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WIRELESS SAFETY SYSTEM IN TRAINS

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ABSTRACT

The Indian transportation system has seen several changes in the past decade, with several commuters opting for public transports especially trains. However the safety of these commuters travelling in train is still at its stake. The main objective of this paper targets the safety aspect of passengers, thereby to propose a system that addresses the fiendish cruelty meted out to commuters in recent times. A security system is designed particularly for trains that protect people in danger especially the women in case of night travel. The designed system consists of an attack threat sensor for every bay in the train which can be triggered/ pressed by the passenger in case of danger. This immediately gives attack/danger information to the nearby compartments, main engine room and police station with help of two controller modules--Beaglebone black, MSP430G2553 and two wireless communication modules-GSM and RF transceiver .Hence this paper discusses the working and the implementation of the wholesome wireless safety system prototype.

Keywords: trains, sensor, beaglebone black, MSP430G2553, RF transceiver, GSM.

INTRODUCTION

When women travel alone especially during nights and when trains are less crowded the safety of women is at stake. Most of them travel with brimming fear and panic. There has not been a specialized system to address this issue especially in transportation in India. Hence this paper aims in devising a module that can integrate various functions at its trigger and ensure safety.

This device shouldn't be compared with the chain pulling clasp brake that is currently existing in trains. The vast majority of the world's trains are equipped with braking systems which use compressed air as the force used to push blocks on to wheels or pads on to discs which consequently brings the train to a stop. These systems are known as "air brakes" or "pneumatic brakes". This is the mechanism used in chain brakes and hence it will provide no information about the coach from where it has been pulled. Also there are some emergency alarms available in modern trains that allows the passenger to interact with the driver about any problem. However the victim during times of harassment or attack will not have the sufficient time to interact or the time delay will give the culprit a chance to escape without his identity being revealed. Also the women protection safety devices currently in existence can only provide them information regarding the nearby police stations and do not provide an aid to immediately communicate with others or intimate public immediately. There are several applications that have been developed (android) such as 'defender' but the connectivity and proper internet connection still remains a question. However if the 'wireless safety system' is implemented in railways, then, it will be tapping the GSM-R that is exclusively available for railways, hence the communication will be assured and it will be on a faster pace This wireless system is an auxiliary additional feature that can be fitted in our trains apart from the current existing air pulleys. Hence there need not be any change made to existing mechanisms in train. This product can be targeted not only at the Indian Railway System extensively but also intercity metro rail networks. The production costs can be reduced significantly during mass production. The further contribution of the paper is summarised below:

A complete study about the various components/devices used to make a prototype of wireless safety system.

Detailed explanation of the proposed model along with the block diagram. This explains both the modules, that is, one which has to attach in all compartments and the other which has to be attached in the main engine room.

A proof-of-concept implementation of wireless safety system in trains with a complete hardware and flexible software prototype. Pseudo code of the complete working is also provided.

The presentation is divided into four parts: Section II describes the system design, especially the MSP430G2553 and beaglebone black board's architecture; Section III explains about the proposed model of the safety system; Section IV explains the hardware implementation of the prototype and pseudo code for the same. Finally, future scope and conclusion is provided in Section V.

SYSTEM DESIGN

The complete structure of the system can completely divided into three parts:

A) Data collection

1) Quantum webcam: Quantum webcam has a built-in mic with noise reduction and interpolated to 25 Mega pixels. The webcam has night vision with 6 bright lights switched ON. The web cam also has a USB 2 port that can be easily interfaced with Beaglebone black. The picture thus captured is saved in windows which can be retrieved later.

2) GPS: The default serial communication parameters of most GPS receivers are set as follows [4]:

1) 4800 Baud rate.
2) 8 data bits
3) No parity bit
4) 1 stop bit

GPS continuously polls the latitudes and longitudes and return respective coordinate. These coordinates can be extracted by reading the initial string that is preceded by '$' and here the navigational string used is '$GPRMC'. The coordinate once extracted is compared with the existing look up table of locations to predict the exact locality name. Using TI's MAX232 IC the GPS modem is interfaced with MSP430 via a RS232 cable. The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator using four capacitors [6].Hence it helps in interfacing GPS modem with MSP430.

