

Vehicle Speed Monitoring System [VSM] (Using RuBee Protocol)

G. Kirankumar, J. Samsuresh, and G. Balaji, *Member, ACET*.

Abstract—A smart vehicle speed monitoring system is proposed, using RuBee. Considering the road safety a new technique is described to identify the speeding vehicle and charge them fine for breaking the rules. This approach involves fixing a device called RuBee in all the vehicles (like the license plate) and by installing two receivers at a specific distance (say 100 meter). RuBee is a wireless protocol which can send some unique data to the receiver. The Receivers receive and store the License plate details along with TIME and time difference between the receivers and it is used to calculate the speed. Speed is determined by using Distance - Time - Rate formula with the help of processing unit. An excess speed calculation algorithm is used to find the speeding vehicle. If the vehicle over speeding is found from the calculation the speeding penalty will be charged by filing a case against the owner of the vehicle.

Index Terms—RuBee, VSM, speed monitoring

I. INTRODUCTION

Excessive speed in driving light, heavy vehicles has been a social and governmental issue around the world for many years, primarily from the perspective of road safety. With increased engine power, attainable speeds for trucks, cars, bikes are currently much higher than the speed limits on highways and secondary roads like school zone, hospital zone, etc in many countries. Excessive speed in trucks, cars, bikes have numerous consequences, including:

- Higher rates of accidents involving serious injuries
- Increased operating and maintenance costs for the transport industry
- Increased costs for insurance companies

The concept is even more significant in developing countries like India, as the on road vehicle population is increasing more than ever. This not only leads to increase in traffic congestion but also acts as a propellant in increasing the number of road accidents which is at its peak according to a recent WHO survey [1].

II. STATISTICS

In the development of a safer highway driving environment, unsafe speeds have been found to be a cause of approximately one-third or more of all accidents. The road accidents are also touching all time high rates. In a dubious distinction for the country, World Health Organization

(WHO) has revealed in its first ever global status report on road safety [1] that more people die in road accidents in India than anywhere else in the world, including the most populous China. WHO, in its report, states that road fatalities will become the biggest killer by 2030. The statistics for India are chilling. At least 13 people die every hour to road accidents in the country. Technology can play a very significant role in bringing the chaos under control.

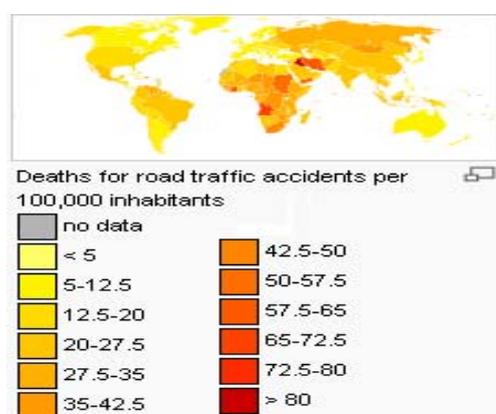


Fig. 1. Statistics of road accidents

III. RELATED WORKS

There have been a lot of approaches for vehicle speed monitoring. A few technologies that have been used in earlier attempts for enforcement of speed limits are Camera based VSM system [5], RADAR or LIDAR based VSM system, and lot more approaches like Electronic speed Regulator , GPS, GSM, etc. However, these approaches lead to a high installation and maintenance cost. Camera and ultrasonic sensors which are fitted underground are less intrusive and easier to install. But these systems are also very costly and maintenance is complex. Their accuracy depends on environment condition. Also one traditional approach involves police officers observing traffic speeds and then chasing, stopping, and citing drivers observed speeding. Camera based VSM system comprises of camera for capturing images of vehicle registration marks (*License Plate*) of passing vehicle. Cam Technology fails in case like Image capturing, Image processing and Environmental factors (weather, fog, mist, snow, etc). Also RADAR Technology need skilled man to focus the Radar rays either electromagnetic waves or laser lights on the vehicle and it is not autonomous and also it is suitable for highways only. This failure has been overcome using low cost high tech simple gadget RuBee that are environmentally robust and has very high life-time and low maintenance costs.

