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Zigbee Based Intelligent Driver Assistance System

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ABSTRACT-

Current driver assistance systems are based on a number of technologies, such as radar, computer vision and sensors. Integrating all of these technologies into a single system is normally a costly and complex solution. We propose a complete ZigBee® based driver assistance system solution that leverages the cost-effective, low-power and secure wireless networking features of the ZigBee protocol. The solution seeks to alert and inform the driver whenever the vehicle approaches a preset waypoint on the road. A ZigBee-based unit is installed at each waypoint, broadcasting relevant information to corresponding ZigBee units embedded in approaching vehicles. Such a system significantly reduces the reliance on human vision and on-road lighting conditions.

Keywords - Adaptive Cruze Control, Driver Assistance Systems, Mesh Network Topology, Vehicular Communication, Zigbee Protocol.

I. INTRODUCTION

In order to make roads safer, cleaner and smarter, sensor and communication technologies are increasingly considered in research, standardization and development. While today's vehicles are already able to sense the surrounding environment, we expect that future cars will communicate with a roadside communication infrastructure and with each other. Connected vehicles create a fundamental building block of intelligent transport systems (ITS) and can provide numerous application services to improve safety and comfort of driving.

Current driver assistance systems are based on a number of technologies such as radar, computer vision and sensors. Integrating all of these technologies into a single system is normally a costly and complex solution. Here we thought of intruducing zigbee. ZigBee® based driver assistance system solution leverages the cost-effective, low-power and secure wireless networking features of the ZigBee protocol.ZigBee-based driver assistance system provides a very cost-effective alternative to more expensive commercially adopted systems like GPS, which provide navigation but do not have any fore-warning capabilities. Zigbee is specifically designed to support sensing, monitoring and control applications with lowest poer consumption. It also supports mesh networking a feature not found in most wireless networking standards.

ZigBee is the only standards-based wireless technology designed to address the unique needs of low-cost, low-power wireless sensor and control networks in just about any market. Since ZigBee can be used almost anywhere, is easy to implement and needs little power to operate, the opportunity for growth into new markets, as well as innovation in existing markets, is limitless.

Motivation for ZigBee-

The ZigBee standard was developed to address the following needs:-

- Low cost
- Secure
- Reliable and self healing
- Flexible and extendable
- Low power consumption
- Easy and inexpensive to deploy
- Global with use of unlicensed radio bands
- Integrated intelligence for network set-up and message routing

Feature	WiFi	Bluetooth	ZigBee
Battery life time	Several hours	Several days	Several years
Complexity	High complexity	Complex	Simple
Nodes Number	32	7	65000
Time for network communication	3 seconds	10 seconds	30 milliseconds
coverage	100m	10m	10m-several km
Extension	Roaming enable	no	Yes
Data Rate	11Mbps	1Mbps	250Kbps
Security	SSID	64bit,128bit	128 bit AES

Fig 1.1 Comparision Chart

This highly flexible concept can perform the following functions:-

- Alert the driver to approaching traffic,streaches of road under maintenance, school and hospital zones, vehicles approaching around a blind corner and many other hazardous conditions.

- Serve as milestones, road signs and simple advertisements such as the menu of a nearby drive-in restaurant.
- Be used as waypoint nodes to record and transmit traffic statistics, such as the number of vehicles passing through an intersection. These nodes can be linked to sensors measuring air quality, temperature or humidity at important locations in the city, and all readings can then be broadcast through a mesh network of various waypoint nodes to in-car units and a central gateway node for further processing.
- Be used for automated,unmanned toll collection for parking lots and toll roads where a secure ZigBee link can help carry out toll transactions before the vehicle reaches the entry point.

In summary, any application that requires car-to-road communication, with a moderate amount of data involved, would benefit from the solution.

