Patent filed at Chennai, IPO - No. 3547/CHE/2010 on November 28, 2010

THE PATENTS ACT, 1970

COMPLETE SPECIFICATION

SECTION 10

TITLE

WIRELESS COMMUNICATION SYSTEM FOR AUTOMATIC OPERATION OF ROUTING GATES AT CROSS ROAD JUNCTIONS AND FOR PROVIDING ADVANCE ALERTS OF DISASTERS

INVENTORS

KALIYAPERUMAL GANESAN
TATAVARTI VENAKTA SREERAMA NARASIMHA RAO

APPLICANT

VIT UNIVERSITY
VELLORE 632014

INDIAN NATIONAL

THE FOLLOWING SPECIFICATION PARTICULARLY DESCRIBES AND ASCERTAINS THE NATURE OF THIS INVENTION AND THE MANNER IN WHICH IT IS TO BE PERFORMED.

WIRELESS COMMUNICATION SYSTEM FOR AUTOMATIC OPERATION OF ROUTING GATES AT CROSSROAD JUNCTIONS AND FOR PROVIDING ADVANCE ALERTS OF DISASTERS

ABSTRACT

The world over cross road junctions have become regions - where a number of accidents take place due to the negligence / ignorance of passengers in vehicles and pedestrians, where significant time delays are caused due to the inefficacies of the present practices, technologies and the persons involved. This in turn results in unnecessary accidents causing loss of money, decreased efficiency of systems and personnel in place and at times mortalities. The present invention involves a new system (method and apparatus) which facilitates automatic opening and closing of the route gates at cross road junctions in an optimal and efficient manner. The automated system functions efficiently and objectively and is economical to implement. The system can be designed for specific requirements at any location. Moreover, the system can also be used for providing advanced alerts of accidents and can be helpful for disaster mitigation and management.

DESCRIPTION

1. Field of Invention

The present invention relates to the field of sensors and devices, communications and embedded systems dealing with the automatic operations of gates.

2. Prior Art

In many parts of the world, the preferred mode of mass transportation is by trains. Particularly in big countries like India, railway is one of the biggest networks and it passes through many cities and villages. The rail networks passes through many cross roads of other modes of surface transport. Many of the cross roads have only sign boards for alerting the public at large. A number of accidents take place at these crossings either due to the negligence of road crossers or due to the ill-literate nature of people who could not read the sign boards.

Apart from this, there are many busy crossroads which are controlled by persons (for example, manned railway level crossings). Employing more and more persons at level crossings is a costly affair. In the present system, the arrival of train is informed to the gate keepers well in advance and hence they close the gates very early than what is intended. Moreover, due to the monotonous nature of the job, these men close or open the level crossing gates with non-optimal efficiency, which in turn brings in more frustration for commuters in vehicles as well as pedestrians who need to cross the level crossings.

In the past, a video detection apparatus for monitoring and actuating the railroad crossings (*Ref: US Patent number 5,825,412 dated Oct.20, 1998 by Gregory Hobson and John R. Wootton*) was developed. But these video based systems are effective only on clear sunny days. They may not work efficiently during the evenings, early mornings and nights due to poor visibility. Moreover, they may fail to work during rainy, foggy condition. Also the monitoring camera has to be positioned at a particular place and angle to watch the railroad crossings. Due to wind, gale and cyclone, these cameras can be titled or damaged thus making the systems useless / inefficient.

The impetus to the present invention is the pressing need for optimal efficiency of operations of the route gates, at cross road junctions for the benefit of pedestrians and commuting passengers in vehicles, as well as their safety.

3. Objects of the Invention

It is thus the primary object of the invention to automate the opening and closing of the route gates at crossroad junctions.

An object of this invention is to provide a safer system to provide audio and visual alerts to pedestrians as well as commuting passengers.

Another object of the present invention is to store all the location information of cross road junctions in specific routes.

Yet another object of the present invention is to find the current location of the system with respect to latitude and longitude, and the relative speed of travel of the vehicle in which the system is located.

An object of the present invention is to initiate actuation signals for closing the route gates ahead and nearest to the system in the route of travel of the vehicle in which the system is located.

Another object of the present invention is to initiate audio and visual alerts on the route gates ahead and nearest to the system which is being automatically closed.

