Application of UICT for the Proactive Management of Emergency Situation and Transport safety

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Abstract—Fast growing technology adds many feature-oriented applications to the society to make the city smarter. Autonomous vehicles are one among them. Traffic, proactive management of emergency situations are some of the challenges we are facing now. In this paper we are taking the advantage of autonomous vehicle for handling an emergency situation in a smarter way. Also investigate the behavior for non-autonomous vehicles on a road network for Real-time Accident Spotting (RAS), Faulty Object Detection (FOD), Proactive Management of Emergency case (PME)and Disposed Object Discovering (DOD) using a Unique Identification Chip Tracker (UICT) with multiple features. Experiments conducted on raw data achieve very promising results outperforms other existing methodologies.

Keywords— RAS-Real Time Accident Spotting, DOD-Disposed Object Discovering, FOD-Faulty Object Detection, UICT-Unique Identification Chip with Tracker.

I INTRODUCTION

Recent technology advancements and living standards have a greater impact on increasing the number of ground vehicles. In particular, researches have explored a proportionality with the number of accidents occur. Root cause of accidents is a crucial part of investigation. Detecting the faulty object using the current law and order might not be accurate at every instance. Social norms insist on keeping minimal distance between two vehicles moving on a single track/lane to avoid collision, in particular for one-way road network. However, sudden behavioral change [1] of object moving ahead creates ill effect on the one behind. Since object behavior inherently vary from person to person, generalizing the method remains difficult. Technologies have come up with GPS tracking devices with surplus features [2][3] to spot the ground vehicles. GPS tracker alone cannot be used to estimate distance between two vehicles as the GPS satellite accuracy is not precise [4]. By measuring the difference between multiple cellular network strength, we can triangulate the current location of an object [5].

Another common practice of the people with illegitimate background are disposing the used/rented vehicles after malpractices or when a financial crisis occurs, which may result in machinery wastes and environmental pollution. Since the tracking devices do not capture the history of vehicle movements, it sometimes leads to incorrect information. More importantly, proactive management of emergency situation such as fire, accident etc. are typically an extension of accident spotting and recovery. An inadequate delay in handling emergency situation may result in loss of life. Introduction of autonomous vehicles [8] [13] have a major role in minimizing the amount of manpower [8]. The driverless vehicles [] services create a smarter city with minimal manpower and maximum throughput [13]. Most self-driving vehicles build their perception on high precision GPS and expensive radars [2]. A novel 3D object bounding proposal method exploits contextual and stereo imaginary information to the domain of autonomous driving [6]. Autonomous vehicles and intelligent driver assistance are intended to enhance safety on road network[8]. Combination of autonomous vehicles features with tracking mechanism exploit high end results. A user level mobile application feature aims to provide live tracking of the owned vehicles.

In short, the accident spotting and emergency situation management are two major growing concerns. To overcome these challenges, a new method is proposed. The existing method identifies the movement patterns vehicles in user level based on GPS data, in particular for the private vehicles as per the request [10]. The proposed method consists of a Unique Identification Chip along with GPS Tracker (UICT) and a sensor which works on both cellular and GPS data. UICT aims to have a central control on all grounded vehicles which can transmit the data to the central transport management unit. The behavioral change in movement pattern alerts the central system on classification and decision making. In general, the proposed method provides, simple yet effective method for live tracking of vehicle movements to discriminate the behavioral changes leading in critical circumstances, to

detect the root cause, and to manage emergency situation; along with user level application. The main contributions and merits of this paper are summarized below:

- Real time accident spotting (RAS)-UICT recognizes the accident location and alerts concerned authority
- Faulty Object Detection (FOD) –Identifies root cause of the collision.
- Proactive management of emergency Situation-Provides services on time to save life and assets.
- Disposed Object Detection (DOD)-Removes the machinery and electronic wastes contributing to environmental protection.
- Live tracking mobile application –User friendly application to support live monitoring of their assets.
- Autonomous Emergency Vehicle Management-Proactive management of emergency situation using self-driving vehicles.