B) Data processing

1) MSP430G2553: TI's MSP430G2553 is used as the main processor in the receiver side module. It consumes ultra-low power and hence it can be used for a prolonged operation. It is a 16 bit, RISC based architecture which has an instruction cycle time of 62.5 ns. This microcontroller remains in active mode while processing, and it goes to standby mode when the complete process is completed. It has a ultra-fast wake up from standby mode which is less than 1µs [1]. Hence the controller response will be fast in case of emergency, i.e., when the threat sensor is pressed. It is ultra low power mixed signal controller with 24 I/O capacitive-touch enabled pins, a versatile analog comparator, and built-in communication capability using the universal serial communication interface (USCI) [1]. Figure-1 shows the architecture of this microcontroller.

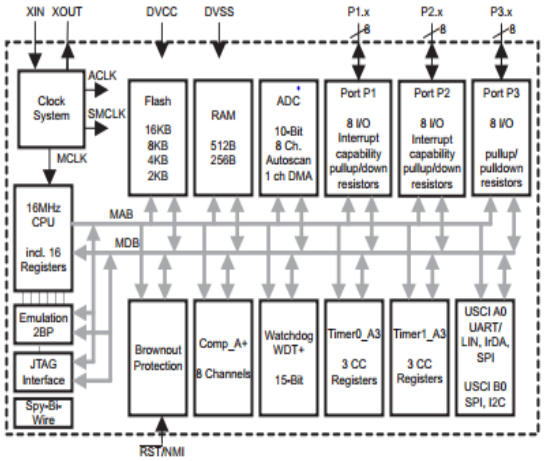

Figure-1. MSP430G2553 architecture.

2) Beaglebone black board: Beaglebone black is an open source hardware single board at low cost with inbuilt linux kernel and an increased memory upto 512 Mb, thereby used in image storage application. The beagle bone black can be coded using the cloud9 IDE and has a provision for the direct uploading of code onto memory card that can be externally inserted in the controller. Here the board was utilized for camera triggering and alarm .However Beaglebone black has 92 pins thus allowing compact integration of multiple functions.

C) Data transmission

1) GSM: Global System for Mobile Communication using the 2G networks at 950 MHz. When the prototype is converted to actual implementation, the railway GSM namely GSM-R which establishes communication between trains and control centres.

2) RF Transceiver: Helps in making a connection between nodes. An inbuilt GUI was used to connect the node to the PC. The node that runs GUI will be HUB node and the other is a SENSOR node. A 40 pin Launchpad and booster-pack standard was used [2] .The booster pack was fitted into the Launchpad through stacking. The GPIO remains unaffected; however VCC, GND, TEST and RESET cannot be used. Once when the booster pack is installed the receiver and the transmission pins of the Launchpad gets reversed.

The transmission and reception of data is synchronised after pairing both end nodes. This is indicated by correlated graphs in the GUI ATC Booster-Stacklite.

PROPOSED MODEL

Figure-2 shows the complete block diagram of the proposed system. In this system two modules are developed, one of which has to be attached in all compartments of the train and the other at the main engine room.

The overall system comprises of compartment room that is fitted with camera and alarm and the engine room that is equipped with GPS, GSM modem and a LCD display. The wireless communication between these two segments is established using RF Transceiver. When the push button is pressed, the alarm rings and a snap shot is taken using the quantum web cam. The picture is saved in the processor memory. The coordinates located by the continuous tracking GPS modem sends the corresponding place referring the stored data base to the engine room using the RF transceiver. The advantage of RF Transceiver is that it provides uninterrupted wireless communication and since it is established at a particular set frequency, the data is not corrupted with noise. This data is displayed on the LCD display at the main engine room and thus alerting the concerned official. The RF transceiver that is interfaced with the MSP430G2553 transfers the data to GSM Modem which sends the information of coach number to the following police station.

The following police station is identified by comparing the current location data with the pre stored list of stations. The police station is thus intimated to take necessary action. This wireless safety system when installed on a large scale reduces the cost and would enhance public comfort. Since it is available in every compartment it provides easy access. Also since a snap

shot is taken, the identity of culprit is revealed even in case of his escape. Thus the overall system together helps in mitigating the crime level in transportation to a very large extent.