Yet another object of the present invention is to initiate actuation signals for opening the route gates behind and nearest to the system in the route of travel of the vehicle, after the vehicle crosses the route gates at the crossroad junction.

An object of the present invention is to switch off audio and visual alerts on the route gates behind and nearest to the system which is being automatically opened.

4. Summary of Invention

The above mentioned objects are achieved through the development of the current invention (a system which would be located on the vehicle traveling on a designated route); that can close the route gates at crossroad junctions before the passage of a vehicle and open the route gates at cross road junctions, after passage of the vehicle. Audio and visual alerts would also be initiated during the closure of the route gates which would be switched off at the time of opening of the route gates after the passage of the vehicle.

5. Brief Description of the Drawings

Example embodiments of the present invention and their advantages are better understood by referring to the drawings, like numerals being used for like and corresponding parts of the various drawings.

Figure 1 shows the schematic of the proposed configuration for automatic routing gates for cross road junctions for the example of automatic gates at level crossing on a railway line. The schematic of the system configuration for automatic routing gates shows the antenna for wireless transceiver at the rear end of the moving vehicle **1**, the Global Positioning Sensor (GPS) receiver at the rear end of the moving vehicle **2**, the moving vehicle (*train in the illustration*)) **3**, the antenna for wireless transceiver at the front end of the moving vehicle **4**, the Global Positioning Sensor (GPS) receiver at the front end of the moving vehicle **5**, a transceiver for transmitting and receiving high powered wireless communications **6**, the route for the moving vehicle **7**, the route gates on either side of the route **8** and **9,** moving traffic at the cross road junction **10**, a high powered wireless transceiver **11** close to the cross road junction to ensure communication to the actuation mechanism in the gate for opening , a high powered wireless transceiver **12** sufficiently far from the cross road junction to ensure reception of signals from the fast moving vehicle and communication of the same to the actuation mechanism in the gate for closing, a series of low powered wireless transceivers optimally located to ensure communication between high powered transceivers and the actuation mechanisms on the gates **13**, and a wireless gateway for ensuring transmission / reception between the high powered and low powered transceivers **14**.

Figure 2 shows the schematic of the embedded units at different optimally separated locations (like at the front, rear and the middle) on the moving vehicle.

Figure 3 shows the flow chart highlighting the sequence of events for automatic operation (opening and closing) of routing gates at cross road junctions.

Figure 4 shows the schematic of sensors and the information flow from and to various subsystems of an embedded unit in the moving vehicle.

6. Detailed Description of the System

The embedded units (located at optimal locations at the front, rear and the middle of a moving vehicle (*for example, a train*) based on functional requirements, sense their current location and speed of travel, typical parameters based on standard sensors deployed as per functional requirements (*for example, a fire sensor*), and then searches for the nearest location of a critical junction (*for example, a railroad crossing*) which is ahead on its travel route, from a stored Geographical Information System (GIS) database. The system then determines whether the vehicle is going to approach the critical junction in the designated threshold of time interval (which is programmable based on the safety requirements, speed of travel of vehicle, requisite time for closing the route gates to pedestrians and traffic, *etc.*). Once the set time threshold is reached, the system sends an appropriate digital signal using relevant high power wireless communication transceiver systems (such as *WiFi*) located on the moving vehicle to another one located at designated location on the route. The high power wireless communication systems on the route of travel shall be positioned at optimal locations of an existing route of moving vehicles, taking into consideration the average speed of travel of vehicles (trains), the safety requirements stipulated, the reaction time to stop the traffic and pedestrians at cross roads *etc.*). These wireless communication systems serve as digital data transceivers. The information received by the high power communication transceiver from a moving vehicle is subsequently communicated through an appropriate wireless gateway on to an appropriate low power wireless communication systems (such as *ZigBee*) located along the route. As the proposed low power wireless communication systems are cheaper, and run on batteries typically for many months to years, the systems becomes very economical with minimal maintenance requirements. Whenever an approaching vehicle relays information about its arrival, the digital information is propagated through the network of high power and low power short range communication systems and the signals can traverse long distances until they reach the cross roads where gate actuation takes place. The transmitted signal actuates a gate and also activates an audio alarm and a visual alert at the critical junction of interest. This

therefore, can prevent injuries to people or other moving traffic at the crossings. The apparatus is unmanned and performs its monitoring operation in a non-invasive manner. That means its operation does not interfere with that of vehicles, pedestrians or barriers which are in place at the crossing.

