Helmet for Road Hazard Warning with Wireless Bike Authentication and Traffic Adaptive Mp3 Playback

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Abstract: ***In India still most of the people prefer two wheelers compared to other form of vehicle due to simplicity and its low cost. One important problem is bike riders suffer from inadequate roads and bad driving conditions. Other important problem with bikers is that most of the time they don't like to wear helmet which could be fatal when accidents happen. Two wheelers in everyone's life play vital role, moreover the safety is considered to be primary of all. According to some statistics 50% of accident occurs due to bad conditions of road and not wearing helmet. To avoid accidents and to encourage people to wear helmet a project is to be introduced that includes smart interactive robotic helmet with features like road hazard warning, wireless bike authentication and traffic adaptive mp3 playback. This helmet will warn the rider when road hazard is ahead, helmet will also communicate with rider if he is not wearing it and will perform wireless bike authentication that act as prevention from theft. It will also adjust the volume of the speakers automatically while rider is listening to music as a safety precaution. Since in India the usage of two wheelers is more compared to four wheelers, it requires more attention as far as safety is concerned***.

Keywords: Road hazard warning, bike authentication, ARM cortex, audio decoder.

1. Introduction

People prefer motorcycles over car as it is much cheaper to run, easier to repair, easier to park and flexible in traffic. In India more than 37 million people are using two wheelers. Since usage is high accident percentage of two wheelers are also high compared to four wheelers. Motorcycles have high rate of fatal accidents than automobiles or trucks and buses. Nearly 600 people lost their lives in road accidents last year [7]. One third of all those who died in road accidents could have survived had they worn a helmet. Studies shows that usage of helmet can save accident death by 30 to 40 percent. The rate at which number of two wheelers in India is rising is 20 times the rate at which human population is growing. In such scenario fatalities are only going to raise if things do not change fast. The risk of death is 2.5 times more among riders not wearing a helmet compared with those wearing a helmet [3] [6].

According to statistics serious head injuries can happen even in low speeds. Ninety percent of head injury cases are due to road traffic accidents, about 72 percent are youngsters in the age group of 18 to 40. At least three young men using two wheelers die every ten minutes in India due to head injury. For a young Indian chance of being killed or disabled by road traffic injury is higher than HIV, heart attack or cancer. Head injuries have acquired the status of a public health problem. These scenarios grabbed my interest over this paper in order to ensure safe bike riding.

2. Overview of system

Helmet unit is capable of recording human speech using the built-in microphones and saves it as audio files. The recording process is started and stopped with a simple push button fitted on the helmet that runs on a microphone. For instance, if rider runs into a blind spot at an intersection path hole in the road, he can activate the microphone by pressing this button and then record 'bad intersection or dangerous hole' [2] [8]. With GPS technology installed helmet will then detect when the rider is travelling near those spots another day and turns on the recorded audio. Of course the rider could also record anything that he is interested like favourite shops, food malls to remind him again. The recorded audio files will be available in the dashboard graphical display and the rider has the option to delete it at any time. The helmet unit has wireless communication capability so that bicyclist would be warned when the bike is started without wearing helmet [1] [4]. The rider should bring the helmet within 100cm of dash board for helmet presence authentication. Although this is simple authentication it could act like an object password and gives additional protection from theft. The dashboard will show the list of mp3 files stored in the memory card and will play the file that is selected by the rider. When detecting important traffic sounds like fire siren or horn sound it mutes music automatically and when there is no traffic sound the music volume will gradually raise. Thus the helmet establishes communication between rider and the environment and creates a kind of virtual city or augmented reality city that is used to improve the rider comfort and safety [10].