  Rest of the paper is organized as follows: Section 2 discusses related works in related domains, while section 3 defines problem and methodology. Section 4 discusses experimental results. Section 5 concludes the paper.

II RELATED WORKS

GPS tracking is one of the most widely explored method which works on ephemeris data [4]. Researches has proved that, GPS has been exposed to cyber security attacks such as GPS spoofing [12] [13]. Recent revolutions in tracking methodology are based on cellular data [F]. LiDAR data processing extracts accurate micro level trajectories of ground vehicles. The LiDAR identifies nearest traffic congestion and data can be broadcasted and received through the DSRC network [I]. Quantitative study shows that LiDAR can provide an accuracy of 82% on real time data set [10]. A significant work has done on GPS and GSM based data capturing which can transmit minute to minute update on location details to users as sms[9]. An antitheft tracking device designed to track two wheelers are based on GPS data [11]. Since real GPS signals are very weak in power, fake signal can be super imposed resulting in deviation of the real location [4][7]. Our main focus is to track the location, identify the cause, and manage the emergency situation, in particular for non-automated vehicles. However, the emerging technology is focusing on autonomous vehicle world [13]. Self-driving cars provides independent mobility for non-drivers including people with disabilities. Researches show that self-driving cars are more economic than human driven [14]. The proposed UICT method contains both GSM and GPS data capturing technique with a heat and light sensor. Another contribution of this paper is UICT mounted autonomous vehicle which can act proactively to manage emergency situation with minimal support resources.

III PROPOSED METHOD

This section discusses various problems and proposed UICT methodology.

1 Real Time Accident Spot detection:

The governing law and order insists up on keeping a minimal distance between two vehicles moving on same track and on parallel track, in particular for one-way road with multiple tracks. At some instance, the sudden change in movement pattern of object moving ahead leads to accident, which includes lane change without notification. In fig1, four trajectories are shown for a one-way road network. The objects are marked as **O1, O2.., Om, On, Op, Oq**. The allowed distance between two object is marked as **Dl**. considering the objects **Om** and **On**, each of them moving on different trajectory at time **t1**. At time t2, Om changed the lane p3 which results in an accident with **Om** at time t3, Fig 2,3. The distance maintained between objects on lane p3 reduced to **Ds**.

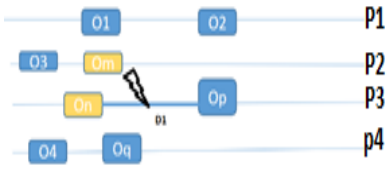

Fig.1 Vehicle movements

Fig.2 Movement violation

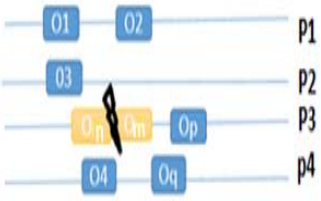

Fig.3 Accident Spot

On is considered as the Faulty Object. But sudden movement of **Om** without maintaining proper distance results in collision. As per the governing law, in particular for one-way track network, the vehicle running behind is identified as offender. UICT mounted on the vehicle quantitatively evaluate the movement pattern and compare distance between nearest neighbor vehicles. The zero or less equivalent distance factor alerts Road Transport Authority (RTA) with 'Accident alert' message. The movement pattern obtained recognizes the faulty object. RTA broadcasts an 'Accident ahead message' to the nearest neighbors (say 1km) allowing an alternate path selection.

2 Faulty Object Detection

The object trajectory pattern (location co-ordinates) identifies the behavior changes of both vehicles to determine the offender. Since the chip contains both GPS and cellular data, tracking is much easier.

