1. Mobile Station: The mobile station (MS) consists of mobile equipment and a Subscriber Identity Module (SIM) card. The most common mobile equipment is the mobile phone. By inserting the SIM card into a cellular phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services. The mobile equipment uniquely identifies the International Mobile Equipment Identity (IMEI).The SIM card stores the sensitive information such as the International Mobile Subscriber Identity (IMSI), Ki(a secret key for authentication), and other user information. All this information may be protected by personal identity number(PIN) .The SIM card itself is a smart card and is in accordance with the smart card standard (ISO 7816- 1, -2). The GSM 11.11 has the detailed specification about the SIM card.

2. Base Station Subsystem: The Base Station Subsystem consists of the Base Transceiver Station (BTS) and the Base Station Controller (BSC). The Base Transceiver Station houses the radio transceivers that define a cell and handles the Radio link protocols with the Mobile Station. In a large urban area, there will potentially be a large number of BTS deployed. The Base Station Controller manages the radio resources for one or more BTS. It handles Radio channel setup, frequency hopping, and handovers. The BSC is the connection between the mobile and the Mobile service Switching Centre (MSC). The BSC also translates the 13 kbps voice channel used over the radio link to the standard 64 kbps channel used by the Public Switched Telephone Network or ISDN.

3. Network Subsystem: The central component of the Network Subsystem is the Mobile services Switching Centre (MSC). It acts like a normal switching node of the PSTN or ISDN, and in addition provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. These services are provided in conjunction with several functional entities, which together form the Network Subsystem. The MSC provides the connection to the public fixed network

4] GPS: Global Positioning System (GPS) satellites broadcast signals from space that GPS receivers, use to provide three-dimensional location (latitude, longitude, and altitude) plus precise time. GPS receivers provides reliable positioning, navigation, and timing services to worldwide users on a continuous basis in all weather, day and night, anywhere on or near the Earth.

The output is serial data of 9600 baud rate which is standard NMEA 0183 v3.0 protocol offering industry standard data messages and a command set for easy interface to mapping software and embedded devices.

5] LCD: LCD is used to display the data. LCD we have used is 16x2 i.e. 16 characters in 1 line , total 2lines are there. We could have used a better resolution LCD but due to limitation of money and for project requirement 16x2 LCD is sufficient. This LCD has 8-bit parallel interface. It is possible to use all 8 bits plus 3 control signals or 4 bits plus the control signals. It requires +5V to operate.It is connected to port 2 of microcontroller. It acts as an output to microcontroller. It uses ASCII values to display the characters. For control signals p0 (p0.5, p0.6 and p0.7) are used and to data signals port 2 is used. 8 bits data are transferred as ASCII consists of 8bits. Pin 1, 2 and 3 of LCD is connected with a resistor to keep contrast constant. We can vary the contrast by varying the resistor across pin 3. LCD's can add a lot to your application in terms of providing a useful interface for the user, debugging an application or just giving it a "professional" look.

LCD Interface: -

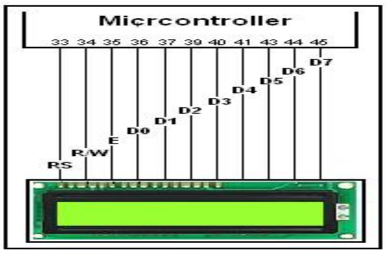

Fig 7: Microcontroller and LCD Interface

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II. TRAFFIC UNIT

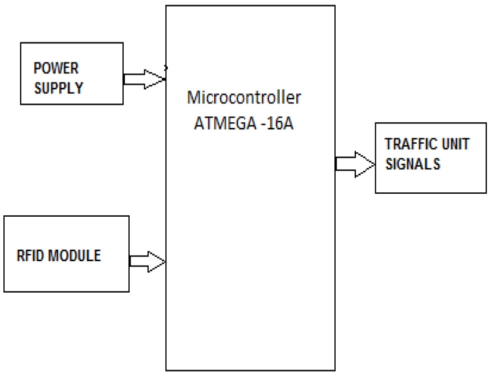

Fig 8: Traffic Unit

Traffic control unit is mainly responsible for managing the signal posts in the path of ambulance. The block representation of the traffic control unit can be seen in fig. The controller is connected to both RF-id module and signal posts; RF module acts as input whereas signal posts are output .The RF-id card reader reads the RF frequency tag .This tag is communicated to traffic control unit via RF-id module. The controller receives the id and then in turn enables the signal post tagged to that id to go green. In this way, whenever the ambulance approaches the signal post. The post goes green. AVR Microcontroller is used to control all operations of the traffic control unit. Controller passes signals to the traffic signals and accordingly they turn green. In this way the signals in the shortest path to the hospital is cleared for the ambulance reaches the hospital in time.