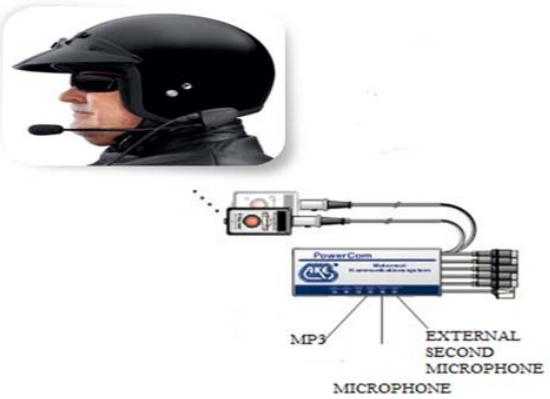

Figure 1: Helmet outlook

The rider location is tracked using GPS modem. The generated voice is recorded as mp3 format files in a 2GB Micro-SD memory card. The voice files are decoded and played with the help of mp3 audio codec chip. Helmet communicates with bike unit using IEEE 802.15.4 wireless network protocol [5]. The bike unit has a graphics LCD and a keypad as its main user interface. The helmet has a built-in microphone near the mouth to record voice and an external second microphone to monitor the traffic noise. The helmet unit and bike unit has LPC1313, a 32-bit ARM cortex-M3 microcontroller from NxP semiconductors that controls everything from playing music on to recording voice commands and communicating with bike unit.

3. Block description

3.1 Robotic Helmet unit

Robotic Helmet unit includes head phone/speaker, internal microphone, push button switch, GPS satellites, MP3 audio decoder, LPC 1300, ARM Cortex-M3, GPS receiver, IEEE 802.15.4/transceiver, micro SD/memory and external microphone. Head phone acts as a speaker to hear recorded voice and mp3 songs. Microphone is used to record voice or commands given by rider with the help of push button switch provided in the helmet. GPS receiver is used to receive the location of the rider through GPS satellites. IEEE 802.15.4 helps in communicating with bike dashboard unit. ARM cortex-M3 controls everything and external microphone is used to monitor traffic sounds.

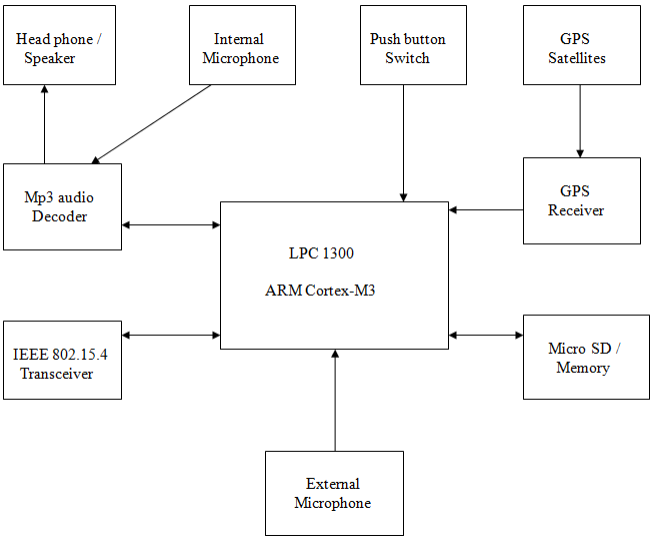

Figure 2: Robotic Helmet unit

3.2 Bike Dashboard unit

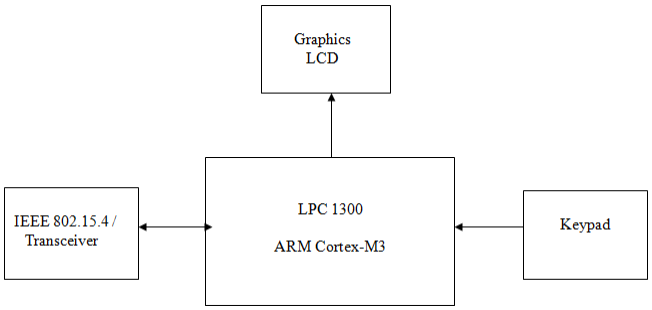

Figure 3: Bike Dashboard unit

Bike Dashboard unit includes Graphics LCD, IEEE 802.15.4/transceiver, LPC1300, ARM Cortex-M3 and keypad. Graphics LCD is use for display purpose. It displays menu. ARM Cortex controls every function. Transceiver is used for communicating with robotic helmet unit. Keypad is used for providing input.

4. Hardware Description

4.1 ARM Cortex- M3

The cortex-M3 processor is the first ARM processor based on the ARMv7-M architecture and has been specifically designed to achieve high system performance in power and cost sensitive embedded applications. It has a hierarchical structure. It integrates the central processor core with advanced system peripherals to enable integrated capabilities like interrupt control, memory protection, system debug and trace. These peripherals are highly configurable to allow the cortex-M3 core and the integrated components have been specifically designed to meet the requirements of minimal memory implementation, reduced pin count and low power consumption.