RuBee technology focuses more on practical deployment

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Authors are with the field of Electronics and Communication Engineering from Angel College of Engineering and Technology, Tirupur (e-mail: kirankumartup@yahoo.in).

of the system in Indian Conditions. A new, simple and inexpensive intelligent vehicle highway system speed monitoring concept that can be easily adapted to existing vehicles and roadways is presented. The concept relies on the speed-distance-time relationship and constant timer to calculate the travel time. The pre-calculated travel time or speed can then be compared with the current vehicle speed or with a constant time to warn the driver of hazardous approaching events (excessive speeds, railroad crossings, or school zones). It can also be used to issue tickets to the vehicle registration if warnings remain unheeded. Current estimates indicate that the use of the speed monitoring device may save approximately 10,000 lives and 500,000 injury accidents per year [1].

IV. VEHICLE SPEED MONITORING

A. About RuBee

RuBee IEEE 1902.1 is a two-way, active wireless protocol that uses Long Wave (LW) magnetic signals to send and receive short data packets in a local regional network. The protocol is similar to the IEEE 802 protocols which are also known as Wi-Fi IEEE 802.11 Bluetooth IEEE 802.15.1, in that RuBee is networked by using on-demand, peer-to-peer, active radiating transceivers. RuBee is different in that it uses a low frequency of 131 KHz carrier. 131 KHz as an operating frequency provides RuBee with the advantages of ultra low power consumption battery life measured in years, and normal operation near steel and/or water. Because RuBee uses long wavelengths 131 kHz and works in the near field under 50 feet it is possible to simultaneously transmit and receive from many adjacent antennas, without interference providing the signals are synchronized. That makes it possible to enhance bandwidth and remove any angle sensitivity normally seen with other RF systems. Finally another advantage is safe to use in hazardous environments with no known human safety risks. RuBee, similar to Wi-Fi and Zigbee in that it is peer-to-peer, is a networked transceiver that actually transmits a data signal on demand. The main difference between RuBee and Wi-Fi or Zigbee is that RuBee works in the long wavelength band using the magnetic field, whereas typically Wi-Fi and Zigbee works in the VHF, UHF bands and with the electric field [2][4].

B. RuBee Tag Details

A typical RuBee Radio Tag about 1 x 1 by 0.07 inches has a 4 bit CPU, 1 kB sRAM, crystal, and lithium battery with expected life of five to ten years. It could optionally have sensors, displays and buttons. RuBee is bi-directional, on-demand, and peer-to-peer. It can operate at other frequencies e.g. 450 kHz but 131 kHz is optimal. RuBee tags can have sensors (temperature, humidity, jog), optional displays and may have a full 4 bit microprocessor with static memory. The RuBee protocol uses an IP Address (Internet Protocol Address) unique identification of Tag which we need for our tracking of vehicle. A tag may hold data in its own memory (instead or in addition to having data stored on a server). Some tags have as much as 5 kB of memory. RuBee functions successfully in harsh environments, with networks of many thousands of tags, and has a range of 1 to 30 m (3 to

100 ft) depending on the antenna configuration. By 'harsh environment' we mean situations in which one or both ends of the communication are near steel or water. RuBee radio tags function in environments where other radio tags and RFID may have problems [6].



Fig. 2. RuBee tag

C. Transmitter

The RuBee Transmitter is burned with a unique License number to identify the owner of the vehicle.

It operates in two modes

- 1) Sleep Mode
- 2) Active Mode

D. Sleep Mode

Since the RuBee Transmitter is concentrated much on low power consumption and long life it is enabled with sleep mode. In this mode the transmitter consumes very less power and does not use any resource and does not transmit data. Since we attach this in vehicles which will be out of the receiver section in most of the time and it switches its state when it enters the receiver section.

E. Active mode

In this mode only the transmitter transmits the data which is the license plate detail of the vehicle which might be a unique number. This mode consumes less amount of power for transmission of data to the receiver. Data's are sending in 131 kHz frequency with 1200 baud as its baud rate

F. Receiver

Receiver section consists of an antenna which covers a small region its fetches the data from the RuBee tags fixed in the vehicles and sends it to central processing unit.

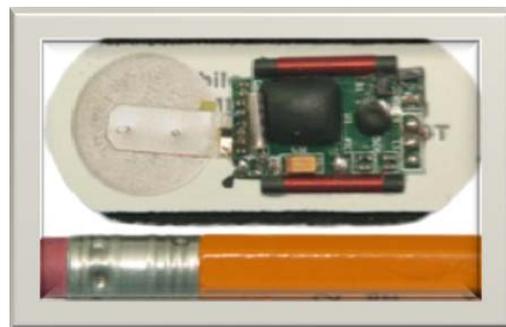


Fig. 3. RuBee internal view

The CPU can be programmed as per the requirements

- 1) It can be programmed to collect the number of vehicles crossing the border i.e. from one region to other it may

be state - state border crossing or country - country and so.