3 Disposed Vehicle detection:

Grounded vehicles in particular rented or with liabilities were inclined by a second party when a financial crisis occurs or after derelictions. Since UICT combines the features of both cellular and GPS data, this is to be beneficial for accurate value determination. Inoperative

4 Live tracking user application

A user level smart application provides an interface for monitoring the vehicle functionalities which includes ON/OFF status, parking status, toll, driving history etc. This application allows user to customize as per the requirements.

5 Proactive management of emergency Situation

The proposed UICT method gears special characteristics on emergency vehicles such as ambulance and fire service. The method allows a specific privilege to broadcast an 'Emergency alert' to nearest vehicles to clear the path ahead to avoid traffic congestion. UICT on emergency services are designed with duplex data transmission method.

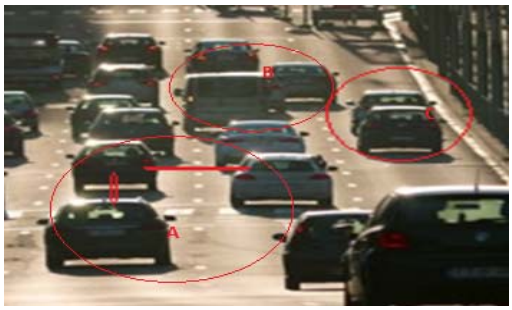

Fig. 5 Violation point A: minimal distance B, C: Accident spot

Fig.6 Disposed vehicles

A. Approach

The proposed Unique Identification Chip with GPS tracker architecture is illustrated in Fig 7. In order to provide the user level application; UICT stores location, ownership details, toll (salik) and, driving history on short term basis. The underlying sensor brings up supervised learning on different attributes such as ON/OFF status, parking status etc. In order to broadcast the 'Accident Ahead' message to nearest vehicles, cellular data transmission method is used, allowing the neighbors (say 1km) to choose unclogged trajectory.

The nearest neighbor violations and accident spot are illustrated in Fig 5(marked A, B, and C respectively). The location coordinates tracked by GPS tracker predict the object behavior pattern which has led to the collision. The violations tracked can be used to charge penalty on vehicle users. The broadcasting facility in emergency vehicles has addressed by specific messages, which include the moving direction. E.g. 'Clear path from X to Y'. The existing method identifies the emergency situation based on emergency vehicle parameters (sound and light signal), which may cause delay in service. A very small difference in managing the situation can save a life or an asset. Since UICT is embedded with both GSM and GPS features, disposed vehicle detection is much easier and effective. Tracing the location on remote areas may not be an easier task when the device is in outside coverage area. The driving history further classifies the ground vehicles as active and in-operative vehicles

(long term-say more than 1year). Identification and removal of in-operative vehicle category favors environmental protection by dropping machinery wastes. The user friendly application enforces the proposed method to preserve the authenticity and integrity of vehicle ownership, by providing a total monitoring facility.