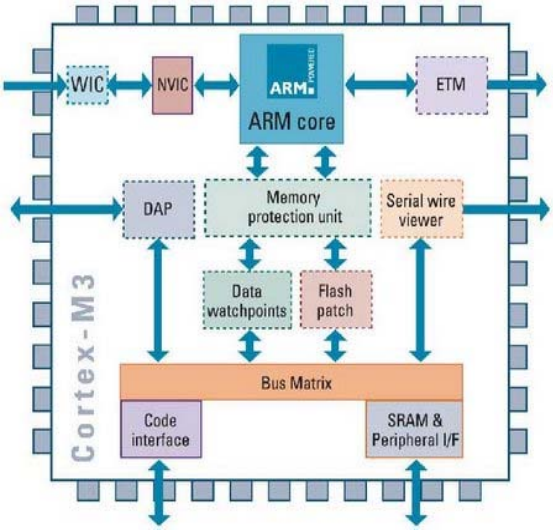

Figure 4: Cortex-M3 core

The central cortex-M3 core is based on the Harvard architecture characterized by separate buses for instructions and data. By being able to read both instruction and data from memory at the same time, the cortex-M3 processor can perform many operations in parallel, speeding application execution. The core pipeline has three stages: instruction fetch, instruction decodes and instruction execute. When a branch instruction is encountered, the decode stage also includes a speculative instruction fetch that lead to faster execution. The processor fetches the bank destination instruction during the decode stage itself. Later, during the execute stage, the branch is resolved and it is known which instruction is to be executed next. If the branch is not to be taken, the next sequential instruction is already available. If the branch is to be taken, the branch instruction is made available at the same time as the decision is made restricting idle time to just one cycle.

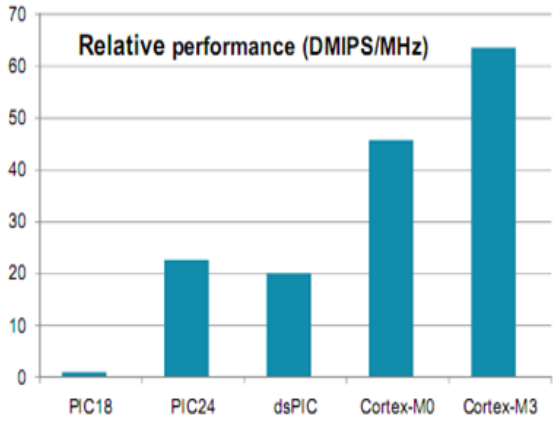

Figure 5: Relative performance of cortex-M3

Performance of cortex-M3 is high compared to PIC18, PIC24, dsPIC and Cortex-M0. High performance often 10x better than the fastest 8051 and 2-3x better than 16-bit MCU. Performance is better even at same or lower clock speeds. And it provides excellent Dhrystone benchmark performance of 1.25 DMIPS/MHZ. It also implements the new thumb-2 instruction set architecture, helping it to be 70% more efficient per MHZ than an ARM7TDMI-S processor executing thumb instructions and 35% more efficient than the ARM7TDMI-S processor executing ARM instructions for the Dhrystone benchmark.

Energy efficiency of Cortex-M3 is much better compared to other types. It helps to squeeze more functionality out of precious battery life and enables to meet the increasing demands for low energy products. It has smallest code size of any microcontroller. Reducing code size is key to squeezing application code into the minimum amount of flash which is easily achieved in cortex-M3.

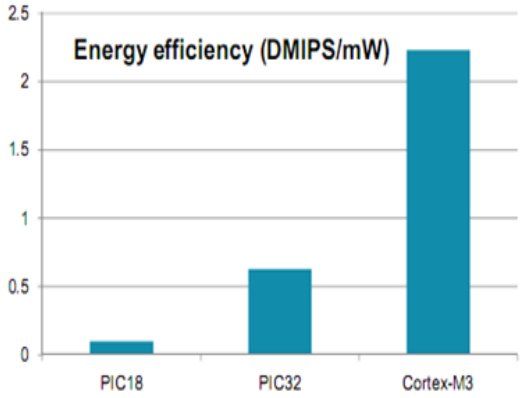

Figure 6: Energy efficiency of Cortex-M3

4.2 LPC1300

Figure 7: LPC 1300

LPC1300 microcontroller family is based on the ARM Cortex-M3 architecture for embedded applications featuring a high level of support block integration and low power consumption. The peripheral complement of the LPC1300 series includes up to 32 KB of flash memory, up to 8 KB of data memory, USB device interface, UART with fractional baud rate generation, SSP controller with FIFO and multi-protocol abilities, SPI interface, I2C bus interface supporting full I2C bus specification, 8 channel 10-bit ADC, 4 general purpose timer/PWMs, and up to 40 general purpose I/O pins. On-chip

