Design and Development of Embedded System for Driver Drowsiness Detection

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Abstract: *The on line detection of drowsiness using brain and visual information is to monitor the driver attentiveness in cars. This project is to monitor the driver's eye movement and brain activity by using webcam and EEG channel respectively. This Embedded project is to design and develop a low cost feature which is based on embedded platform for finding the driver drowsiness. Specifically, This Embedded System includes a webcam placed on the steering column which is capable to capture the eye movements and EEG placed at the forehead of the Driver to find out the brain activity. If the driver is not paying attention on the road ahead and a dangerous situation is detected, the system will warn the driver by giving the warning sounds. This Embedded System uses ARM11 32/64-bit micro controller has a feature of image processing technique as well as Analog to Digital Conversion. Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Analog to Digital Conversion is the technique to convert the signals such as analog signals coming from the EEG and convert it into digital signals. The EEG digital signals are provided as input to artifact and EEG detection both provides input to temporal synchronization. The temporal synchronization defines that input is available for monitoring conditions for every 20secs. Whenever the driver is drowsy at any time, then automatically message is transferred to selected mobile phones by the GSM module through MAX232. This Embedded System is going to use S36410 based micro controller to process the brain and visual information of driver.*

Keywords: *ARM11, camera, GSM modem and touch screen.*

1. INTRODUCTION

Every day, about 5% to 10% of car crashes are due to driver drowsiness. Drowsiness can be defined as the transition between the awake state and the sleep state where one's ability to observe and analyze are strongly reduced. The consequences are an increase in reaction time as well as a decrease in driver vivacity which lead to an impairment of driving abilities. Efforts to increase traffic safety have led the research community to focus on the detection of this unsafe state in an automated way.So, the above problem can be overcome by a drowsiness detection system using both brain and visual activity. According to Renner and Mehring, from a physiological stand point, drowsiness can be described using both brain activity, which gives an indication of the brain's ability to process the information, and ocular movements, which gives an indication of perceptive ability. This is, therefore, the information used by expert doctors to evaluate drowsiness [7].For Effective Assessment of Driver Vigilance and Warning According to Traffic Risk Estimation (AWAKE) consortium. The electroencephalogram (EEG), which measures brain electrical activity, is used here to detect burst of energy in the α ([8–12] Hz) and in the θ ([4–8] Hz) frequency bands. These frequency bands are known to be linked to drowsiness. The length of these bursts is used to evaluate drowsiness. At the same time, EEG analysis is complemented by an analysis of visual signs: blinking (lids movements) and eye movements.Unfortunately, there are no standardized rules to distinguish the different level of drowsiness (as the Reschtschaffen and Kales rules for the study of sleep for example). The drowsiness evaluation

depends on the expert doctor analyzing the signal. As for sleep study, the evaluation may vary from one expert to another. Nevertheless, it can be seen in the literature that drowsiness mainly manifests itself through an increase of energy in α and θ bands, as well as a slowing down of eyes and lids movements. In literature, several systems have been developed using EEG to monitor driver drowsiness. Drowsiness can be described through variations of spectral power in specific frequency bands of the brain activity. These variations are studied by processing a spectrum analysis of the EEG signal. Various means can be used to detect drowsy states using the variations of energy in EEG.

II . SYSTEM DESIGN MODEL

A. Hardware module implementation

This paper introduces a Development of Embedded System for Driver Drowsiness Detection system at any place based on the technology of ARM11 and GSM technology. It uses ARM11 hardware platform and embedded Linux operating system with buzzer indication as well as message send to the selected numbers. Driver drowsiness has been monitored with three kinds of systems. The first one is "vehicle oriented" [2], [3]. T is detected by analyzing the Driver's behavior using information measured by sensors located in the vehicle, such as its position on the road, steering wheel movements, and pressure on the driving pedals or the variability of the car's speed.