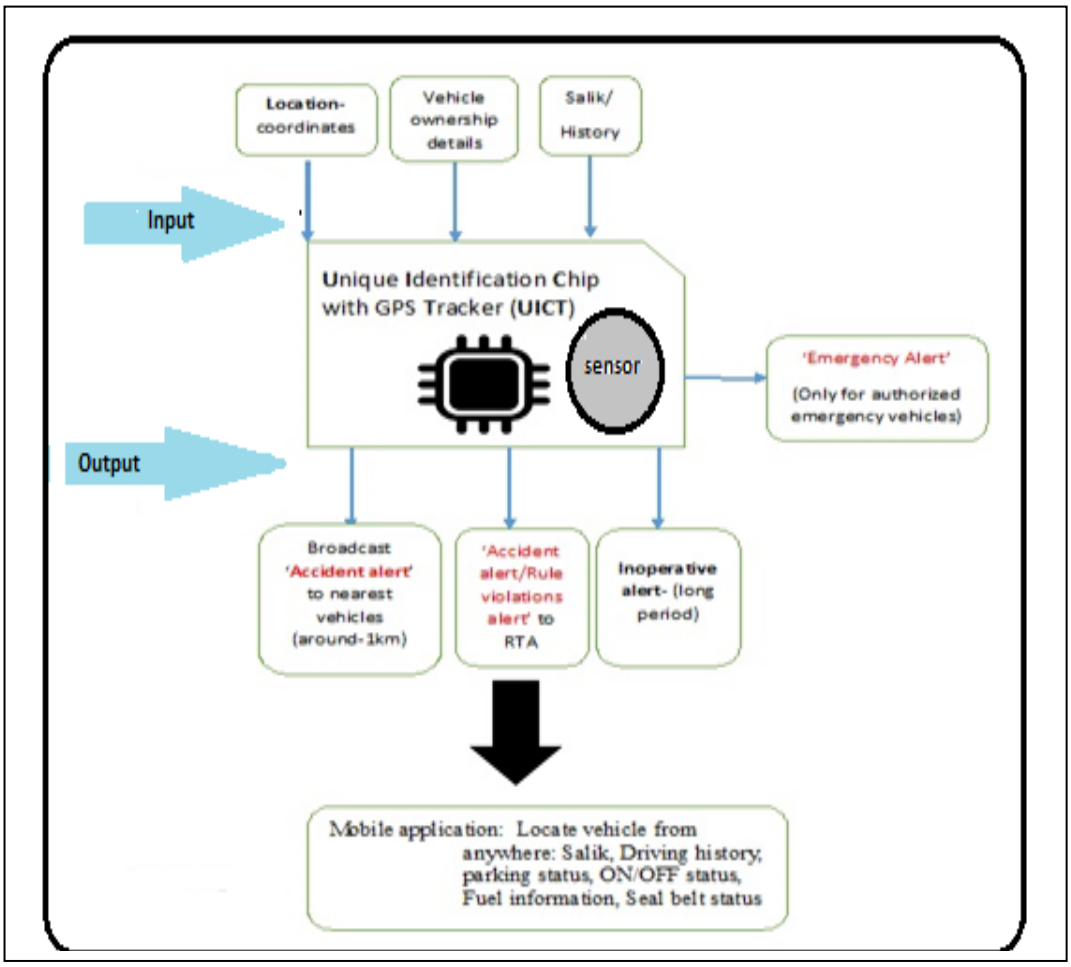

Fig 7. Architecture of proposed scheme-UICT

B. Autonomous Emergency Vehicle Management

Emerging smart system technologies make use of autonomous vehicles to reduce man power. Combining the application of UICT with self-driving technology together provides a proactive emergency situation management system. The components are:

1. UICT mounted emergency vehicles such as ambulance/police force/Fire engine etc.
2. An autonomous management system unit in organization such as hospital/Fire rescue service station/Police station etc.
3. Autonomous management system unit in emergency vehicles.

