

Operation of a Smart Home by Using Brain Wave Sensor.

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Abstract— Main aim of this paper is to deal with paralyzed and physically disabled people to control the home appliances using Electroencephalogram (EEG) signals, so they may become independent in their daily life. The BCI (Brain Computer Interface) is considered as one of the recent and unique transmission medium between the human brain and computer. This approach offers a communication path and the control system. It is known as an artificial system that circumvents the human body's normal adequate pathways, which are the output channels. Here, non-invasive Brain-Computer Interface approach will be implemented. The Neuro Sky brainwave sensor will be sensing the attention values of the brain signals and the eye blinks. The ARM7 processor is used as the main interfacing device. According to the eye blink and the brain concentration values the devices will be selected and through relays the switching on and off of the home appliances will be done accordingly. Smart Homes, also called as automated homes, intelligent buildings, integrated home systems or domestics, are the recent design development. Smart homes incorporate all devices that control features of the home. Smart home technology is used to control environmental systems. The concept on smart home application and development includes implementation techniques and is ever growing.

KEYWORDS—EEG; MATLAB; UART; ARM7; BCI; Brain wave sensor.

1. INTRODUCTION

1.1 EMBEDDED SYSTEM

An **embedded system** is a computer system with a firm function within a larger mechanical or electrical system, often with real-time computing constraints. It is *embedded* as part of a complete device that includes hardware and mechanical components. Embedded systems control many devices today. Ninety-five percent of all microprocessors are manufactured as components of embedded systems. Modern embedded systems are mostly based on microcontrollers (i.e. CPU's with integrated memory or peripheral interfaces). In alternative case, the processor used may be the types ranging from general purpose to those specialized in certain class of computations, or even custom designed for the application at hand.

1.2 PEOPLE WITH DISABILITIES

Disability is circumstance or inability when compared to the normal human's beings. It has various functionality that includes physically, sensory, cognitively, intellectual illness, and numerous types of disease. Mobile devices have been a great aid to such people but interaction with mobile devices by

disabled people can be a really challenging task. This chapter discusses an EEG brain wave sensor for the people with disabilities to perform different tasks.

1.3 ELECTROENCEPHALOGRAPHY(EEG)

An electroencephalogram (EEG) senses an electrical signal in our brain using small, flat metal discs (electrodes) attached to your scalp. Your brain cells interconnect through electrical instinct and are engaged all the time, even when we fall asleep. This process shows up as wavy lines on an EEG recording.

An EEG is one of the main diagnostic tests for epilepsy. An EEG may also play a role in diagnosing other brain disorders.

1.4 ANALYSATION

The process is analyzing the brain wave signals. Human brain consists of millions of interconnected neurons. The pattern of these interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts and emotions, this pattern will be changed which in turn produce different electrical waves.

A muscle contraction will also generate a unique electrical wave called as signal. All these electrical waves will be sensed by the brain wave sensor and it will get converted to the data into packets and then transmits through Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will extracts the received data and processes the signal using MATLAB platform.

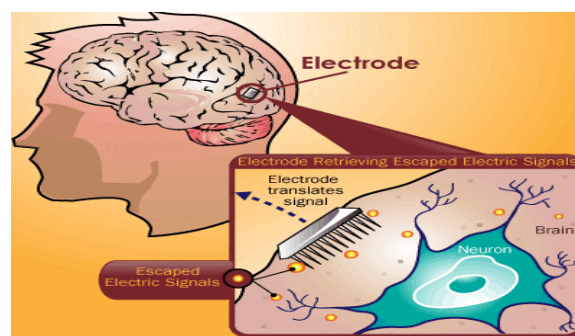


Fig: 2.2: Electrode Placement

Synchronized electrical pulses from masses of neurons that communicates with one other when human body is in motion. Brainwaves are detected using sensors which are placed on the scalp. They are divided into bandwidths to describe their functions as slow, sound and functional - to fast and complex. It is a handy analogy to think of Brainwaves as musical notes. The low frequency waves are likely penetrating drum beat, while the higher frequency brainwaves are more like a subtle high pitched flute. Likewise, the higher and lower frequencies link and cohere with each other through harmonics. Our brainwaves changes according to our body muscular and mental movement. When slower brainwaves are dominant, we can feel tired, slow, sluggish, or dreamy. The higher frequencies are dominant when we feel wired, or hyper-alert. Brainwave speed is measured in Hertz (cycles per second).

