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GPS Based Advanced Railway Level Crossing Management System Using FPGA

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ABSTRACT: Railways are the biggest transport system all over the world and also for any country too. It is the main backbone for transport system and hence railway safety is a crucial part of railway management system. Rail/road intersections are potentially dangerous and yet unavoidable in the World. The major safety aspect is the safe level crossings. Level crossing is a point at which railway track and road interact on same level and are characterized as manned (where man power is available) level crossings and unmanned (no man power in any from available) level crossings. Unmanned level crossings are more prone to level cross accidents. The railway safety is ensured by improving the passing efficiency in railway crossing, a new railway crossing warning system based on Global Positioning System (GPS) and General Packet Radio Service (GPRS) using Field Programmable Gated Arrays (FPGA) is proposed. This system is compress of high-precision positioning feature of GPS and efficient transmission rate feature of GPRS, combining with the computer control technologies are used to provide a safeguard for the railway system.

KEYWORDS - FPGA, GPS, GPRS, Railway crossing, Alarm system, ACD.

I. INTRODUCTION

Rail/road intersections are very common, special, dangerous and not avoidable in the World. By considering the current domestic situation and international situation of railway crossing, developing an alarm technology is a major task. A variety of alarm systems has been proposed, but all of them were having some issues. At First, they were having poor system performance and stability; secondly, the sensors were having some defects like short reliable life cycle and instability. This system is integrated with GPS and GPRS positioning, which combines the advantages of both GPS and GPRS will overcome the disadvantages of each. Main Principle behind is that the train positions is located and also their speeds measured by using the satellite communication.

Field Programmable Gated Arrays [6] based technology is very popular in designing an embedded system with low cost and high reliability. Field Programmable Gate Arrays are semiconductor devices which comprise of configurable logic blocks (CLBs), Look Up Table (LUTs), programmable interconnects. FPGAs can be reprogrammed to any desired applications. These feature categories the FPGAs from Application Specific Integrated Circuits (ASICs). The objective of the work is to develop GPS [4] Based Advanced Railway Level Crossing Management System using FPGA [6]. GPS communications systems are now common in use variety of navigation applications such as sea, air and land transport. GPS [4] establish the navigation coordinates of aircraft or surface transport receivers using communications links with number of satellites. On the whole GPS [4] systems are very cost-effective. The advantage of train control functions uses GPS [4] is more economical.

The fundamental process in this system is that getting the train location with the help of GPS [4] technology and transferring the data with the help of GSM [5] network, towards the central control unit for analyzing the current position of train. The information regarding the position is periodically sent through the GSM [5] transmitter of the module to the central server. GPS [4] based wireless system is a subset of Anti Collision system, which constituting mainly a Loco unit and a gate unit. The device is capable of storing all the required data in to a buffer. The device is

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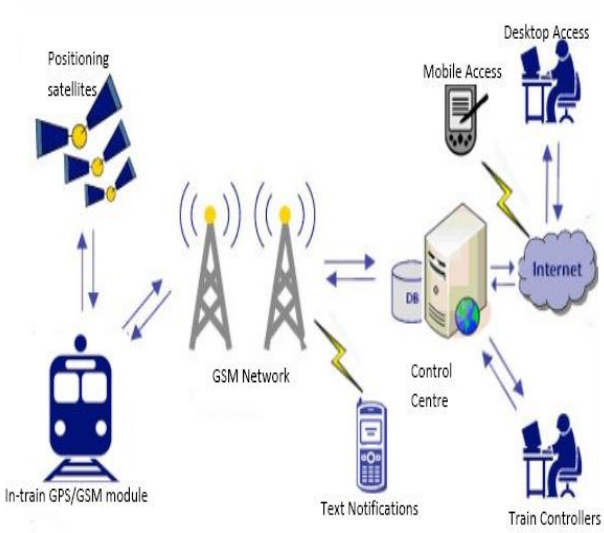
capable in responding to commands and data calls from the remote server as per administrative requirements of the train controllers. The GSM [5] network act as communication medium between the train locator and the central server to improve availability of the system. Detailed architecture is as follows,