In this paper, we propose and analyze a hybrid architecture that combines vehicle-tovehicle communication and vehicle-to-roadside sensor communication. From the wide range of possible use cases, we have chosen accident prevention and post-accident investigation, which we regard as important future services

TYPICAL APPLICATIONS-

There are numerous applications that are ideal for the redundant, self-configuring and self-healing capabilities of ZigBee wireless mesh networks. Key ones include-

•Energy Management and Efficiency—To provide greater information and control of energy usage, provide customers with better service and more choice, better manage resources, and help to reduce environmental impact.
•Home Automation—To provide more flexible management of lighting, heating and cooling, security, and home entertainment systems from anywhere in the home.
•Building Automation—To integrate and centralize management of lighting, heating, cooling and security.
•Industrial Automation—To extend existing manufacturing and process control systems reliability.

II. THE ZIGBEE NETWORK

The ZigBee networking stack is built upon the IEEE® 802.15.4 standard that defines the physical (PHY) and medium access control (MAC) layers for a low-data-rate, low-power network. ZigBee adds network (NWK) and application (APL) layer specifications on top of 802.15.4 to complete what is called the full ZigBee stack.
The solution network has the following types of ZigBee nodes:

- **Waypoint Nodes**

There are two types of waypoint nodes-networked and stand-alone. Networked nodes perform heavy data logging operations and are permanently linked with a gateway node. Such nodes could be placed along major thoroughfares, freeway entrances and exits and at major intersections. In addition to capturing and transmitting traffic information, these nodes could broadcast useful driver information, such as nearby gas stations or hospitals, car unit nodes. These waypoint nodes should be capable of handling traffic on either side of the road. Thus, each car unit would inform the waypoint node about its heading and the waypoint node would respond with pertinent information. Since these nodes are mesh networked with the gateway node, they can be updated with information on new landmarks and utilities in their vicinity.

Stand-alone nodes are temporarily deployed and may or may not be linked to gateway nodes in the area. They can be used as emergency notification nodes that warn approaching traffic about accidents, construction in progress and other road hazards. These would be removed once the hazard has been resolved. Stand-alone waypoints can also serve as advertisements, which would not require a connection to the city administration waypoint network.

- **Car Unit Nodes**

These are nodes placed in each car to communicate with waypoint nodes. These nodes would have a human interface, such as a keypad, LED display or LCD, for user-friendly access to the system. Every ZigBee car unit node has a unique ID assigned to it, much like the vehicle's registration number. At periodic intervals, the car unit sends out a "ping" packet that includes the ID. On receiving a ping, a waypoint unit will transmit a particular message in return.

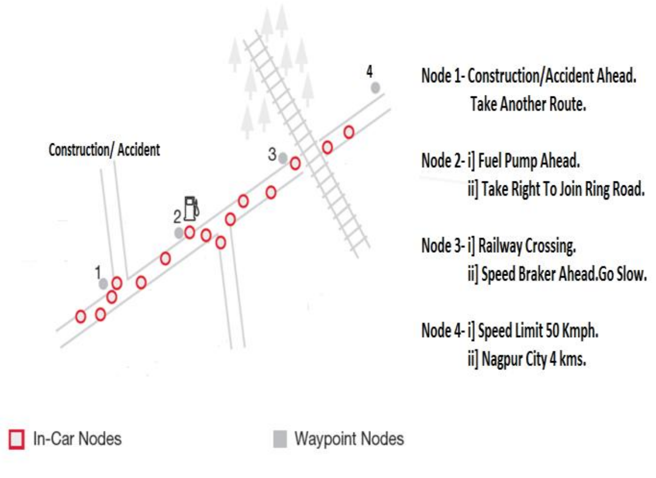

Fig. 2 Methodology

From the above figure it is clear that at what places the nodes are to be installed. For example, at node 1 in figure; we can give information about construction or accident ahead so that the driver willing to take that route gets an idea about the road condition before he takes the turn to choose that route. Sameway we can warn or infrom the driver with fluel pump ahead, railway crossing ahead, speed breaker ahead, milestone along with the specific speed limit of the road.