RFID READERS: The RF-id Reader additional board is used to read identification cards (RF-id Cards) using radio waves. This additional board features a receiver/transmitter module with antenna and a 2x5 male connector that enables connection with development systems. The operation of the RF-id Reader board is based on amplitude modulation of radio waves and electromagnetic induction. The RF-id card is not provided with the RF-id Reader but you can buy it separately.

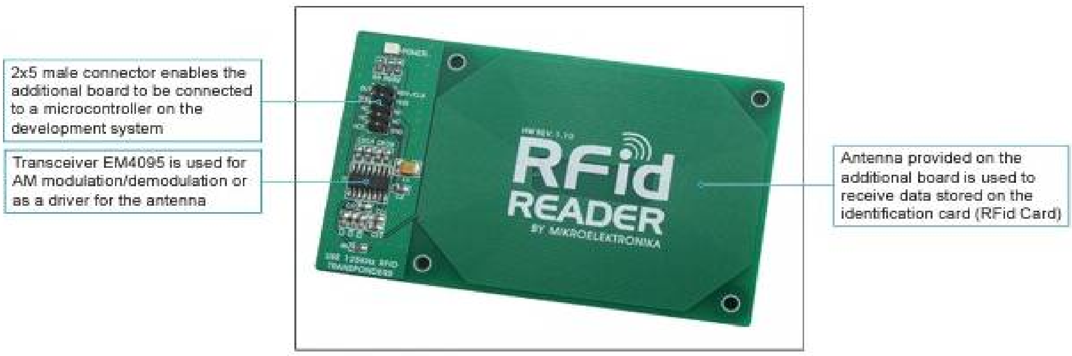

Fig 9: RFID READER

RF-id Reader is powered via a development system it is connected to. The presence of the power supply is indicated by a LED marked POWER. When the RF-id Reader is turned on, a 125 kHz voltage is supplied on its antenna. As a result, the antenna starts emitting an electromagnetic field necessary for reading the RF-id identification card. As passive RF-id card doesn't have its own power supply, it features a coil where the voltage is automatically induced by approaching the card to the RF-id Reader's antenna. This voltage is necessary for the chip featured on the RF-id card to work. The

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memory chip on the RF-id card contains a unique identification code. This code is sent by the card when it is placed close to the RF-id Reader's antenna. The code is received via this antenna. Then, it is sent to the microcontroller for further processing.

Fig 10: Identification card (RFID card)

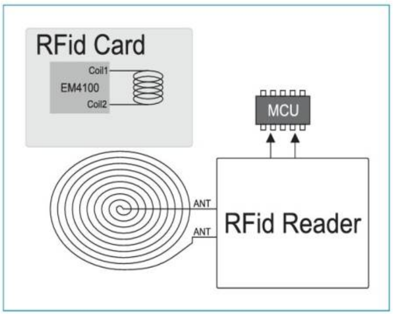

Fig 11: Principle of RFID reader operation

III. WEB SERVER

To interact with users, a website has been developed where a user with the hardware can create an account and monitor all the vehicle installed this system. User will get notification if any vehicle gets into accident through the website account, mobile application and mobile SMS with the exact GPS location of accident. Also any police station and hospital can open an account from the website and will get notification through website and mobile SMS about an accident with the accident location and direction towards the accident location using google map.