ROM is also present which contains in-system programming capability supporting UART and USB flash programming as well as APIs for user code. The flash API implements a simple interface to the on-board flash programming functionality and allows entry to ISP mode at any time. The USB API supports development of human interface devices and mass storage class devices without requiring driver code to be written by the customer or stored in flash. It runs at frequencies up to 72 MHZ and built-in Nested vector interrupt controller. Single power supply (2.0 V to 3.6 V). GPIO pins can be used as edge and level sensitive interrupt sources.

4.3 Audio decoder

Figure 8: Audio codec

It is device or program capable of coding or decoding digital data stream. It can decode multiple formats such as MP3, AAC, WMA, FLAC, WAV, MIDI. It uses SPI protocol to interface with LPC1300. It is used to control volume, bass and treble. Its features includes low power operation, high quality on-chip stereo DAC, zero cross detection for smooth volume change, stereo earphone driver capable of driving a 30-ohm load, quiet power on and off, 16.5 KB on-chip RAM for user code and data.

4.4 Graphics LCD

Figure 9: Graphics LCD display

Graphics LCD used in this project is PCD8544. It is a low power CMOS LCD controller/driver which is designed to drive a graphic display of 48 rows and 84 columns. All necessary functions for display are available in single chip generation of LCD supply and bias voltage that results in a minimum of external components and low power consumption. PCD8544 is manufactured in n-well CMOSCAN controller MCP2515. Logic supply voltage range VDD to VSS is 2.7 to 3.3V. Display supply voltage range VLCD to VSS is 6.0 to 8.5V with LCD voltage internally generated and 6.0 to 9.0V with LCD voltage externally supplied.

4.5 IEEE 802.15.4

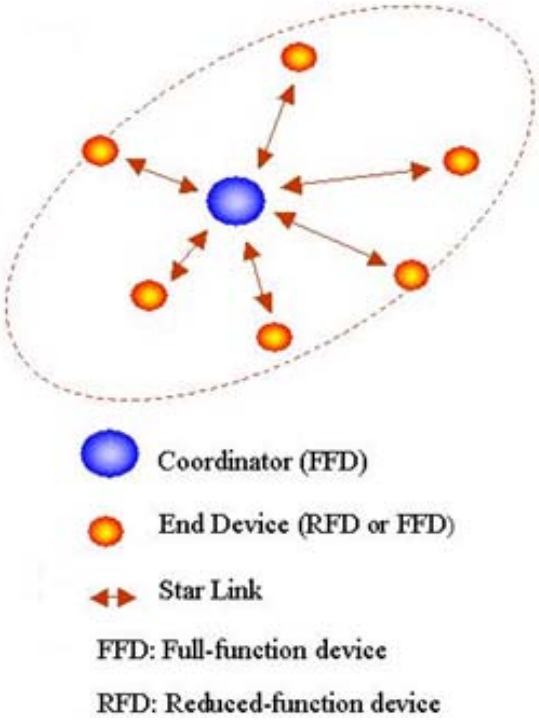

Figure 10: IEEE 802.15.4 Network

IEEE standard 802.15.4 intends to offer the fundamental lower network layers of a type of wireless personal area network which focuses on low cost, low speed ubiquitous communication between devices. The basic framework conceives a 10 meter communication range with transfer rate of 250 kb/s. Tradeoffs are possible to favour more requirements through the definition of not one, but several physical layers. Lower transfer rates of 20 and 40 kb/s were initially defined with 100kb/s rate being added in the current revision. Even lower rates can be considered with the resulting effect on power consumption.

The main identifying feature of IEEE 802.15.4 among WPANs is the importance of achieving extremely low manufacturing and operation costs and technological simplicity without sacrificing flexibility or generality. Important features include real time suitability by reservation of guaranteed time slots, collision avoidance through CSMA/CA and integrated support for secure communications.