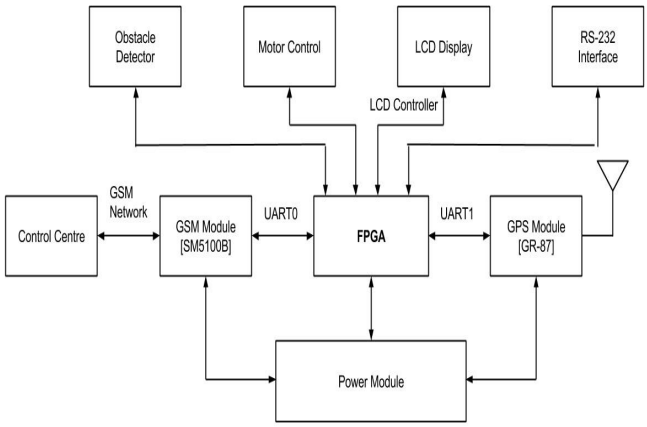


II. BASIC COMPONENTS AND PRINCIPLES OF THE SYSTEM

The system is divided into two major subsystems, one is on-board equipment, and the other is control center unit. Systems are mainly used to find the train travel information, and to notify the control center to alarm with sound and light and to close the gate.

A. On-board Equipment Subsystem

On-board equipment includes: Master module FPGA [6], GPRS [5] module, GPS [4] module, LCD display module, Obstacle Detector module, Motor Control module, and serial port operation module. The simple block diagram is as follows,



Field Programmable Gate Arrays popularly known as FPGAs is an alternative solution for implementing the digital logic in a system. The first static memory-based FPGAs [6] are commonly known as SRAM based FPGA [6],

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which was proposed by Wahlstrom. The First commercial FPGA [6] was introduced by Xilinx in 1984. First commercial FPGA[6] consist of 64 CLBs and 58 inputs and outputs, FPGAs had grown enormously. The basic architecture of consists of three major components such as programmable logic blocks, programmable interconnects and I/O blocks.

Difference between a FPGA [6] and a Microcontroller, FPGAs are concurrent, while the microcontrollers are sequential. FPGAs are flexible as compared to Microcontroller. The development time in case of conventional microcontroller is shorter than that of FPGA [6]. Peripherals' are already available and can choose the Microcontroller based on the required application; in FPGA [6] soft peripherals are also readily available. Microcontrollers are up-till now, are power efficient. Microcontrollers are low cost, much lower than FPGA [6].

The Global Positioning System GPS [4] categories under space-based satellite navigation system which is capable in providing the location and the time information in all conditions, where there is an unobstructed line of sight. Space segment, Control segment, and the User segment are there segments in which the system is consisting of. The GPS [4] receiver will convert the satellite signals into its position, velocity, and time, which is used for estimate the navigation, positioning, time dissemination, or geodesy. Each GPS [4] satellite transmits data on two different frequencies such as L1 (1575.42 MHz) and L2 (1227.60 MHz). GPS [4] satellites provide a service to the civilian and military users.

One of the globally accepted standards for digital cellular communication is Global system for mobile communication (GSM). GSM[5] is a standardization group established in 1982, in order to create a common European mobile telephone. The GSM[5] network is being classified as switching system (SS), base station system (BSS), and operation and support system (OSS).

The RS-232 is one of the popular serial communication protocols for connecting computers to modems and even with other different peripherals. The RS-232 is a simple and reliable serial interface communication protocol. This interface is being developed to operate over a distances of up to 15 meters. The maximum baud or bits per seconds for RS-232C is 19.2 k, although slower rates are often used. In theories it is possible to use any baud rate, but there are number of standard transmission speeds used.

A liquid-crystal display (LCD) is a flat panel display, or video display which works under the principle of light modulating properties of liquid crystals. In which the Liquid crystals will not emit the light directly. The different applications in which the LCD displays are used are in computer monitors, and televisions.

B. System Operating Principle

On-board equipment subsystem consists of a control unit FPGA[6] (Spartan 3 - XC3S400), GPS[4] positioning module, GPRS[5] module, LCD display module, power module, Obstacle Detector [IR (Infra Red)] module, Motor Control module. After an initialization at power up, the terminal will get the train's speed and position information through the GPS [4] module and GPRS [5] module, and will send the location information to the control center through the GPRS [5] network. GPS [4] module is to complete the function of receiving GPS[4] information, GPRS[5] module is to complete the function of network location and receiving and sending positioning information. LPC2114 has two serial ports, UART1 and UART0. It communicates with GPS [4] module through the serial port 1 and GPRS [5] module through serial port 0. Just because the two serial ports of LPC2114, GPS [4] module communication port, and GPRS [5] module communication port are all TTL level, it does not need the level converter chip. The TXD and RXD of LPC2114 can directly connect the RXD and TXD of the other two modules (note: one must connect the TXD of LPC2114 to RXD of the other two modules and connects the RXD of LPC2114 to TXD. They cannot be reversed, otherwise there is no communication). Once GPS[4] and GPRS[5] get the train running information, on one hand, the information is send to control center through GPRS[5], on the other hand, which is stored in RAM of LPC2114, and is displayed through the LCD for future investigations. LCD is connected to the LPC2114 by a serial way. GPRS[5] receiver module in the control center subsystem receives the real-time train speed and position information. Through filtering the received data, AT89C51 then briefly calculates arrival time of the latest trains, and alarm by sound and light at the right time. Based on the arrival time the railway level crossing gate will be closed and before closing the gate, the Obstacle detector module will detect any obstacle is there or not. If any obstacle is detected