For all alert scenarios, the placement of the waypoint units must allow the alert message to be sent out early enough to give the driver enough time to react. The correct placement of the unit depends on the following factors:-

Factor 1: The broadcast range of the waypoint unit or the car unit (whichever is shorter)

Factor 2: The data rate of the ZigBee link between the car and the waypoint unit.

Factor 3: The average human reaction time.

Factor 4: The posted speed limit, which helps determine the average distance it takes for the car to come to a halt.

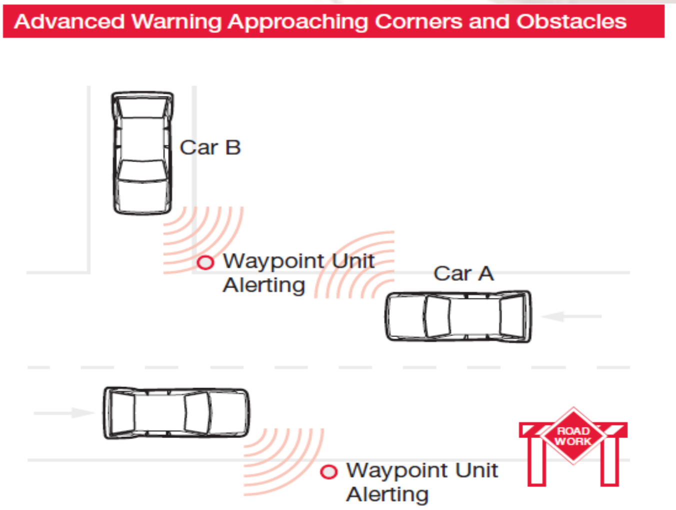

Fig 3. Architecture.

III. Mesh Network Topology

Mesh topology, also called peer-to-peer, consists of a mesh of interconnected routers and end devices. Each router is typically connected through at least two pathways, and can relay messages for its neighbours.

As shown in the image above, a mesh network contains a single coordinator, and multiple routers and end devices.

Mesh topology supports "multi-hop" communications, through which data is passed by hopping from device to device using the most reliable communication links and most cost-effective path until its destination is reached.

The multi-hop ability also helps to provide fault tolerance, in that if one device fails or experiences interference, the network can reroute itself using the remaining devices.

Benefits-

• This topology is highly reliable and robust. Should any individual router become inaccessible, alternative routes can be discovered and used.

• The use of intermediary devices in relaying data means that the range of the network can be significantly increased, making mesh networks highly scalable.

• Weak signals and dead zones can be eliminated by simply adding more routers to the network.

IV. System Details

We introduce the terms "mobile unit" and "static unit" here. The ZigBee unit installed in the vehicle is called the mobile unit, while a waypoint unit on the road is the static unit. In a mobile unit, an LCD screen and an array of LEDs on a vehicle's dashboard serve to display the messages and alert the driver along with audio warnings. The kind of LCD used (segmented or color) depends on the kind of MCU used and the cost of the unit. If the MCF1322x Platform in a Package™ (PiP)[1] is used, then the LCD can be connected via SPI. LEDs can be applied through GPIOs or RGPIOs and can be used in a low-cost solution in place of an LCD. Also, waypoint nodes and gateway nodes do not require LCDs, as a technician can connect the node to a laptop to view its information during debug and maintenance. Audio alerts are a must for all mobile nodes.

To conserve power, the static unit is in sleep mode most of the time, waking up when it detects an approaching vehicle. Solar energy can also be used to power the waypoint and recharge its batteries for enhanced 24-hour energy efficiency.

