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Advanced Embedded System of Vehicle Accident Detection and Tracking System

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Abstract— in highly populated Countries, when an accident happened people lose their lives due to unavailability of proper medical facilities at that time. No one can prevent the accident, but can save their life by providing medical facilities. The main objective of this system is to first detect the accident location and call for the emergency services. This system which can detect accidents in significantly less time and send the basic information with geographical coordinates to first aid centre within a few seconds. Vehicle accident detection is possible with the help of sensors. A GPS and GSM module helps to trace the vehicle.

Keywords—GPS, GSM, Sensors, Vehicle tracking, geographical coordinates.

I. INTRODUCTION

Vehicle accident detection system is used to recognize the location of accident easily to reach the location. According to this system when a vehicle meets with an accident, sensor will detect the signal and send it to controller. Controller sends the alert message through the GSM MODEM including the accident location to police control room or a rescue team. After receiving the information, police can immediately trace the location through the GPS MODEM. A Switch will be provided in order to terminate the sending of a message when there is no casualty. This can save the precious time of the medical rescue team. This system is mainly used to track the position of the Vehicle.

It can also be used in the public transportation system by the people to know the location of the buses or trains. In case of any accident, the system sends automated messages to the pre-programmed numbers. System uses a GPS (Global Positioning System) to know the exact position of the vehicle. This can also be used for other purposes such as asset tracking, Stolen Vehicle recovery, Field Service Management, Field Sales etc. The hospitality industry has caught on to this technology to improve customer service. For example, Vehicle tracking systems have also been used in food delivery and car rental companies.

II. RELATED WORK

Many of the authors explained the vehicle tracking in embedded system. One of them, Benjamin Coifman [1], explained a real-time computer vision system for vehicle tracking and traffic surveillance. His paper proposed a feature based tracking system.

R. Ramani, S. Valarmathy, Dr. N. Suthanthira Vanitha, S. Selvaraju, M. Thiruppathi, R. Thangam [2] explained Vehicle Tracking and Locking System Based on GSM and GPS. Their paper proposed a novel method of vehicle tracking and locking systems used to track the stolen vehicle by using GPS and GSM technology.

Kunal Maurya, Mandeep Singh, Neelu Jain [3] explained the vehicle tracking system installed in a vehicle to enable the owner or a third party to track the vehicle's place. This paper proposed to design a vehicle tracking system that works using GPS and GSM technology. This system built based on embedded system, used for tracking and positioning of any vehicle by using Global Positioning System (GPS) and Global system for mobile communication (GSM). This design will continuously watch a moving Vehicle and report the status of the Vehicle on demand.

Chen Peijiang, Jiang Xuehua [4] explained the remote monitoring system based on SMS and GSM. In their paper, the GSM network is a medium for transmitting the remote signal. System includes two parts that are the monitoring center and the remote monitoring station. The monitoring centers consist of a computer and communication module of GSM. The remote monitoring station implemented by using VB. The demonstration shows that the system can watch and control the remote communication between the monitoring center and the remote monitoring station.

V.Ramya, B. Palaniappan, K. Karthick [5] explained the system which provides vehicle cabin safety. This system monitors the level of the toxic gases such as CO, LPG and alcohol within the vehicle and provides alert information as alarm during the dangerous situations. The system sends SMS to the authorized person through the GSM. Detection of gases prevents further accidents.

Albert Alexe, R. Ezhilarasie [6] Explained system based on cloud computing infrastructure. In this system sensors are used to monitor the fuel level, driver conditions, and speed of the vehicle. All the data transferred to cloud server-using GSM enabled device. All the vehicles equipped with GPS antenna to locate the place. To avoid the drunk and drive, the alcohol sensor installed to monitor the driver status. The proposed technology significantly avoids the accident in highways.

Arias Tanti Hapsari , Eniman Y Syamsudin and, Imron Pramana[7] explained system based on Design of vehicle position tracking system using short message services and its implementation on fpga‖. In this system paper authors used GPS module to receive the vehicular position and, short messaging service via mobile phone to receive user request and to send the vehicle position. These components are controlled by a system which is designed using VHDL on Altera MAX plus I1 software, and it is implemented on FPGA chip Altera UPlX demoboard (Altera FLEX 10KEPF). In this way the author gets the position of the vehicle and sends it to any user who gives the request for tracking. The objective of this paper is to achieve a design of such system that can give information of the vehicle position every time there's a request for it. Safety and security is a major concern for all vehicle owners. This vehicle tracking system ensures safety and security of vehicle by tracking its position and sending it to owner or any people whenever it is requested by them. And also GPS system ensures maximum accuracy in finding the vehicular position ranging within few feet. Using the mobile phone attached in the system, the position of the vehicle is sent as short message service (SMS) to the requested people. There are two testing and verification procedures of this system.