The apparatus along the route should consist of a collection of high power short range wireless communication systems, few wireless gateways and many low power short range wireless communication systems. The high power short range wireless communication systems (*such as WiFi or Bluetooth*) are located at few strategic locations along the route. As these, high power short range wireless systems are capable of receiving signals from a high speed moving platform; they are used as collection centers from the moving platform. The signals to close the nearest railroad crossing gates are transmitted from the moving train, and are received by the trackside high power short range wireless system. These high power short range wireless systems consume more power and hence only a few of them may be located along the route.

Upon receiving the actuation signal the high power short range wireless system forwards the same to the next nearest low power short range wireless system (*such as ZigBee*) through a wireless gateway. The purpose of these wireless gateways is to forward the incoming message received from high power short range wireless systems to low power short range wireless systems. The job of low power short range wireless systems is to route the actuation signal to the railroad crossing guard system. As this low power short range wireless systems are not only cost effective but also require very less power. Most of the time, they live in dormant state. Only when an actuation signal comes to it, it wakes up and forwards or routes the data to the next node or end device. The amount of data that we transfer in the proposed invention is very small, and hence low power short range wireless systems are enough.

The proposed invention can provide audio and visual alerts to pedestrians as well as commuting passengers, and replaces the existing unmanned level crossings by automatic systems. In the present invention, we propose to use wireless systems which can work

independent of the direction and also as the wireless systems utilize mesh networks, the digital data can be routed even if one of the nodes fail. The apparatus not only actuates the gates to save the life of people, animal or vehicle crossing the railroads, but also provides assistance to passengers in the vehicle (train) from nearby villagers when they are in desperate need of medical or food help. The wireless systems can work in a 24×7 mode, for all 365 days in a year. Moreover, they are less affected by light, weather conditions such as rain, fog, gale, etc.

Some of the benefits of the proposed invention are that the accidents at level crossings can be significantly reduced as this automatic system's functioning will be objective compared to the existing methods where human subjectivity is involved. The additional investments associated with human resources at manned level crossings can be significantly reduced with the introduction of the proposed automatic method. The present invention uses freely available GPS technology, and a low cost short range communication system (*for example*, *ZigBee* network) and hence the implementation will be cost effective and economical. As the proposed system is autonomous, the amount of time wasted at level crossings by people/vehicles will be much less than that compared to the existing systems and practices which are highly subjective to the efficacy of the persons employed.

7. Working Example 1

This invention relates to railroad safety systems, and more particularly an automatic level crossing gate closure / open system. The apparatus sends an electronic signal and closes the railroad crossing gate in advance so that vehicles, persons or animals are prevented from crossing the railroad while the moving locomotive (train) is about to cross it soon. The apparatus also sends another signal after crossing the railroad, to open the gates. The apparatus initially sends an audio alert signal before closing or opening the gates at the road /rail crossings. Thus the proposed system prevents injury to a person or animal or damage to the vehicle in the crossing.

An unmanned apparatus at the railroad crossing continuously listens for the short range wireless communication system which gets a signal from the approaching train only when the railroad crossing is reachable within few minutes (at its current speed of travel). The guard system generally consists of two guards kept on either side of the crossing. Each guard is pivotally mounted on a pole P and is movable from a vertical, raised position to a horizontal, lowered position to present a barrier to the lane of traffic approaching the crossing. Normally, the guard system is accompanied with a lighting system (red, amber and green) and a bell. Whenever the short range wireless communication system receives a signal from the moving train, it routes or forwards it to the next nearest railroad crossing apparatus, which in turn initially flashes the amber light and also sounds the alarm. This is just to alert the vehicles, people and animal that the guard is about to be lowered. After few minutes, the guard system closes the traffic, after flashing red lights alerting pedestrians and traffic.

The apparatus of the proposed invention is useful in protecting the lives of people sitting in the vehicle which is crossing, pedestrians and animals. Apparatus obtains information about the arrival of the train in a non-invasive manner.