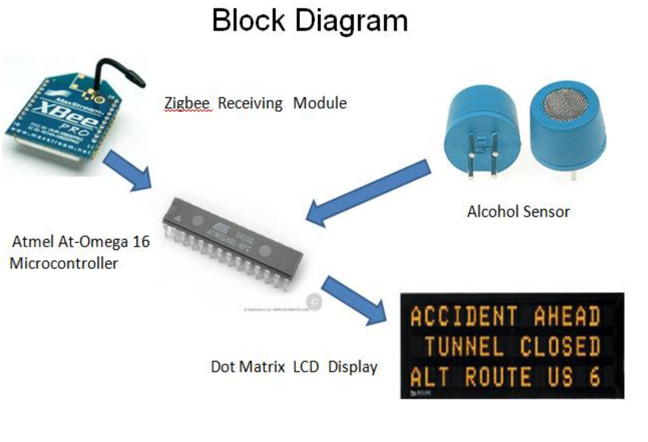

Fig. 4 Receiver Block Diagram.

Figure Shows the block diagram of the car unit that is the receiver unit which is embedded in the car. It is clear from the figure that the zigbee is interfaced with the microcontroller to receive the data sent from the zigbee nodes situated outside the car on the roadside.

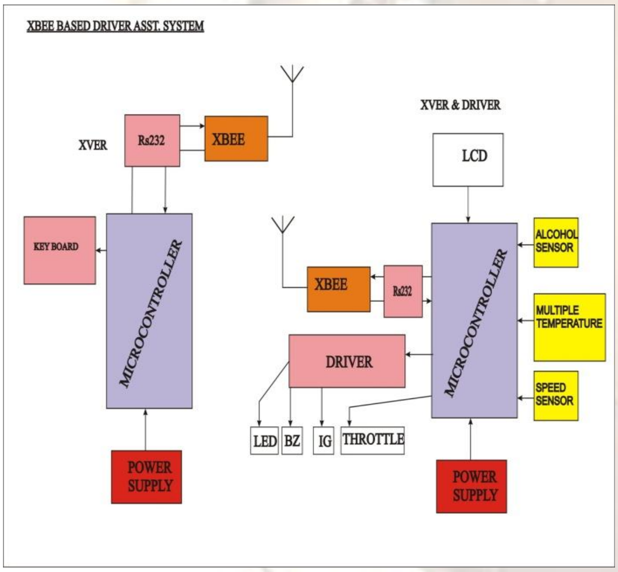

Fig 5. Transmitter and receiver block diagram.

The relevant information that is transmitted by the zigbee nodes is catched by the car receiver and the corresponding characters are displaced on the lcd display which is basically a dot matrix display. Along with the visual indication we can also provide the driver with the audio indication such as a buzzer so that the driver pays attention to the information that is displayed on the screen.

Along with this information the driver can also get aware of the engine temperature of the car. We have introduced a sensor near the engine to sense the temperature of the engine. If it exceeds a predetermined value the ignition is cutoff from the mains and the car is stopped to avoid the overheating of the engine which can cause a serious issue to the persons sitting inside a car.