Arias Tanti Hapsari Eniman Y Syamsudin Imron Pramana [8] explained system based on Vehicle Tracking System-On Chip. Modern powerful reconfigurable systems are suited in the implementation of various data-streams, dataparallel, and other applications. An application that needs real-time, fast, and reliable data processing is the global positioning system (GPS)-based vehicle tracking system (VTS). This system is designed using a system-on-chip (SOC) replacement of the current microcontroller-based implementation. The proposed SOC is built on a field programmable gate array (FPGA) promising a cheaper design, a more cohesive architecture, a faster processing time and an enhanced system interaction**.** Reconfigurable systems enable extensive exploitation of computing resources. The reconfiguration of resources in different parallel topologies allows for a good matching with the inherent intrinsic parallelism of an algorithm or a specific operation.

The introduction of a new paradigm in hardware design called Reconfigurable Computing *(RC)* offers to solve any problem by changing the hardware configurations to offer the performance of dedicated circuits. Reconfigurable computing enables mapping software into hardware with the ability to reconfigure its connections to reflect the software being run. The ability to completely reprogram the computer‘s hardware implies that this new architecture provides immense scope for emulating different computer architectures. As the complexity of *FPGA*-based designs grow, a need for a more efficient and flexible design methodology is required. It consists of two main parts, the Base Station *(BS)* and the Mobile Unit *(MU).* The *BS* consists of a *PIC* Microcontroller based hardware connected to the serial port of a computer. The *MU* is a self-contained *PIC* Microcontroller based hardware and a *GPS* module. The latter would keep track of all the positions traversed by the vehicle and records them in its memory. The system has a great storage capacity, and could perform a significant recording with a considerable sampling rate. The mobile unit *(*MU*)* of the addressed Aram Locator consists of two communicating microcontrollers interfaced with memory. There is also a GPS unit and RF transceiver.

III. SYSTEM DIAGRAM

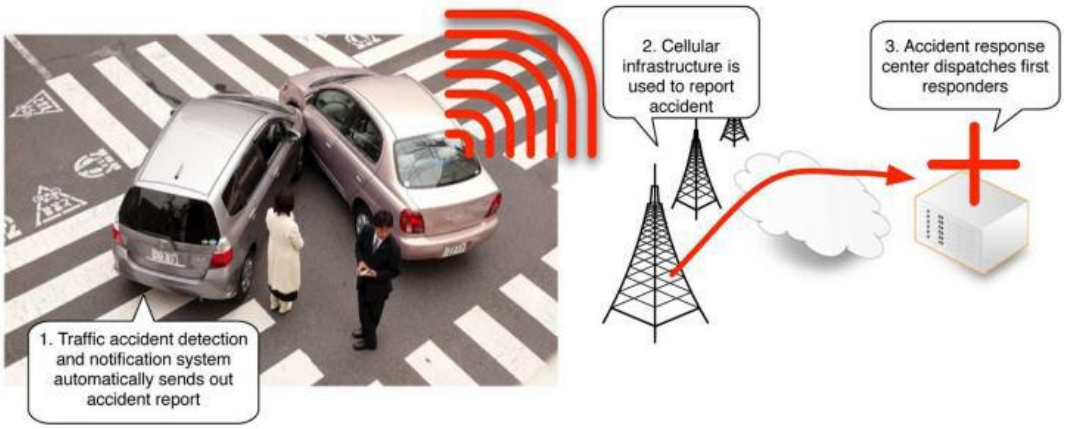

Fig.1 A Vehicle based Accident Detection and Notification System

Key features of this design include:

a. Real-time monitoring system sending "its" information regarding position (longitude, latitude), time, 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.

b. User/owner has an access to get real-time position of a vehicle in real time.

Also in case of theft vehicle should be stop at the same time where this system is ported on the mobile vehicle.

IV. WORKING COMPONENTS

A. GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into or-bit by the U.S. Department of Defense. GPS was originally in-tended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

Distance = Velocity * Time here Velocity of the GPS signal is the speed of light, approximately 300,000 Km/s.
GPS transmissions occur on a frequency of 1575.42 and 1227.60 MHz both of these frequencies are within the L Band.
Function of GPS
The Global Positioning System satellites transmit signals to equipment on the ground. GPS receivers passively receive satellite signals; they do not transmit. GPS receivers require an unobstructed view of the sky, so they are used only outdoors and they often do not perform well within forested areas or near tall buildings. GPS operations depend on a very accurate time reference, which is provided by atomic clocks on board.
Each GPS satellite transmits data that indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions.
There are at least 24 operational GPS satellites at all times plus a number of spares. The satellites, operated by the U.S. Department of Defense, orbit with a period of 12 hours (two orbits per day) at a height of about 11,500 miles travelling at near 2,000mph. Ground stations are used to precisely track each satellite's orbit.

Accuracy of G.P.S

The accuracy of a position determined with GPS depends on the type of receiver. Most hand-held GPS units have about 10-20 meter accuracy. Other types of receivers use a method called Differential GPS (DGPS) to obtain much higher accuracy. DGPS requires an additional receiver fixed at a known location nearby. Observations made by the stationary receiver are used to correct positions recorded by the roving units, producing an accuracy greater than 1 meter. When the system was created, timing errors were inserted into GPS transmissions to limit the accuracy of non-military GPS receivers to about 100 meters. This part of GPS operations, called Selective Availability, was eliminated in May 2000.