A) Module description

Module at transmitter side (compartment)

Here beaglebone black microcontroller is used as the base device as shown in Figure-3. Ubuntu, operating system was flashed on to the board and it was coded using linux. In case of danger or attack, the sensor can be immediately triggered by pushing it. When the sensor is triggered, logic 0 will be obtained at GPIO (general purpose input output pins) and consequently the BEAGLEBONE controller will be triggered. The device performs 3 main actions:

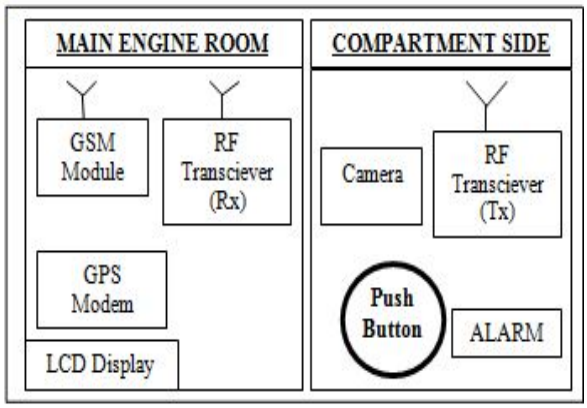

Figure-2. Overall block diagram of proposed model.

Alarm: It immediately triggers a siren alarm through the buzzer circuit. However the processor will be coded such that alarms in 2 consequent compartments near the one from where the sensor is activated will only be triggered. Hence people in nearby compartments can be intimated and they can go to their rescue at once. The GPIO pin which is connected to the driver IC of the alarm will give logic 1 under such circumstances.

Snapshot: It triggers the GPIO as 1 for the camera which will immediately take a snapshot of the bay and store the image of the attacker in the 4-GB on-board eMMC flash memory of the beagle bone black processor.

Coach number message: Then it sends an alert message with the respective coach no. through RF transceiver to a receiver placed at the main coach of the engine where the concerned authorities can be intimated. Interfacing of two nodes, that is, the transmitter node and receiver node of RF transceiver are interfaced through ATC booster Stacklite.

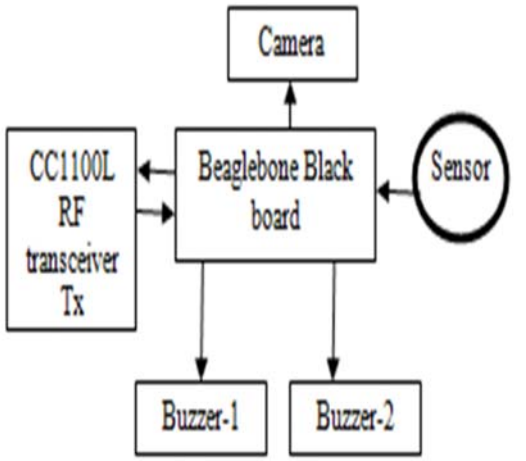

Figure-3. Block diagram of transmitter side module.

Module at receiver side (main engine)

Here MSP430G2553 is used as the base board as shown in Figure-4. Once the RF transceiver receives information from any one of the compartments, it performs 3 steps:

LCD Display: LCD display will be interfaced with MSP430.Here the coach number information received by the RF transceiver will be displayed.

GPS Activation: GPS modem is interfaced with MSP430 controller. The controller will obtain the latitude and longitude information of that particular area with the help of GPS. MSP430 will have an inbuilt database stored in the memory that essentially consists of the latitude and longitude of all the stations in their corresponding order of arrival pertaining to a particular train route, and name of the corresponding stations. Once the latitude and the latitude of the current position is obtained by the GPS, it is immediately matched with the stored data and the offset is calculated (difference) and 2 nearest stations are determined based on the least offsets.

GSM work: The GSM will also be interfaced with the MSP 430. And the message is sent to the respective two police stations through this GSM.

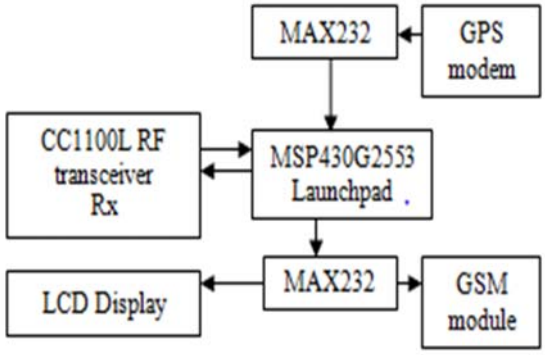

Figure-4. Block diagram of receiver side module.