Devices also include power management functions such as link quality and energy detection.

4.6 ADC

An ADC is defined by the range of frequencies it can measure and how accurately it can measure a signal relative to the noise it introduces. The actual bandwidth of an ADC is characterized primarily by its sampling rate and to a lesser extent by how it handles errors such as aliasing. The dynamic range of an ADC is influenced by many factors including the resolution, linearity, accuracy and jitter. The dynamic range of an ADC is often summarized in terms of its effective number of bits. An ideal ADC has an effective number of bits equal to its resolution. In this project it is used to detect the important traffic sounds like traffic horn, fire siren Through External Microphone And Mute The Volume of mp3 so that rider can hear those important traffic sounds and can be cautious.

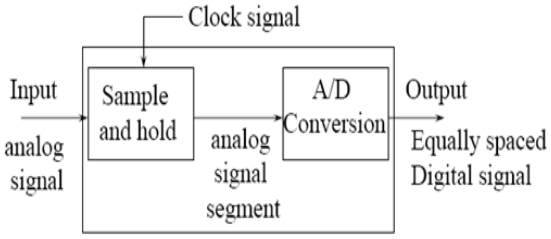

Figure 11: ADC process

5. Software tool

5.1 LPCXpresso IDE

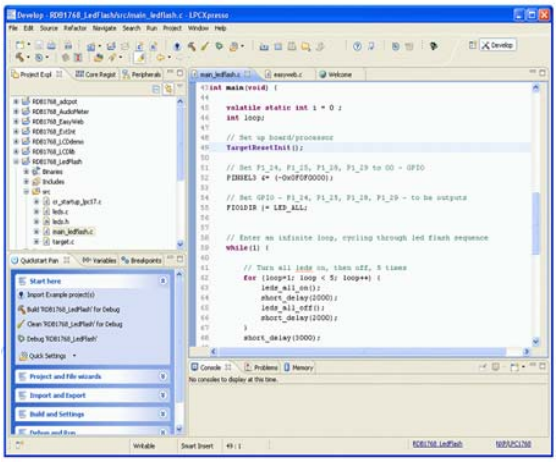

Figure 12: LPCxpresso window

The LPCXpresso IDE is a highly integrated software development environment for NXP's LPC microcontrollers. It includes all the tools necessary to develop high quality software solutions in a timely and cost effective manner. LPCXpresso is based on eclipse and has many enhancements to simplify development with NXP LPC microcontrollers. It also features the industry standard GNU tool chain with a choice of a proprietary optimized c library. It can build an executable of any size with full code optimization. LPCXpresso is the low cost development platform available from NXP. It supports NXP's ARM based LPC microcontrollers. The platform is comprised of a simplified Eclipse based IDE and low cost target boards which include an attached JTAG debugger. Features of LPCXpresso are eclipsed based IDE, GNU compiler, linker and libraries, enhanced GDB debugger, supports LPC link programmer and debugger, complete tool chain for LPC1000 series of Cortex-M, developed by NXP semiconductors and code red technologies.

6. Benefits

The project offers protection from inadequate roads and bad driving conditions that is common in countries like India. The device also allows the rider to record any spot of interest like their favourite shops, food malls to remind him on the road. Large on board memory to store voice files recorded. Ability to delete the previously recorded voice files at a later time which is useful when the hazard has been removed. Smart wireless bike authentication feature acts like a password which is also useful to protect the vehicle from theft. All the units are powered by a 32 bit ARM Cortex-M3 microcontroller which is low cost, low power and provides superior performances compared to available 8, 16 and 32 bit offerings from different vendors.

7. Result

Bike engine starts only when helmet is brought near to bike dashboard unit. The condition is – helmet: present = engine on and helmet: absent = engine : off. Hazard warning information is passed to rider when he is at distance of 10 meters from the hazard to alert him. The volume of MP3 playback is automatically adjusted to mute, when important traffic sounds are detected.

Figure 13: Hardware test-bed

8. Conclusion

Helmet for road hazard warning is designed with wireless bike authentication and traffic adaptive mp3 playback. The main aim of this project is to encourage people to wear helmet and to prevent road accidents, which is achieved. Thus road accidents can be prevented to some extent and safety of bike riders is ensured.

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Author profile

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