It considers a network with N mobile unlicensed nodes that move in an environment according to some stochastic mobility models. It also assumes that entire spectrum is divided into number of M non-overlapping orthogonal channels having different bandwidth. The access to each licensed channel is regulated by fixed duration time slots. Slot timing is assumed to be broadcast by the primary system. Before transmitting its message, each transmitter node, which is a node with the message, first selects a path node and a frequency channel to copy the message. After the path and channel selection, the transmitter node negotiates and handshakes with its path node and declares the selected channel frequency to the path. The communication needed for this coordination is assumed to be accomplished by a fixed length frequency hopping sequence (FHS) that is composed of K distinct licensed channels. In each time slot, each node consecutively hops on FHS within a given order to transmit and receive a coordination packet. The aim of coordination packet that is generated by a node with message is to inform its path about the frequency channel decided for the message copying.

Furthermore, the coordination packet is assumed to be small enough to be transmitted within slot duration. Instead of a common control channel, FHS provides a diversity to be able to find a vacant channel that can be used to transmit and receive the coordination packet. If a hop of FHS, i.e., a channel, is used by the primary system, the other hops of FHS can be tried to be used to coordinate. This can allow the nodes to use K channels to coordinate with each other rather than a single control channel. Whenever any two nodes are within their communication radius, they are assumed to meet with each other and they are called as contacted. In order to announce its existence, each node periodically broadcasts a beacon message to its contacts using FHS. Whenever a hop of FHS, i.e., a channel, is vacant, each node is assumed to receive the beacon messages from their contacts that are transiently in its communication radius.

IV. ALGORITHM & FLOW CHART

5.1 ALGORITHM FOR ACCIDENT DETECTION

Step 1: Start the program.
Step 2: Read ADXL sensor data.
Step 3: If sensor value is more than limit go to step 4, otherwise go to step 2.
Step 4: Ask Driver for confirm accident. Set wait time 60 second.
Step 5: If Driver confirm accident go to step 6, otherwise go to step 7
Step 6: Send notification to web server owner account, nearest police station, hospital also send SMS. Go to step 2.
Step 7: Decrement wait time each second

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.Step 8: if wait time = 0 second go to step 9, otherwise go to step 5.
Step 9: go to step 6.
Step 10: Stop

5.2 FLOW CHART

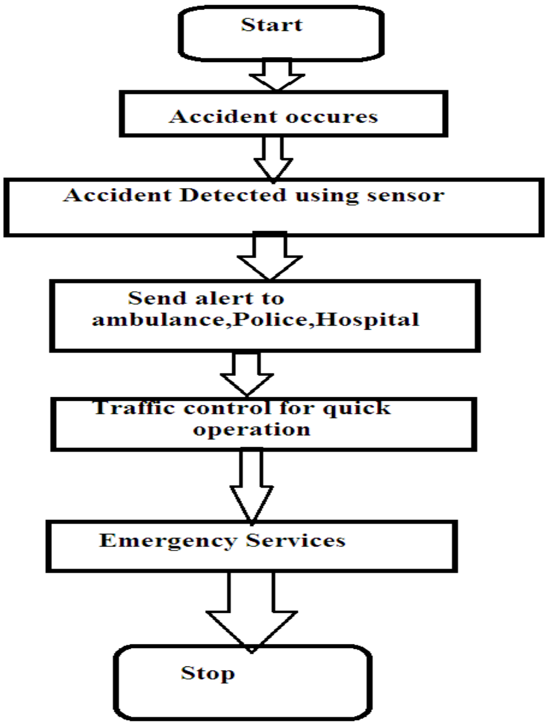

Fig 12: Flow chart of proposed system

V. ADVANTAGES & APPLICATIONS

ADVANTAGES

1. Totally advanced version of Ambulance system with vehicle tracking.
2. With the help of GPS we get the latitude and longitude of the detected position.
3. The ambulance would be able to cross all the traffic junctions without waiting
4. This Scheme is fully automated, thus it finds the accident spot, controls the traffic lights, helping to reach the hospital in time.
5.

APPLICATIONS

1. Mainly used for Ambulance vehicles
2. Fire Engines;
3. Other Life Saving Emergency Vehicles
4. All vehicle tracking system.

V. CONCLUSION

Thus the article explains the basic structure and system design for IOT based vehicle tracking and vehicular emergency system. The article also explains the basic blocks and components used in this system. It's a complete case study for the

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proposed system design. The system is very much helpful for avoidance of road accidents and ambulance supply. Using this system we can do real time surveillance of vehicles and emergency systems.This Scheme is fully automated, thus it finds the accident spot, controls the traffic lights, helping to reach the hospital in time.

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