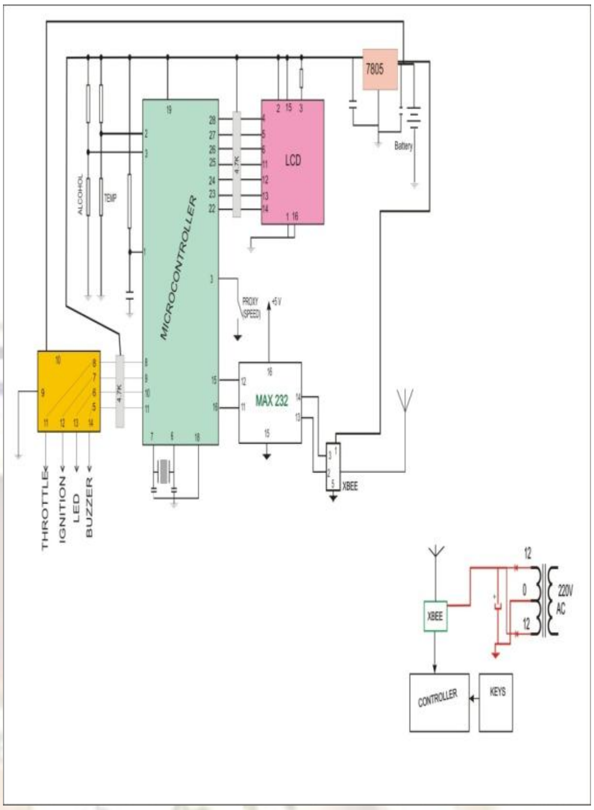

Fig 6. Transmitter and Receiver circuit.

The above figure shows the transmitter and the receiver circuit. Here we have used a MAX 232 IC to make communication possible with the zigbee module. We have used a 16*4 LCD display for the receiver unit.

As is needless to say; a majority of accidents, which occur, are due to drunk driving. As such, there is no effective mechanism to prevent this. Along with this assistance system we are planning to install a drink and drive prevention system. The alcohol level of the driver is continuously monitored and when it exceeds a particular limit the fuel supply is cutoff.

Also nowadays speedy cars are one of the main reason for accident.So we are installing such a sytem along with this assistance system that whenever the driver speeds above the given speed limit, warning will be given to him. If he dosent slow down even after the warning the car will automatically reduce the speed and now the car will run with the given speed limit irrespective of the acceleration provided by the driver.

Drink and Drive Prevention System

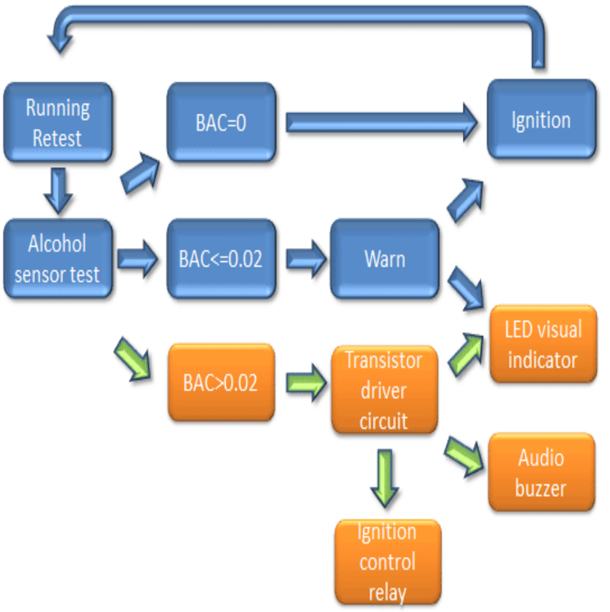

Fig 7. Flow chart for Drink and Drive Prevention system.

Drunk driving is a big problem in every part of the nation. In 2009 alone, over 10,000 traffic fatalities were linked directly to drivers who had blood alcohol levels above the legal limit. Alcohol sensors can help to prevent these accidents. There are three common alcohol sensing technologies. One is a sniffer, which detects alcohol in the air or in the breath of the driver.

Sniffers can detect trace amounts of alcohol in the air. They can be used to determine if the person behind the steering wheel is drunk. An advantage is that sniffer systems do not require skin contact and can operate at a distance. Sniffers placed in the vicinity of a driver are capable of measuring the driver's breath or tissue for alcohol. This technology is rather small and can be placed into law enforcement flashlights to determine whether a driver has alcohol on his or her breath or whether a drink has alcohol in it. Alcohol can be detected in the air of a car, even when the windows are half-down and the air conditioning is on. Systems employing these sensors can lock a car's ignition if the driver is too impaired to drive legally.