- 2) It can be programmed to store data for tracking the missing vehicles
- 3) And can be programmed for our discussion topic i.e. for speed calculation using comparison and speed - distance - time formula.

G. Rubee Protocol Working Law

IEEE 1902.1 RuBee uses magnetic waves also often called inductive communication. James Clerk Maxwell presented his now famous set of equations (Maxwell's Equations) to the Royal Society in 1864. These equations describe what happens when an electron travels along a conductive wire. Two fields are created, the Electric Field E, and the Magnetic Field H. These electric and magnetic fields travel through the outer space, at the speed of light with an assumed impedance of 377 Ω. E, the electric field, may be given in Newton per coulomb or volts per meter, and H, the magnetic field, may be given in gauss or amperes per meter. However, when these two fields are measured in what is called the near field (much less than the wavelength of the signal) very strange things happen. E and H are no longer connected in a simple predictable manner. Virtually all of the energy radiated by a RuBee base station or a RuBee radio tag is contained in the magnetic field (H), not the electric (E) field. This stems from the fact that the RuBee antennas are short relative to the wavelength (about a mile and half or 2½ km at 131 kHz), and RuBee operates in the near field. A typical emitted E from a RuBee base station is about 40-50 nano-watts, and H is about 900 milli-gauss. Finally, RuBee is a packet based protocol in which only one end of the communication at a time generates fields, that is, a RuBee tag is a radiating transceiver.

H. RUBEE Based VSM

In this technique RuBee tag must be fixed in all the vehicles like the license plate fixed in all the vehicles and install two receivers (A, B) at a specific distance say 100 meter. RuBee used to eliminate the problems caused by Cam based VSM. RuBee is a wireless protocol which is used to send specific data here License plate details. Receiver A and B are used to receive and store the License plate details along with TIME at which they are received and a comparison between receiver A & B is performed after that some electronic processing is done to find the speed using Distance - Time formula and a comparison is made with the pre-calculated Distance -Time relation. If the vehicle over speeding was found during the calculation and comparison the speeding penalty will be charged by filing a case against the victim. See block diagram for clear understanding when the vehicle with RuBee Tag enter the region of receiver A. The receiver A gets the data and store it along with time and similarly the receiver B also receive and store data with time when the vehicle enters its sniffing region. It temporarily store data for calculating speed in local processing unit. When the vehicle over speeding is found from the calculation then the vehicle license detail will be send to main office at District level for citing fine for over speeding. The GSM technology can be used to send the data to District office or RTO office.

V. DISTANCE - TIME FORMULA

To find Rate/ Speed,

$$\text{Rate/Speed} = \frac{\text{Distance}}{\text{Time}}$$

Rate is distance (given in units such as miles, kilometers, meters, etc.) divided by time (hours, minutes, and seconds). Rate can always be written as a fraction that has distance units in the numerator and time units in the denominator, e.g., 25 miles/1 hour [7].

VI. DISTANCE - TIME FORMULA ALGORITHM

The processing in this approach is done at two stages. Each vehicle crossing the sniffing region of the receivers will be received and stored temporarily in local processing unit. Local processing unit calculated the time difference only when the data received by receiver A matches with the data received by the receiver B. With the calculated time difference and pre stored constant distance vale the speed of the vehicle is calculated. And the speed calculated is compared with the speed limit range which is already stored in the local processing unit, if the speed is above the speed limit then the data received from the RuBee Tag is send to main server. Officials can file case against the victim for over speeding.