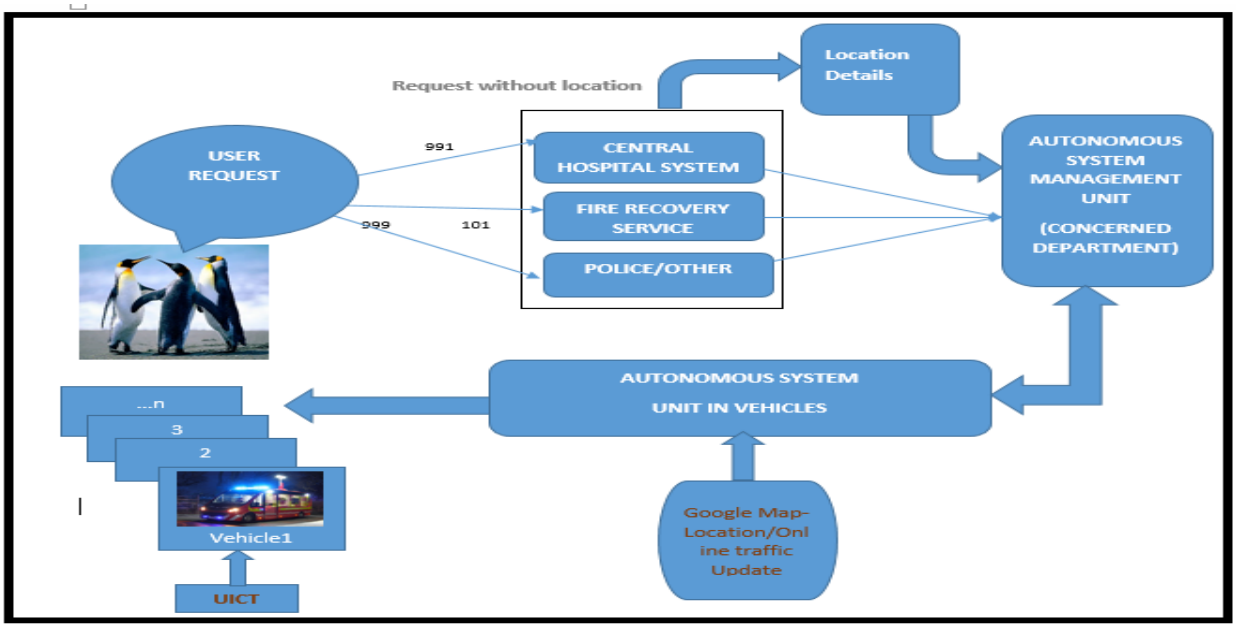

Fig 8. Autonomous Vehicle Management Scheme

User request has processed and transferred to autonomous management system unit of concerned department which can initiate the self-driving service.

The working strategy is described below:

1. User places a request/call to the concerned authority such as hospital/Fire service/Police. The request may be with or without location.
2. The autonomous system unit in concerned department assigns the request to specific grounded emergency vehicles. This application is capable of providing better services even when there is a lack in number of skilled resources.
3. The autonomous management system unit is trained to choose shortest and uncongested path to reach in minimum amount of time.
4. The features of UICT alerts concerned authorities to take necessary steps.
5. If user provides information with location, autonomous management system automatically assigns the location coordinates to the vehicles.

a) Advantages

1. Implementation of UICT results in proactive management of emergency situation.
2. Chances of accidents, malpractices can be reduced to an extent.
3. Disposed vehicle detection helps in reducing the electronic/machinery waste, adding up to the environmental protection.
4. Smart mobile application associated with UICT allows the driver/Owner to monitor the vehicles.
5. The stored information on UICT exploits in finding the driving history in particular, for school buses, organizational vehicles, rented vehicles, and public transports.
6. Autonomous vehicles with UICT minimize the man power.

b) Disadvantages

1. Implementation of GPS devices may affect privacy. But when we consider, only in emergency situation history/vehicle tracked and otherwise only owner is authorized to see details, will be more convenient.
2. The driverless vehicles are useful to an extent. Even though, technology can't beat human capability
3. Broadcasting mechanism requires centralized connectivity.