2.1 BRAIN WAVE SENSOR



Fig: 2.3: Brain Wave Belt

3. ZIGBEE MODULE

There are several and numerous high data rate communication standards that are available, but none of these meet the sensors' and control communication standards. These high-data rate communication standards require low-frequency and low-energy consumption even at lower bandwidths. The available wireless systems ZigBee technology is low-cost and low-power consumption and characteristics make communication best suitable for several embedded applications, industrial control, and home automation, and so on. Christo Ananth et al. [3] discussed about Positioning of a Vehicle in a Combined Indoor-Outdoor Scenario, The development in technology has given us all sophistications but equal amounts of threats too. This has brought us an urge to bring a complete security system that monitors an object continuously. Consider a situation where a cargo vehicle carrying valuable material is moving in an area using GPS (an outdoor sensor) we can monitor it but the actual problem arises when its movement involves both indoor (within the industry) and outdoor because GPS has its limitations in indoor environment. Hence it is essential to have an additional sensor that would enable us a continuous monitoring /tracking without cutoff of the signal. In this paper we bring out a solution by combining Ultra wide band (UWB) with GPS sensory information which eliminates the limitations of conventional tracking methods in mixed scenario(indoor and outdoor) The same method finds application in mobile robots, monitoring a person on grounds of security, etc.

ZigBee communication is specially designed for control and sensor networks on IEEE 802.15. Standard for wireless personal area networks (WPANs).

This communication standard defines physical and Media Access Control (MAC) layers to handle many devices at low-data rates. The data rate of 250 kbps is best suited for intermediate two way transmission of data between sensors and controllers.

ZigBee is low-cost mesh network widely developed for controlling and monitoring applications where it covers 1100 meters within the specified range. This communication system is less expensive and simpler than other short-range wireless sensor networks as Bluetooth and Wi-Fi.

ZigBee supports variety of networkinfrastructures for master to master or master to slave coordination. And also, it can be operated in several modes as a result the battery power is conserved. ZigBee networks are extendable in area with the use of routers and allow many nodes to interconnect with each other for building a wider area network



Fig: 3.1: ZigBee Module

4. FLASH PROGRAMMER

Flash programmer is a Straightforward and intuitive user interface. Thereare five simple steps to clearing and programming a device and setting any options desired. The programs are enabled with Intel Hex Files. It automatically verifiesafter each completion of programming.

It fills unused Flash to increase firmware security of the program. It has Ability to automatically program checksums. By using the supplied checksum calculation routines your firmware can easily verify the integrity and flexibility of a Flash block, ensuring no unauthorized or hacked code can ever be executed.

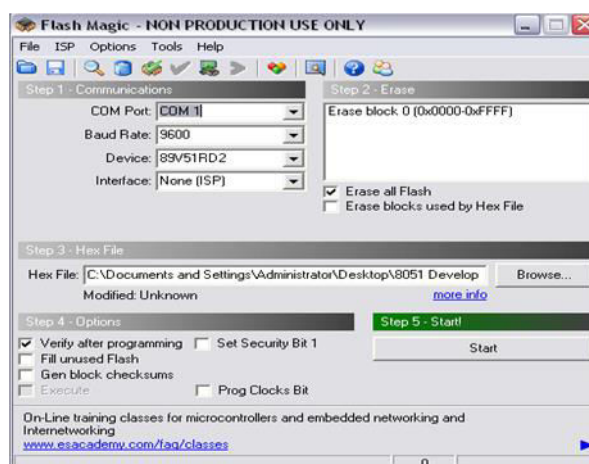


Fig4.1: Flash Programmer

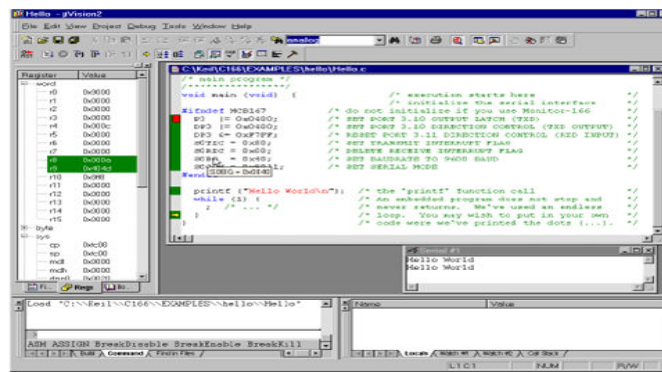


Fig: 4.2: Kiel IDE C compiler

5. EMBEDDED C

The C for microcontrollers and the standard C with syntax and semantics are slightly different in nature. The c is aimed at the general purpose programming paradigm language whereas the latter is for a specific target microcontroller program such as 8051 or PIC.

