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# Intelligent Accident Management System using IoT and Cloud Computing

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**Abstract— Sensing and computing wrapped ubiquitously by enabling Wireless Sensor Network have recently penetrated across various modern areas of living. As the sensors are becoming more and more cheap and with the implementation of IPv4, the vision of Internet of Things have come out to reach the unexpected bounds of today's computing world. In this paper, we have implemented the concept of IoT, so that we can leverage the nearby sensors to help the vehicles which have collided or are in need of any help. In case of accident, there will be some collision in the vehicle which will be sensed by the sensors. The crash sensors will measure and report the intensity of collision based on certain parameters and operations related to the automotive design of the vehicle. This strength of collision mapped on a scale will then inform the respective nearby sensors in IoT which can come out to help the victims. In case of lighter collision, only the local car repairs and other nearby sensors forming an IoT network will be informed. In case of high intensity collision, the data relating to location of car and other things will be sent to cloud which will then inform the nearby car repairing showroom, hospital services and the repairing services.**

***Keywords***: *Cloud Computing; Internet of Things (IoT); Sensors; Wireless Sensor Network*

## I. INTRODUCTION

The advent of technologies like Cloud computing, Internet of Things, Ubiquitous computing, Autonomous computing etc. have turned a number of unimaginable concepts and theories into reality. Earlier a major setback in the realization of any concept or a theory was the lack of availability of computing resources but now, with the introduction of these new technologies we are able to introduce our concepts to the future world in no time. Nowadays, traffic has increased by a major proportion on the roads. As the vehicles are becoming cheaper day by day, their number is increasing exponentially as mapped against the fixed number of roads. Now this has resulted in higher probability of accidents on the road costing many lives, for which the necessary measures should be taken. Presently the vehicles are coming with a built in accident tracking system which can detect accidents and can also trigger the emergency help actions. Adoption of such systems is greatly discouraged and is therefore not very popular among the public. Major disadvantages of such systems comprises of factors like non-portability, high cost, limited options, false delivery etc. Other systems like some of the Intelligent Traffic Systems (ITS) leverage the capabilities of smart phones in various forms as a central source to detect accidents. These systems face a great deal of shortcomings due to lack of resources. Firstly, in case of major accidents the phone can itself get destroyed and hence, no emergency action will be taken. Secondly, there can be cases where smart phones cannot detect any accident at all (even if there is a major one). Thirdly, mishaps like free fall of the smart phone can trigger false emergency request. Another Intelligent Traffic Systems proposed to amalgamate the GPS with the mobile phone where GPS is responsible to trigger the emergency action. In such system, the corresponding server is informed about the accident whenever any accident takes place. This results in a higher amount of load on the server which can thereby increase the time of response to the causalities of a major accident because of the loss faced by the smaller accidents. This trade-off is very costly when applied to a real world scenario.

To overcome these major bottlenecks faced by any Intelligent Traffic or Accident handling System, we have proposed a solution which leverages the power of nearby sensors to trigger help whenever an accident takes place. With the introduction of IPv6, unique IPs can be allocated to each and every sensor which can happen to be present in the nearby location. These sensors when interact with one another result in the formation of Internet of Things. Internet of Things is basically a group of entities which can interact with each other and can generate result without entirely depending on the availability of internet. The entities involved in IoT here are sensors which can easily exchange small amount of information. Whenever any accident will take place, the vehicle sensors will detect it and inform the nearby sensors about the accident. All of these sensors come under the shelter of IoT itself.

Whenever an accident happens, we map its severity on a scale and on the basis of that scale we judge the severity of the accident. If the accident is not severe, then only the nearby sensors are informed about the accident so as to gather help. If the scale corresponds to a value of major or severe accident, we inform the cloud server about the accident which triggers emergency response. With an increased number of accidents and other intelligent traffic management systems, the load on cloud server pertaining to a place increases significantly giving rise to large computation and large amount of data (Big Data).

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By using our concept, we can reduce the load on the cloud server and other computational entities by at least 30% as the minor cases will not be reported to the cloud server thereby decreasing load on it.