B. GLOBAL SYSTEM FOR MOBILE COMMUNICATION

GSM is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band.
GSM is the de facto wireless telephone standard in Europe. GSM has over one billion users worldwide and is available in 190 countries. Since many GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries.
A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.
A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM 12 modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like:

- Reading, writing and deleting SMS.
- Sending SMS.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.
- SIM Phonebook management
- Fixed Dialling Number (FDN)
- Real time clock

AT commands:
AT commands are also known as Hayes AT commands. There are different views to
Understand the meanings of "AT". Some call it "Attention Telephone", whereas others interpret it as "Attention Terminal" commands.
AT commands allow giving instructions to both mobile devices and ordinary landline telephones. Different manufacturers may have different sets of AT commands. Fortunately, many AT commands are the same. Mobile device manufacturers may also give attention to operators to allow or not to allow some commands on phones.
Examples for send and receive SMS
For sending SMS in text Mode:

AT+CMGF=1 press enter
AT+CMGS="mobile number" press enter
Once The AT commands is given' >' prompt will be displayed on the screen.
Type the message to send via SMS. After this, press ctrl+Z to send the SMS.
If the SMS sending is successful, "ok" will be displayed along with the message number.
For reading SMS in the text mode:
AT+CMGF=1 Press enter
AT+CMGR= no.
Number (no.) is the message index number stored in the sim card. For new SMS, URC will be received on the screen as +CMTI: SM 'no'. Use this number in the AT+CMGR number to read the message.

GSM Features

- Tx : 880-915
- Multiple Access Method : TDMA/FDM
- Duplex Method : FDD
- Number of Channels :24 (8 users per channel)
- Channel Spacing :200 kHz
- Modulation :GMSK (0.3 Gaussian Filter)
- Channel Bit Rate :270.833Kb
- Mobile Frequency Range Rx : 925-960;

C. Accelerometer

An accelerometer measures acceleration. Acceleration is a measure of how quickly speed changes. Accelerometer sensor is used to measure static (earth Gravity) or dynamic acceleration in all three axes, forward/backward, left/right and up/down. The output of accelerometer provides 1.65V to 3.3V in positive direction and in negative direction the voltage drop from 1.65V to 0V. It is in analogue form with three different output voltages each representing X, Y and Z direction of motion. Accelerometer is used in this design for the collision detection. The maximum output voltage of accelerator module is 3.3V that is a CMOS voltage of the processor. Accelerometers operate on the piezoelectric principal: a crystal generates a low voltage or charge when stressed as for example during compression. (The Greek root word "piezein" means "to squeeze") Motion in the axial direction stresses the crystal due to the inertial force of the mass and produces a signal proportional to acceleration of that mass. This small acceleration signal can be amplified for acceleration measurements or converted (electronically integrated) within the sensor into a velocity or displacement signal.

D. Vibration Sensor

The three parameters representing motion detected by vibration monitors are displacement, velocity, and acceleration. These parameters can be measured by a variety of motion sensors and are mathematically related (displacement is the first derivative of velocity and velocity is the first derivative of acceleration). Selection of a sensor proportional to displacement, velocity or acceleration depends on the frequencies of interest and the signal levels involved. Eddy current probes are non contact sensors primarily used to measure shaft vibration, shaft/rotor position and clearance. Also referred to as displacement probes, eddy current probes are typically applied on machines utilizing sleeve/journal bearings. As compared to accelerometers, velocity sensors have lower sensitivity to high frequency vibrations. The mechanical design of the velocity sensor; an iron core moving within a coil in a limited magnetic field, no clipping of the generated signal occurs, but smooth saturation.

E. Control Unit

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. Control unit receives information from accelerometer, vibration sensor, GPS module and send it to rescue system and police station with the help of GSM.

V. ADVANTAGES

- Easy to operate.
- Sophisticated security.
- Simple and Reliable Design.
- Isolates both GSM and GPS signal.

VI. APPLICATIONS

Asset Tracking: Companies needing to track valuable assets for insurance or other monitoring purposes can now plot the real-time asset location on a map and closely monitor movement and operating status.
Fleet Management: When managing a fleet of vehicles, knowing the real-time location of all drivers allows management to meet customer needs more efficiently. Whether it is delivery, service or other multi-vehicle enterprises, drivers now only need a mobile phone with telephony or Internet connection to be inexpensively tracked by and dispatched efficiently.

Stolen Vehicle Recovery: Both consumer and commercial vehicles can be outfitted with RF or GPS units to allow police to do tracking and recovery. In the case of LoJack, the police can activate the tracking unit in the vehicle directly and follow tracking signals.

Field Sales: Mobile sales professionals can access real-time locations. For example, in unfamiliar areas, they can locate themselves as well as customers and prospects, get driving directions and add nearby last-minute appointments to itineraries. Benefits include increased productivity, reduced driving time and increased time spent with customers and prospects.

VII. CONCLUSION

The proposal of the paper is to give an overview of vehicle tracking and vehicle accident detection system. This Vehicle accident detection system can track geographical information automatically and sends an alert SMS regarding accident. Experimental work has been carried out carefully. The result shows that higher sensitivity and accuracy. This system is verified to be highly beneficial for the automotive industry.

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