Speed Control System

It is known that road accidents are increasing day by day. Most of these road accidents are caused because the automobiles are driven at high speeds even in the places where sharp turnings and junctions exist [1]. Running the automobiles even at those places is the main cause for the accidents. Reduction of number of such accidents is the prime step needed to be taken. Many systems have been developed to prevent these road accidents. One of them is Cruise control system (CC) [2] that is \capable of maintaining speed defined by the driver and its later evolution version Adaptive Cruise Control (ACC) [3] that keeps the automobile at safer distance from the preceding vehicle. But these systems have no capability to detect the actual speed limit of the road which is required for safer transportation. So we are proposing a system in which the zigbee node placed on the roadside broadcasts the speed limit of the road. The receiver in the car gets the speed limit and gives the control to the speed check circuit. If it is found that the car is over speeding; the speed control is taken by the controller and the car runs with the specified speed limit as broadcasted by the zigbee node.

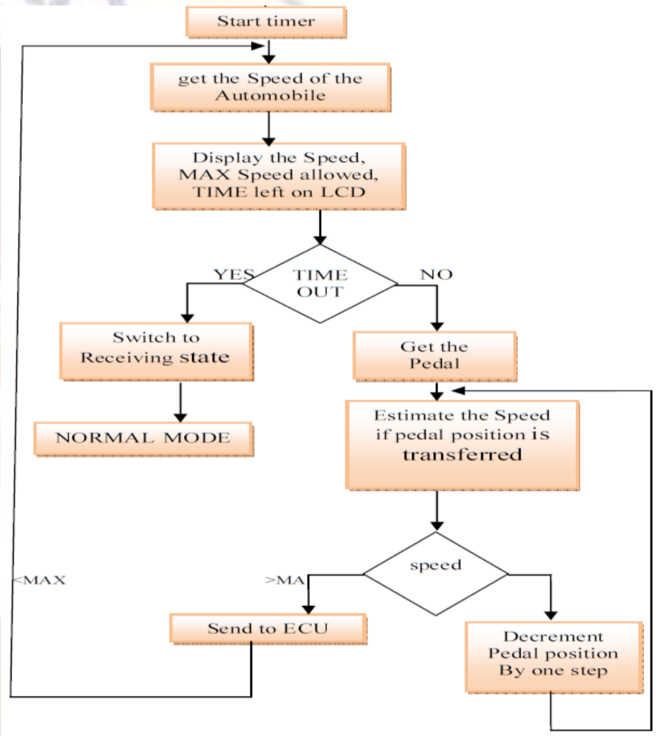

Fig 8. Flow chart of speed control system.

In our proposed design automobile is always in either Normal mode or Active mode. An automobile operates in normal mode until wireless module receives any data packet from the transmitter.

In Active mode of operation microcontroller unit continuously studies the speed of the car. To control the speed of the car according to the limits we have developed the fuzzy logic. If the speed of the car is above the Maximum speed limit, then it sends the digital signal to the ECU such that speed of the automobile will be decreased. When the accelerator pedal is moved to increment the speed, microcontroller calculates the speed that would be reached on the new pedal position. If the speed is greater than the maximum speed limit then it denies excess speed and gives appropriate signal to the ECU.

FUTURE SCOPE

For future scope we propose and analyze a hybrid architecture that combines vehicle-to vehicle communication and vehicle-to-roadside sensor communication. From the wide range of possible use cases, we have chosen accident prevention which we regard as important future service. For accident prevention, roadside sensor nodes measure the road condition at several positions on the surface, aggregate the measured values and communicate their aggregated value to an approaching vehicle. The vehicle generates a warning message and distributes it to all vehicles in a certain geographical region.

V. CONCLUSION

In this paper we discussed the importance of an efficient driver assistance system and how it can help us improve safety standards on the road. The solution can significantly reduce the risk to drivers and enable better traffic management.

Our ZigBee-based driver assistance system provides a very cost-effective alternative to more expensive commercially adopted systems like GPS, which provide navigation but do not have any fore-warning capabilities..We showcased a number of ZigBee-enabled application scenarios related to automotive and road safety, such as data logging, information broadcasting and driver alerts.

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