The rest of the paper is categorized as follows: The related work in this field is specified in Section2. In Section 3, state of the art technologies are briefed out. Section 4 elucidates the need of integration of IoT and Cloud Computing so as to take out the best from them along with their integrated solutions. We explain our proposed model and architecture and its working in detail in Section 5 and 6. Section 7 outlines the related future research directions in this field. Section 8 summarizes and also concludes the paper.

## II. RELATED WORK

There has been a lot of research over the various intelligent accident detection schemes like in [8] where the author have proposed the accelerometer of a smart phone to detect the accident. But, very less has been done like proposing a new scheme of designing an intelligent Accident Detection System using both the IOT and the cloud computing, making the detection not only smarter but efficient and lifesaving.

Today the modern communication technologies are embedded into vehicles like Sonica et. al in [7] has proposed the shortest path for the ambulance by governing the traffic signals of that locality using the GPS and the GSM modem. By the new system introduced, an RF technology reduces the time lag by prioritizing the ambulance service, following thee queuing methodologies through the server interaction.

Similar wise, Luigi Atzori et al in [9] has shown various communication technology and electronics with enabled IoT, is used to identify and track the sensors deployed in the wireless sensors network. They have used the M2M technology, where the decision is taken without any human intervention.

Also Sujitha et al in [10] has proposed an automatic notification using the transport protocol of ZigBee IEEE 802.15.4 standard using the M2M client and M2M server which enables the rescue resources to reach the injured and needy as soon as possible by forwarding the data into cloud resources and other M2M client Vehicle.

## III. STATE OF THE ART

Internet of things: With the electrification of the world around us, the IOT is a much profound term for the advancement where the billions of smart, connected technology would be making our life much easier, smarter and safer by "commanding and controlling" things. The creativity of this much hyped term is limitless with an astonishing potency to improve and make our life safer. The things in the IOT could be a variety of million things. The digital and the physical world would portmanteau, by providing things with unique identities and corresponding personalities, by catering permeate detection and propulsion characteristics.

Cloud Computing: Recently Cloud Computing has successfully emerged as a giant for serving and entertaining IT services over the internet. The approach is appealing, for it saves the requisite of users to plan ahead for provisioning, and pave path for the start up to increase their resources only on demand, saving the idle Capital expenditure. Today, the IT has been revolutionized as how the computing is abstracted and utilized by the third party consumer, but there do exist challenges in adopting it but with the obstacles come the opportunities, and with opportunities we could devise advancement to it.

Wireless Sensors Network: A Wireless Sensor and Actor Network (WSAN) uniquely distribute the self-governing sensors processed and analyzed according to our need and requirements, abridging the gap between the virtual and the real world approach collaboration. WSN is built upon nodes which could scale from hundred to thousand, primarily existing with gateways and software incorporating with the existing wired measurement and control system finding its application in military surveillance, weather monitoring and in our proposal intelligent accident control system.

Sensors: Sensors are the hardware components that are designed to sense and respond to the activity they are programmed with to deliver the result to an entity which could be programmed software or a defense mechanism to analyze and acts according to the data sent by it. Sensors are capable of handling small computations, can also store small amount of data and have a short battery life.

## IV. INTEGRATION OF CLOUD COMPUTING AND INTERNET OF THINGS

According to estimation, around 50 billion devices will be interconnected over networks by the year 2020. All of these devices adapt to take the form of IoT in one way or the other. Sensors are small entities which have very less storage, low computational and communication capabilities. They are used in IoT as things which can collect data by interacting with the neighboring dynamic environments. Around 2.5 quintillion bytes of data is generated everyday by the interconnected things and all of this data is either in unstructured form or in semi structured form. The computational entities involved in IoT are so small that they are incapable of handling this data. Here comes the use of cloud computing which provides a most breakthrough approach to handle this ever generating data. Cloud provides standard Application Programming Interfaces which handle data in a homogeneous approach and result can be thereby sent again to things in IoT.