The apparatus in the train continuously finds its current location using a location finding device such as GPS and also obtains its current speed from the engine. The apparatus at regular intervals probes the database of all unmanned level crossings through which the train is suppose to travel before reaching its destination. Using this information, it roughly calculates how much time it would take to reach the next nearest unmanned level crossing (with its current speed of operation). Every unmanned level crossing guards are to be closed at least few minutes (*say 5 minutes*) before the arrival of the train. This value is stored as a threshold value. The apparatus compares whether the above computed time is less than or equal to the threshold time. If so, it immediately actuates a signal. The apparatus in the train also has a high power short range communication system (*such as WiFi*). The actuated signal is transmitted through this to the wireless systems situated on the roadside or trackside.

8. Claims

We claim:

1) An automatic method and apparatus for opening and closing of the route gates at crossroad junctions to enable safe and efficient passage of moving vehicles on the route.
2) A method and apparatus for enabling disaster alerts (like accidents, fire, floods *etc.*) on the route of the moving vehicle, the details of which would be apparent to experts in the field.
3) A method and apparatus for detection and alert of any fire, smoke or undue vibrations on the moving vehicle.
4) A method and apparatus for communication of signals from various sensors inside the moving vehicle to the command control station elsewhere.
5) A method and apparatus for communication of signals from the command and control station situated elsewhere on to the moving vehicle.
6) A method and apparatus for the provision of transceivers, at appropriate locations, to transfer communication signals between the high powered short range wireless systems (such as *WiFi*) located on the moving vehicle and along the route.
7) A method and apparatus for the provision of gateways, at appropriate locations, to transfer communication signals from the high powered short range wireless systems (such as *WiFi*) into low power short range wireless communication systems (such as *ZigBee*).

9. Drawings

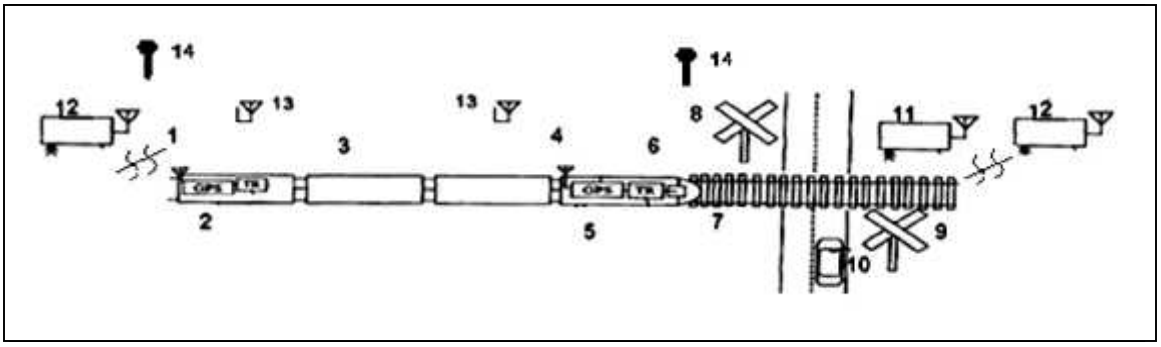

Figure 1: Schematic of the proposed system configuration for automatic routing gates for crossroad junctions.