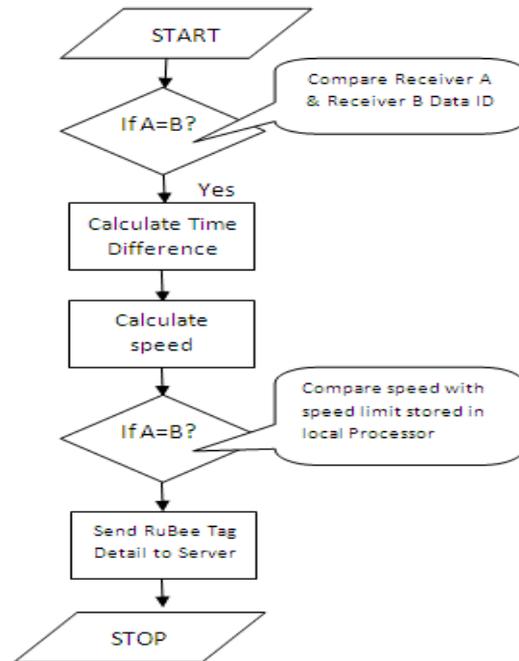


Chart 1.Flow Chart of Algorithm

VII. RUBEE ADVANTAGES

The use of LW magnetic energy brings about a number of advantages:

Long battery life – Because of the use of low frequencies and data rates the chips and detectors can run at low speed. Using micro-meter CMOS chip technology, this leads to extremely low power consumption. LW magnetic wave tag systems can and have achieved 15 year lives using low-cost lithium batteries.

Tag data travels with the asset – Because data is stored in the tag, IT (Information Technology) costs are reduced. This means that with a low-cost handheld reader one can simply read a RuBee tag and learn about the asset - manufacturing data, expiry date, lot number, etc. In addition, the distance between the reader and the asset is not critical. RuBee can also write (optional) to a tag at the same range as it can read it.

Cost effective - With RuBee, relatively simple base stations and routers can be employed, which means receivers and card readers can be reasonably priced as compared to higher frequency transceivers. In addition, the tags often include a single chip, a battery, a crystal and an antenna, and can be priced competitively with respect to active RFID tags (those including a battery).

Less noise - Because ambient noise in a region falls off as $1/r^3$, RuBee exhibits reduced susceptibility to extraneous noise. The major limit to antenna size is deep space noise. The RuBee has slow speed and small packet size. The RuBee protocol is limited to 1,200 baud in existing applications [6].

VIII. ADVANTAGE OF THIS APPROACH

- Cost is low for both implementing and maintaining it. Because of computerized record maintenance system can be implemented easily.
- Protocol is handy, small, and compact and can be easily installed in all vehicles space occupied is also very less.
- Protocol overcomes all the drawbacks of previous technologies like ultrasonic, Photo radar, Radar or Lidar.
- Long life of the system makes it more suitable for Indian conditions.
- It can receive data from n number of tags at the same time i.e. simultaneously.
- RuBee can work under any circumstance. Environment won't affect its operation.
- Duplication cannot be done. Cannot be hidden and cannot stop receiver from sniffing data when tag is in sniffing region. Also the system is fully automated.

IX. FUTURE WORKS

One this RuBee technique is implemented lot many future works can be done.

- 1) Can be used to track the location of vehicle.
- 2) Can maintain records of insurance validity of vehicle, owner details, etc.
- 3) Can be used to find the missing vehicle.
- 4) Lot more can be done with the advancement in receiver section.

X. CONCLUSION

For growing country like India, traffic congestion has to be maintained and accidents has to be reduced because of no existing system for monitoring the speed very many accidents took place to avoid this and save many lives a VSM

system must be implemented soon also this gives income to government in the form of fine for over speeding the vehicle which can be used for maintain good roads in the country.

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Mr. G. Kirankumar is pursuing bachelor degree in the field of Electronics and Communication Engineering from Angel College of Engineering and Technology, Tirupur.

His field of interest is Embedded System and Automation. He has presented various Papers in National Conferences. He is the Secretary of R&D lab in Angel college of Engineering and Technology and has done many projects in Robotics. Some of his projects have been awarded prizes in various

institutions.



Mr. J. Sam Suresh is working as an Assistant Professor in the Department of Electronics and Communication Engineering in Angel College of Engineering and Technology, Tirupur. He received his M. Tech degree in VLSI Design from SRM University, Chennai in the year of 2010. His research interest focuses on Nano scale Electronics, Networks on Chip, Design methodologies of integrated systems and Computer Networking. He has presented various Papers in International Conferences and published in journals.



Mr. G. Balaji is working as an Assistant Professor in the Department of Electronics and Communication Engineering in Angel College of Engineering and Technology, Tirupur. He received his M. Tech degree in Embedded Systems from Sastra University, Chennai in the year of 2009. His research interest focuses on Real time operating System, open Source in Embedded and Embedded internet. He has presented various Papers in National and International Conferences and published in journals.