IoT and Cloud Computing both have evolved as technologies and they continue to evolve by cooperating with each another hand in hand. The technological limitations of IoT can be serviced by leveraging the unlimited, scalable, pay per use resources of cloud. Thus cloud provides a way to provide better service management and implementation of advantages of data collected or sensed by IoT. Whereas, on the counterpart, IoT provides a way to cloud so that it can interact with the real world scenarios. Without the data sensed by IoT, cloud would have been unable to develop and deploy new services based on dynamic and distributed real life scenarios. Cloud provides and encapsulated way to handling data to IoT where data is sent to cloud which is received by simple interaction with API and is sent back after processing in a similar way. There are issues related to the IoT which are solved by cloud and are discussed as:

*Storage resources*: Iot is formed by a collection of things which generate large amounts of data (semi-structured and non-structured) whose processing is very difficult in real life scenarios. This large amount of data is nowadays known as Big Data which is something traditional data centres are incapable of processing, sharing, analysing, storing, searching, handling etc. The most viable solution to carry out the above operations on Big Data is given by Cloud Computing. As the sensors and things are themselves small computational entities, they are limited to very low or no computations at all. Cloud computing allows us handle Big Data on the unlimited virtual instances which have very high storage capacity. This gives birth to new directions where we can easily aggregate, integrate and share data with other parties.

*Computational resources*: Things in IoT are bound by their limited computational capabilities which prohibit the on location processing of data. The data is collected and is sent to other nearby nodes for processing and the corresponding result is received. When we leverage other stationary infrastructure to process the data then, scalability turns out to be a challenging task. This problem can be handled by leveraging cloud for data processing as cloud provides unlimited, on demand, scalable, real time, collaborative and ubiquitous infrastructure which can easily handle complex as well as easy computations.

*Communication resources*: With the introduction of IPv6, it is possible to generate IP addresses for virtually everything i.e things. IoT is responsible for providing communication between these things (which have their own IPs) over dedicated hardware which can turn out to be very costly. Cloud solves this problem by providing easy to go APIs and built-in apps which can easily collect, track and connect these things to one another.

## V. MODEL

The model presented here is adaptable and thus it can be deployed anywhere. For instance, for a specific location i.e on a road there are numerous vehicles traversing the road on different speeds going towards different destinations taking different routes. There is a high probability of accident between vehicles and the rigorousness of resulting loss can vary. Any accident is detected or accompanied by some kind of collision. By measuring the intensity of these collisions, we can detect how harsh the accident is. For example, if a smaller collision is detected we can easily judge that the vehicle has experienced just a small dent or puncture. Whereas on the other hand, if the collision detected is of larger momentum then we can judge that a large amount of loss is incurred in terms of human lives as well as in terms of vehicle damage. Information about a major collision is thus sent to the cloud server which then becomes responsible for gathering help.

In our model, the collision and its intensity is measured and the corresponding value is generated let it be z. The value of z is mapped on a scale ranging from 1 to 4. If the value of z is less than 2, we need not to inform the cloud server about it. We can easily inform the nearby sensors about the event thereby leveraging the concept of IoT to gather help. If the value of z is greater than 2, then we can assume that a major loss has occurred and a higher level help is required. The cloud server is informed about the collision where the database of cloud server is searched for appropriate people and the requests are generated to other helping agents like ambulance, car agency, hospital etc. The entire working is depicted pictorially in the following figure as:

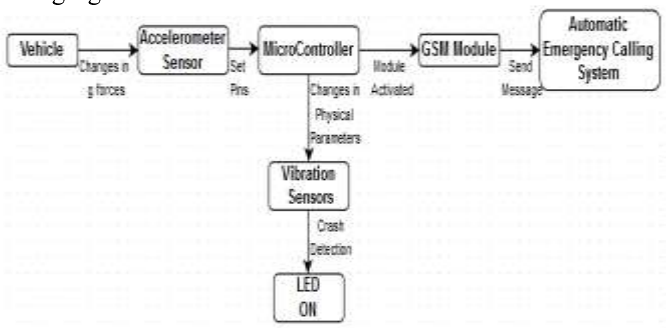


Figure 1: Flow chart triggering emergency calling system

## VI. ARCHITECTURE

The model presented here involves a collective integration of different types of sensors as well as microcontroller units which acknowledge emergency calling system. This technology includes the benefits of GSM modem used as automatic emergency calling system and GPS sensor for location calling. GSM modem requires a SIM card and works with a GSM wireless network. Accelerometer sensors and vibration sensors are collaborated. Accelerometer sensors measure proper acceleration and when at rest on the Earth's surface quantify an acceleration g=9.81 $m/s^2$ straight upwards. Vibration sensors measure various physical parameters like changes in acceleration, temperature by converting them to electrical signal. During an accident, the changes in g-forces (acceleration) in the vehicle are sensed by the accelerometer sensors. The flags are set on a microcontroller which is a single integrated circuit. It represents the data by setting the appropriate pin of LED. Turned ON LED implies crash detection by vibration sensors. Therefore the microcontroller instructs the GSM modem and a message is sent to a predefined telephone number by the GSM modem.

The estimate of g-forces measured by the accelerometer sensors can be used as a reference to be rated on a scale in order to provide an idea about the depth of the accident. For this purpose, the sensitivity of the accelerometers must be very high and must measure low level accelerations precisely from d.c. up to 50Hz (or above). Also, they must be installed with a high positional accuracy. Hence the accelerometer sensor module works as an important factor in detection of vehicle accident.

This technique employs the use of Accelerometer based Transportation System, commonly referred to as ATS. As the effective sensitive value is set for the accelerometer sensor for crash detection, the signal is received by the microcontroller as soon as the accident takes place. Further, the display is provided in LCD interfaced with the microcontroller and LED indicates the occurrence of an accident. The GSM module is activated at once by the microcontroller, which has a saved number of a nearby emergency calling location. The location is selected based on a scale defining the amount of loss incurred during the accident. The depth of accident occurred at a place can be illustrated on a scale which varies from safe level to critical level. The LCD display occurs only during the moderate and critical range of accident.

TABLE I. ACCIDENT DETECTION FOR VARYING VALUES OF G-FORCES

| **Accident severity** | **Value of z** | **Approximate value of G range** |
|---|---|---|
| Safe level | 1 | 0-4 g |
| Slight level | 2 | 4-20 g |
| Moderate level | 3 | 20-40 g |
| Critical level | 4 | 40+ g |

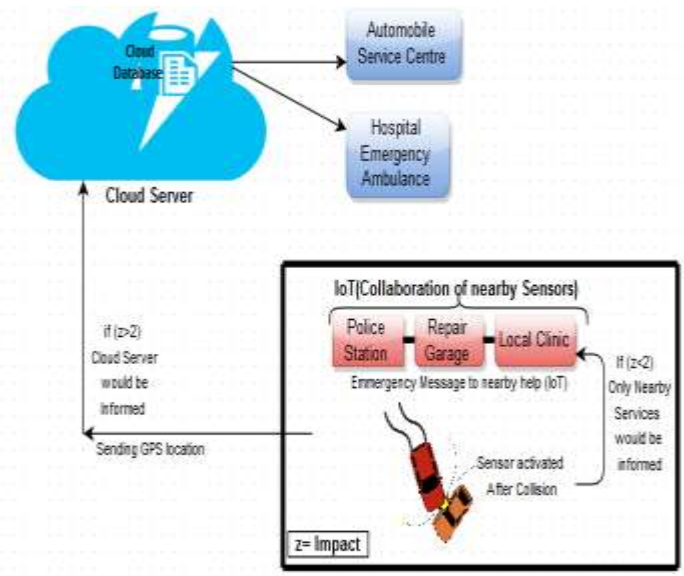


Figure 2: Diagrammatic representation of the working of the system.

## VII. CONCLUSION

In this paper, we have inherently proposed an intelligent accident detection and safety scheme from the integration of the hyped technology available today, i.e. IoT, Cloud and the Wireless Sensor Network. Given that, the idea could be taken into study using just the GSM modem and required sensors but our aim was to globally inter-connect with the IoT and the cloud because with the use of cloud computing, the higher impact i.e. the emergency situation could be monitored by the cloud server, saving the precious lives.

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