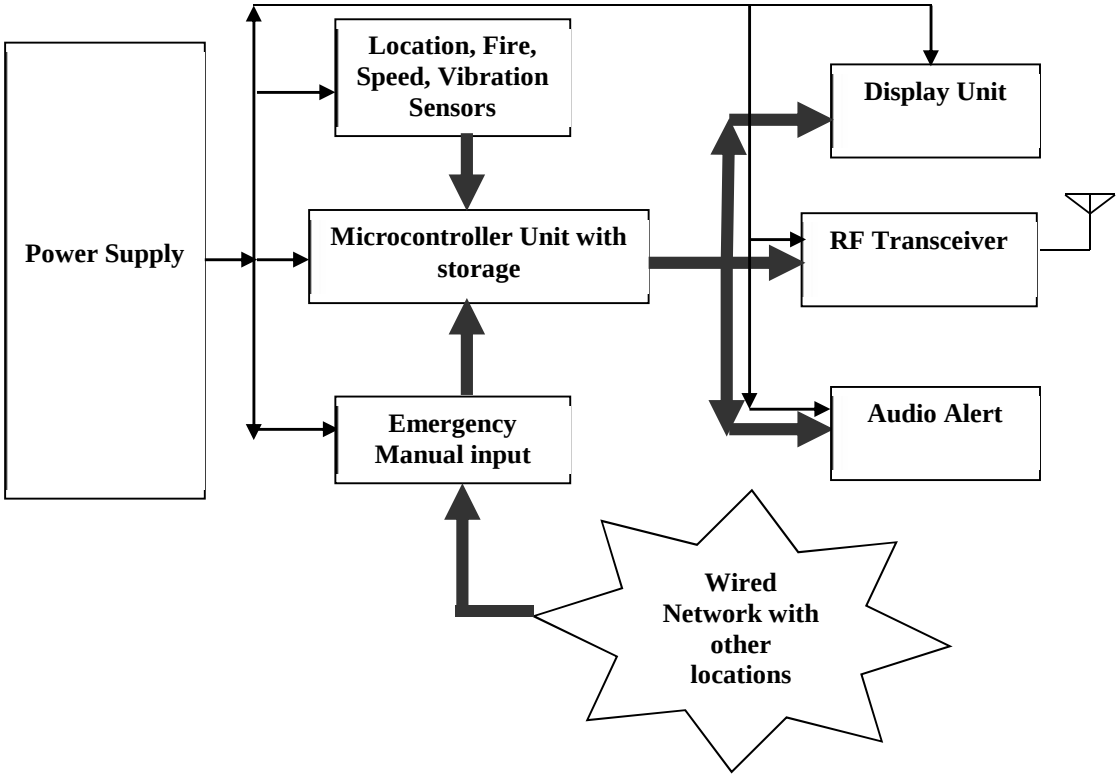

Figure 2: Embedded unit to be located at different positions on the moving vehicle as per functional requirements.