IV RESULTS AND DISCUSSION

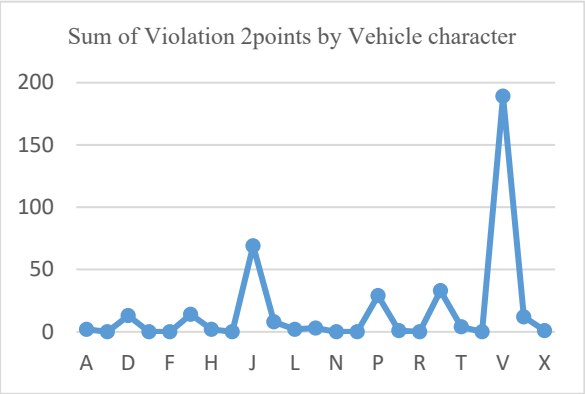

Fig. 9 Accident violation plot

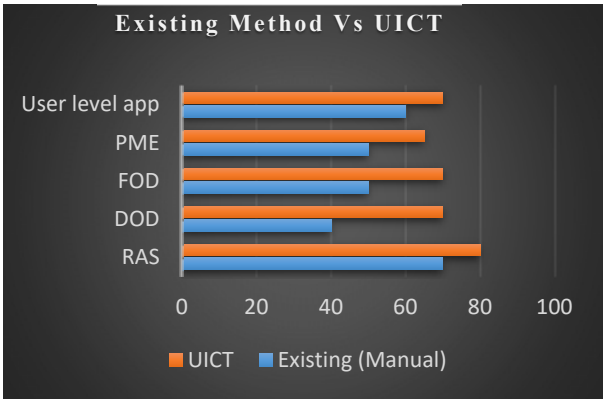

Fig. 10 Comparison: Existing Vs UICT

In this section, the experiments and working results of UICT are described. For conducting the experiments, CDI-Vehicle data is used. Experiments are conducted using the data set size greater than 10,000 on Intel(R) core™-i5-2400, 3.10GHz PC with 4GBytes of memory, running on windows7 operating system. The UICT method requires a list of attributes-minimal distance between nearest neighbor vehicles, toll value assigned, and vehicles details. Here we assume that the minimal distance between nearest neighbors has been chosen as 1m.The vehicle character code (plate number) has chosen as alphabets (A-Z).UICT device The violation points which may lead to accidents are categorized as 1 point and 2points.The driving history includes ownership details, year licensed, annual mileage, percentage used, types of vehicle (private or public).We have used a dataset having 10,000 vehicle data and compared different methodologies based on the time required to provide the services, in particular for accident detection and emergency situation management. The efficiency comparisons are shown in Fig 10.

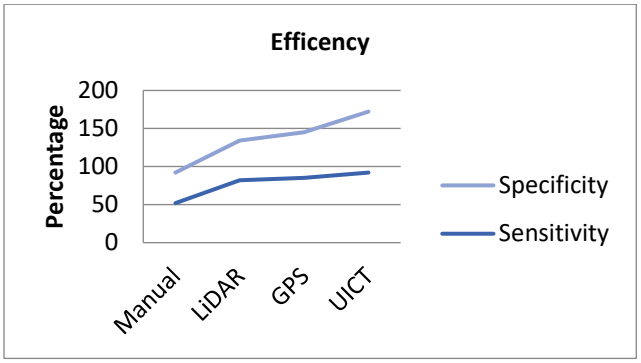

Fig. 11 Efficiency comparison

The comparison is plotted in fig u. The efficiency analysis of UICT identifies a proportionality with time for service in action (Ts), shown in Equation (1).

$$\text{Efficiency} \ \alpha \ \text{Ts} \tag{1}$$

Table1 shows the comparison of autonomous and non-autonomous vehicles with and without UICT based on different attributes, and quantitative analysis.

Class	Autonomous(self-driving) vehicles		Non- Autonomous vehicles	
	Normal	**UICT**	**Normal**	**UICT**
Price	Low	Low	High	High
Technology	High	High	Low	Low
Man power usage	Low	Low	High	High
Threat/attack	High	Low	Low	Low

TABLE I. AUTONOMOUS VS NON-AUTONOMOUS

V CONCLUSIONS

The proposed method aims to provide a smarter city with minimum manpower and with maximum technology advancements. Use of UICT can secure the life of an individual, and thus to the nation. We have shown the working strategy of UICT on both autonomous and non-autonomous vehicle system, in particular for emergency situation management. In order to track all grounded vehicles, UICT implementation should include in law and order. Since privacy issues matters, implementation may be a primary concern of the users. Extorting the user details on case to case basis, could overcome this challenge. Another factor is climate condition, which may affect the coordinates. The main advantages of proposed method are redundant feature that ensure the tracking function. As a future work, we propose to develop a revised scheme for all self-driving vehicles with more supporting applications.

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