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the information will be passed to the central office and this time from the central office the train can be stopped. To open and close the gate NR-DC-ECO DC geared motor is used. It is simple weightless device and easy to interface with SOC using driver circuit. The construction of the motor has the sophisticated technology. In the motor gears are fixed on hardened steel spindles. These spindles rotate between bronze plates which ensures noise free running. It is DC operated device able to work with 4 to 12 V, and its speed is 30 RPM.

III. SYSTEM CHARACTERISTICS

A. Wide Control Range

The positioning terminal receives GPS[4] information and performs GPS[4] positioning through the GPS[4] receiver module. At the same time, it will also realize the positioning through the GPRS[5] which is provided by the GPRS[5] network service. The dual positioning terminal can be realized in the caves, high-rise areas and mountains by combining the advantages of GPS[4] positioning and GPRS[5] network.

B. High Reliability

It has high reliability, real-time and high performance. This can provide a convenient wireless alarm mode to railway crossing by using the existing high-precision satellite navigation and positioning technology and GPRS[5] network resources. We make full use of their wide network coverage, good transmission characteristics and other advantages, to ensure reliability of data transmission and to save the costs.

C. Build a network easily, simple procedures, simple system management, low operating costs, facilitating communication.

The traditional sensor communication is usually prone to work instability because of the impact of pressure, vibration and weather. Moreover, it has the short reliable life cycle, complex working principle and low cost-effective. However, using GPS[4] global satellite positioning and the GPRS[5] network transmission, without building their own network; we can achieve higher stability and lower cost.

D. Satisfy "failure - security" principle of the railroad signal

It can relieve and even prevent the loss to ensure the road safety by communicating through GPRS[5] network when the railway signals equipment in the situation of obstacles, errors or failures.

IV. SIMULATION RESULTS

A.TECHNICAL INDICATORS

Host Power:

CPU operating voltage range: 1.65V 1.95 V (1.8 V 0.15 V).

I / O operating voltage range: 3.0 ~ 3.6 V (3.3 V ± 10%), can withstand 5V voltage.

Host Operating temperature: -10 ~ 50 SM5100B

GPRS [5] module performance indicators:

Operating voltage: 3.2V ~ 4.2V, standard operating voltage: 3.6V SIM card voltage: 3V.

GR-87 (GPS [4] module) performance indicators:

Receiver structure: SiRF star parallel 12-channel

Receive mode: L1, C / A code

Positioning accuracy: 25m

Interface format: RS232 or TTL level serial interface

Output information: SiRF Binary NMEA-0183, GGA GSA

GSV RMC VTG GLL

Operating voltage: 3.3V ~ 5.5V

Step 8: End.

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V. CONCLUSION AND FUTURE WORK

The proposed system is to make sure the railway safety by improving the passing efficiency of trains at the railway crossing, a system which is based on GPS and GPRS using FPGA. This work will be more useful in railway level crossing management, as it is required to avoid the railway level crossing fatalities.

With over 32700 level crossings and complex nature of road traffic, India ranks better than many advanced countries in safety at level. The Railways are continuously following the various steps to reduce the unmanned level crossing accidents and no effort is made to dilute the gravity and the seriousness of accidents. In the control and scope of intervention in curbing a unmanned level crossing accidents, the role of Railways is limited and highly constricted as most of them have been found occurring due to negligence on the part of road vehicle users. It is always an impossible task for a train driver to stop and prevent the collision if he notices a road vehicle on the crossing from a distance of 500 to 600 meters nor is it possible to change the course of a train similar to that of road vehicle.

The simulation results showed that the proposed algorithm performs better with the total transmission energy metric than the maximum number of hops metric. The proposed algorithm provides energy efficient path for data transmission and maximizes the lifetime of entire network. As the performance of the proposed algorithm is analyzed between two metrics in future with some modifications in design considerations the performance of the proposed algorithm can be compared with other energy efficient algorithm. We have used very small network of 5 nodes, as number of nodes increases the complexity will increase. We can increase the number of nodes and analyze the performance.

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