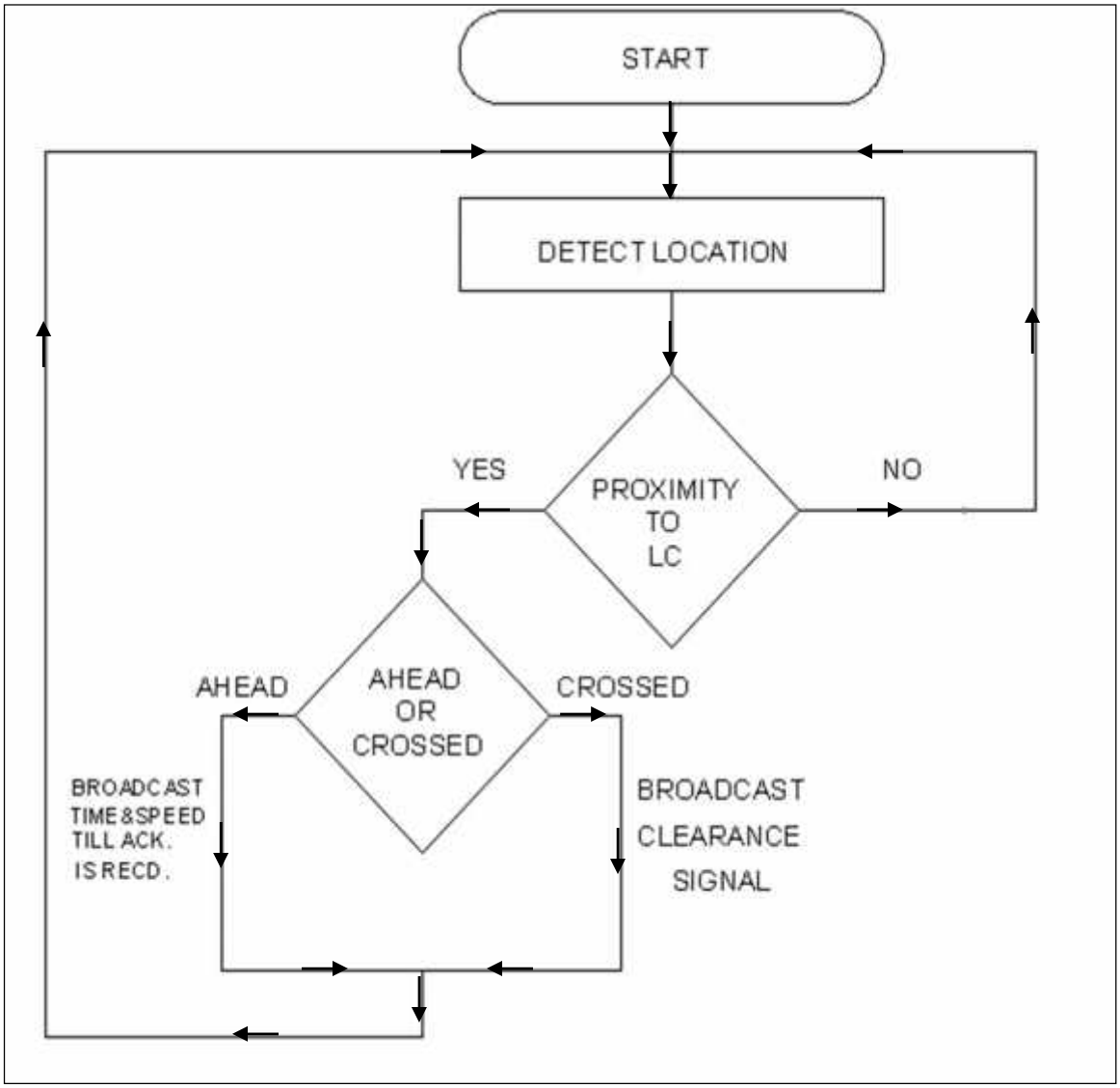

Figure 3: Flow chart highlighting the sequence of events for automatic operation (opening and closing) of routing gates at cross road junctions *(for example an LC, Level Crossing***).**

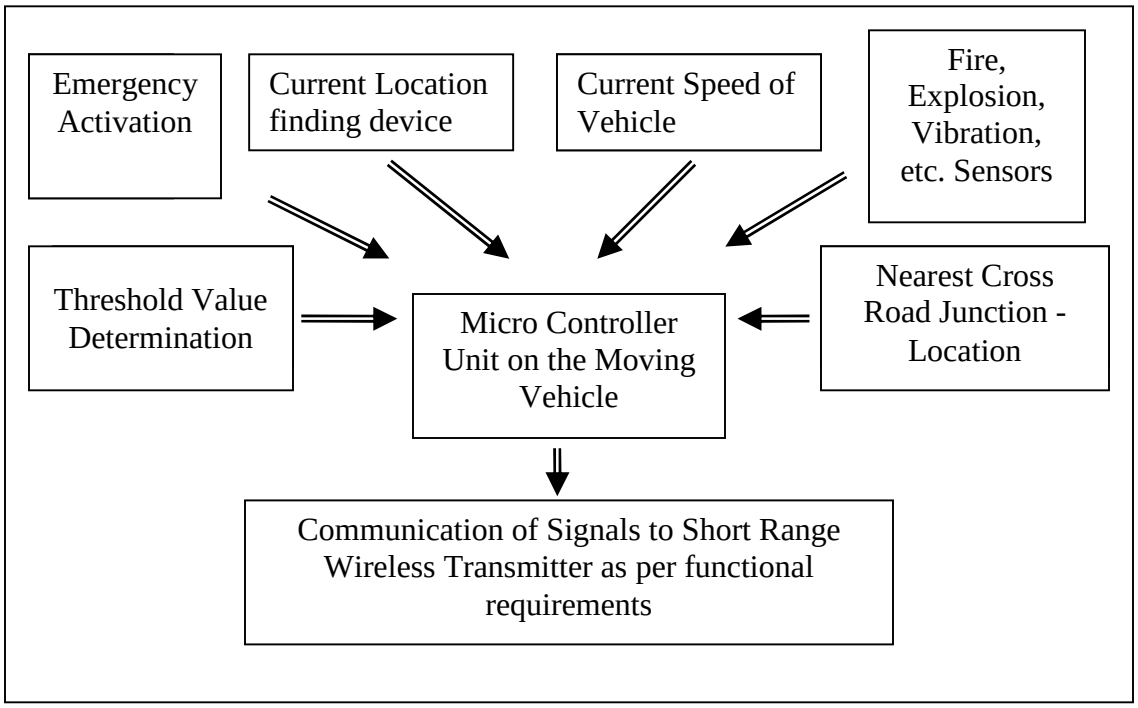

Figure 4: Schematic of information flow from various sensors to the microcontroller in an embedded unit on the moving vehicle.