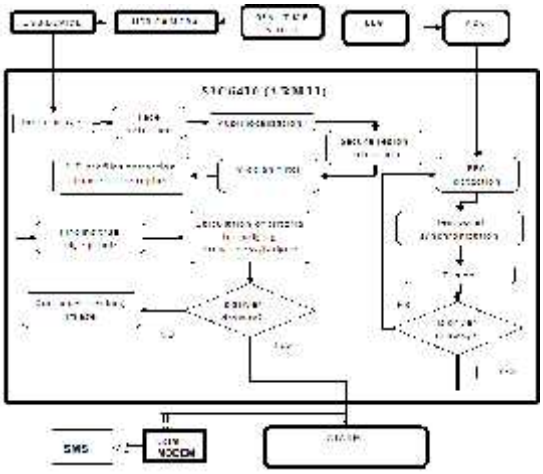
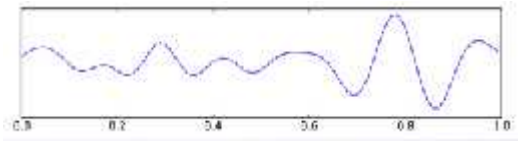


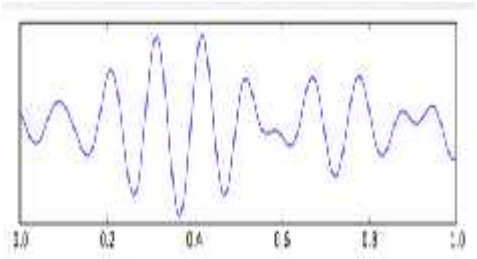
Figure: 1 Implementation Block Diagram

Brainwaves:

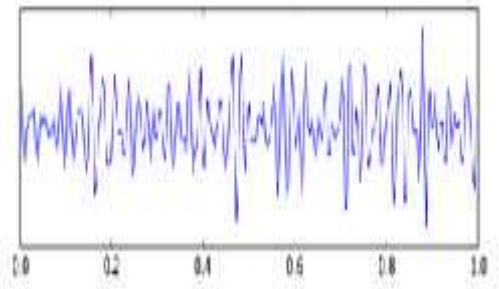
Theta waves (4-8 Hz) are found in the transition from sleep.



Alpha waves (8-13 Hz) are predominantly found with wakeful relaxation (while eyes are closed). Alpha waves are reduced with open eyes, drowsiness, and sleep.



Beta waves (14-30 Hz) are increased with open eyes and found in normal waking consciousness. Low amplitude Beta waves signify active, busy concentration, or anxious thinking. Beta waves are increased when movement has to be resisted or when it's voluntarily suppressed. A reduction of Beta waves occurs with changes in movement. When the wave of ions reaches the electrodes on the scalp, they can push or pull electrons on the metal on the electrodes. Since metal conducts the push and pull of electrons



Software module implementation

The proposed motion detection system makes use of USB camera which is interfaced to lower power consumptive and highly advanced micro controller like S3C6410. S3C6410 is a Samsung company's microcontroller which is designed based on the structure of ARM 1120T family.

This microcontroller works for an voltage of +3.3V DC and at an operating frequency of 700 MHz The maximum frequency up to which this micro controller can work is 533MHz. We cannot get S3C6410 microcontroller individually. We will get it in the form of FRIENDLY ARM board otherwise we can call it as MINI 6410 board .In order to work with ARM 11 micro controllers we require 3 things. They are listed below.

1. Boot Loader
2. Kernel
3. Root File System

Boot loader: The main functionality of boot loader is to initialize all the devices that are present on the mother board of MINI 6410 and at the same time to find out whether any problem or any other fault is there in the devices that are present on that mother board of MINI 6410.The other feature of the boot loader is to find out what are the different operating systems that are present in the standard storage devices and to show it on to the display device so that user can select between the operating systems into which he wants to enter. One other feature of the boot loader is lo load operating system related files byte by byte into the temporary memory like RAM. In our current project we are using boot loader like Super vivi which is MINI 6410 specific.

Kernel: The core part of an operating system we can cal like kernel. Operating system will perform its functionalities like File management, Process management, Memory management, Network management and Interrupt management with the help of the kernel only. Kernel holds the device related drivers that are present on the motherboard. FRIENDLY ARM board supports for operating systems like SYMBION, ANDROID, EMBEDDED LINUX, and WIN CE. But in all these operating systems EMBEDDED LINUX will provide high security to drivers and files. So in our current project we are making use of kernel of EMBEDDED LINUX with which device related drivers that are present on the mother board of FRIENDLY ARM board will automatically come when we load EMBEDDED LINUX related kernel.