IMPLEMENTATION

Figure-5 shows the complete hardware connection of the prototype in compartment side. Threat sensor/ push button is connected to the GPIO pin of the beagle bone black. And the 2 buzzer circuits are also connected to the two GPIO pins of the board. Quantum webcam is interfaced with the beaglebone black via a USB port. Once the camera is connected via an USB to the board, the camera driver will be present inside the Linux terminal of the beaglebone board. RF transceiver is directly interfaced with beaglebone board. Interface between the two nodes of the RF transceiver (Tx and Rx) is done using a GUI- ATC Booster Stacklite. Initial pairing is done by connecting one of the nodes to the beaglebone black which acts as miniature PC. This node is called the hub node. The other node which is controlled by the GUI is called the sensor node. Sensor node is connected to the MSP430. The pairing process is completed by opening 'discover node' in the GUI and pressing S2 button of the sensor node simultaneously. Once the pairing process is over, the information from the hub end is transmitted to the sensor node.

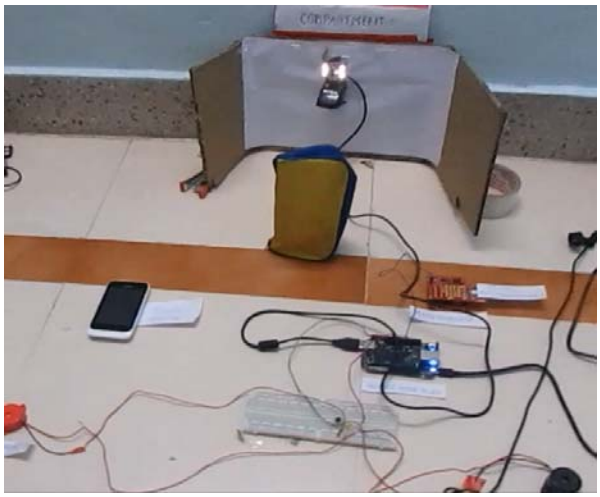

Figure-5. Prototype of safety system- transmitter side module (Compartment).

The LCD is interfaced with MSP430G2553 by connecting the data bus line of the LCD to the GPIO pins of the controller. The control signal RS, R/W and E are accordingly set to serve the purpose of displaying the coach number information. The GPS receiver which provides the navigational output is connected with RS232 cable. Serial pins of MSP430 will be connected to the RS232 via MAX232 IC. For GSM connection, we configured two I/O pins as UART pins for serial transmission, and then connected the GSM module to those configured pins of msp430 via MAX232 IC. The GSM module is coded for the purpose using AT-Commands. Here the MSP430 is coded using Energia E1010011 and Beaglebone black is coded using Linux.

Pseudo code

Compartment side

1. START
2. Check if pin 9_12==1
3. If yes

i) 9_24=1(alarm)
9_15=1(msp rf trigger) Main Engine:

1. Check if pin 9_15=1
2. If yes

P_2.3=1 (msp RF receiver)
P_2.1=1(turn. Of GPS)
P_2.2=1(reception of GPS)
P_1.1=1(turn. Of GSM)
P_1.2=1(reception of GSM)

3. If no

END

Figure-6. Prototype of safety system- receiver side module.

CONCLUSIONS

This paper presents low power and safety ensuring wireless system using Beaglebone black board, MSP430G2553, GPS modem, GSM module, CC1100L RF transceiver.

There are many other ways by which the project can be extended and many features that can be further exploited for a multitude of purposes.

Some of them are: 1) Every compartment can be intimated through an LCD display apart from the alarm which will let them know the exact place of crime immediately.2) This paper deals with the scope of triggering the device only at the push of the button. However the recent image processing technology can be exploited using opens operation which can enable the camera to identify an attack or a mishap by tracking various movements, variation in rate of velocity, position and area. It involves the concept of fuzzy theory to predict an instant before it happens. The judgment of whether an abuse will happen or not is made using "behavioral abnormalities" of continuous images.3) There is a

possibility of the attackers vandalizing the cameras either through physical offense or by subjecting the cameras to IR radiation. To prevent these highly protective screens that reflect the radiation can be provided. In cases of physical damage a separate automatic buzzer can be provided.

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