Root File System: File system will tell how the files are arranged in the internal standard storage devices. In embedded Linux, kernel treats everything as a file even the input and output devices also. In embedded Linux, Root is the parent directory it contains other sub directories like dev, lib, home, bin ,sbin ,media ,mint ,temp ,proc , etc, opt and etc. According to our application we will interface some external devices also. All the devices means internal devices that are present on the motherboard of MINI 6410 will get their corresponding drivers when we load Embedded Linux related kernel. But these device drivers require micro controller related header files and some other header files which will be present in the lib directory which is present in the root directory. And also the devices related driers will be present in the device directory which is again present in the root directory. So whenever we will load the Root File System then we will get different directories which will be helpful to the kernel. So compulsorily we need to load the Root File System. MINI 6410 specific Root File System is Root Qt. The essential programs that are required in order to work with MINI 6410 like Boot loader, Embedded Linux related Kernel, Root File System will be loaded into the NOR flash which is present on the MINI 6410 board itself. The program that is related with the application will be loaded into NAND flash which is also present on the MINI 6410 board itself. By using boot strap switch that is present on the MINI 6410 will help the user to select either NOR or NAND flash. After that by using DNW tool we can load Boot loader, Embedded Linux neither related kernel and Root File System into NOR flash by using USB cable and the application related program into NAND flash. Once loading everything into MINI 6410 board it will work based on the application program that we have loaded into the NAND flash. Now the CMOS type camera will be interfaced to the MINI 6410 board itself. The camera will continuously record the video and continuously it will send them through Ethernet technology frame by frame. If any motion is detected it can be either related to any person or related to any object at that moment it will capture that image and stores into the internal memory of the micro controller. So it will reduce the power

consumption when compared to the normal Motion detecting Systems.

In this way we can design a lower power working Motion Detection System by using MINI 6410 board and Embedded Linux.

A. Design model operation:

This paper contains ARM11 board which is having in built memory where we store program. The ARM11 board uses a 1.8v power supply. The board is programmed through DB9 connector to the PC. We have serial communication ports which are used to interface directly to the RS232 cable interfaced directly to the PC. The program is burned inside the controller by using the tool DNW. Qt is a cross-platform application framework that is widely used for developing application software with a graphical user interface (GUI) (in which cases Qt is classified as a widget toolkit), and also used for developing non-GUI programs such as command-line tools and consoles for servers. Qt uses standard C++ but makes extensive use of a special code generator (called the Meta Object Compiler, or moc) together with several macros to enrich the language. Qt can also be used in several. other programming languages via language bindings. It runs on the major desktop platforms and some of the mobile platforms. It has extensive internationalization support. Non-GUI features include SQL database access, XML parsing; thread management, network support, and a unified cross-platform application programming interface (API) for file handling.

EXPERIMENTAL RESULTS:

For implementing this project we are using Linux, Qt for embedded Linux and open CV library. The Linux open source operating system, or Linux OS, is a freely distributable, cross-platform operating system based on Unix that can be installed on PCs, laptops, net books, mobile and tablet devices, video game consoles, servers, supercomputers and more.Qt for Embedded Linux is a C++ framework for GUI and application development for embedded devices. It runs on a variety of processors, usually with Embedded Linux. embedded devices with a lightweight window system.

Fig.2: Total setup for online driver drowsy detection system

Results of the EEG-Based Detection System:

The drowsiness detection system based on the EEG analysis reaches 84.6% correct detections of “drowsy” states, which corresponds to a level of drowsiness greater or equal to 1 in the OSS scale (see Table I) and 17.9% false alarms (epochs classified 0 by the expert and detected as “drowsy” by the system),[5].

III.CONCLUSION

The project “ON-LINE DETECTION OF DROWSINESS USING BRAIN AND VISUAL INFORMATION” has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM11 board and with the help of growing technology the project has been successfully implemented.

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