The underlying fact is that everything will be ultimately mapped into the microcontroller engaged in machine code. If a certain feature such as indirect access to I/O registers is inhabited in the target microcontroller, the compiler will also restrict the same at higher level. Similarly some C operators with functions which are meant for general purpose computing are also not available with the C for microcontrollers used.

Even the operators and constructors which may lead to memory inefficiency are not available in C programming meant for microcontrollers.

5.1 KEIL IDE C COMPILER:

Kiel Software, world's largest developer of Embedded Systems Software, makes an ANSI C-compilers, themacro assemblers, the real-time kernels, debuggers, thelinkers, thelibrary managers, simulators, theintegrated environments. Kiel IDE Software implemented the first C compiler designed from the ground-up specifically for the 8051 microcontroller.

Kiel development tools offers a complete development environment for ARM, Cortex-M, and Cortex-R processor-based devices.

They were easy to learn and to use, yet the most powerful for the most demanding embedded applications. The MDK Core contains all development tools including IDE, Compiler, and Debugger. The new Pack Installer adds and updates Software Packs for devices, CMSIS, and middleware.

Software Packages that add support for a complete microcontroller family are called Device Family Packs. Today only some devices are supported by Device Software Packs, but we will be doing support for more microcontroller devices shortly.

MDK-CORE is based on μ Vision with most leading support for Cortex-M devices including the new ARMv8-M architecture. **DS-MDK** contains Eclipse-based DS-5 IDE/Debugger

and gives supports 32-bit aCortex-A processors ora hybrid systems with 32-bit Cortex-A and Cortex-M.

MDK includes the two **ARM C/C++ Compilers** with assembler, linker, and highly optimizable run-time libraries that are tailored for optimum code size and performance. **Software Packages** may be added any time to MDK-Core or DS-MDK making a new device support and middleware updatations which are independent from the tool chain.

They contain several device support, CMSIS libraries, middleware's, board support, code with templates and example projects. New is the IPv4/IPv6 networking communication stack that is extended with ARM embedded software components to enable Internet of Things (IoT) applications.

Through a Digit proprietary RS-232 or USB interface board. Art Serial Port to Ethernet Wi-Fi Wireless Network Converting. Adapter Module Features are as follows: This product is an embedded module, is fully based on the universal serial interface which according with the network standard, built-in TCP/IP for protocol stack, can realize the user with a serial port.

5.2 DATA FLOW DIAGRAM:

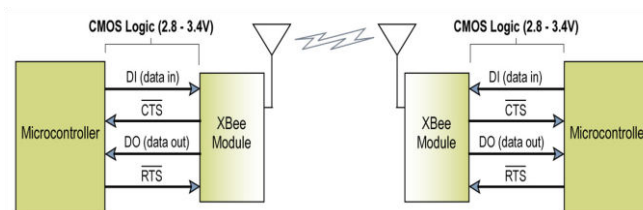


Fig: 5.2 Data Flow Diagram

The Bee®/Bee-PRO OEM RF Modules interface to a host device through the logic-level asynchronous serial port. Through its serial port, the modules can communicate with any logic and voltage compatible UART port; or through a level translator to any serial device .Through a Digit proprietary RS-232 or USB interface board. Art Serial Port to Ethernet Wi-Fi Wireless Network Converting Adapter Module Features are as follows: This product is a embedded module, is fully based on the universal serial interface which according with the network standard, built-in TCP/IP for protocol stack, can realize the user with a serial port.

6. ARM 7 CONTROLLER

Increasingly, embedded systems administrators and system-on-chip designers select particular microprocessor cores and a family of tools, libraries, componentsto quickly develop new microprocessor used products and applications. ARM is one of the major options available for embedded system developer. The ARM architecture has become the most pervasive 32-bit architecture in the world, with wide range of ICs available from various IC manufacturers. ARM controllers are embedded in products ranging from mob phones to automotive braking systems. A community of ARM partners and third-party vendors has developed among semi conductor and product design companies, includinghardware.

An ARM processor is one of the family of CPU s based on the RISC (reduced instruction set computer) architecture was developed by Advanced RISC Machines (ARM). ARM makes use of 32-bit and 64-bit RISC multi-core processors...

RISC processors which are designed to built the smaller number of types of computer instructions so that they can operate over a higher speed, performing more millions of instructions per second (MIPS). By stripping out the unneeded instructions and optimizing pathways, RISC processors provides the outstanding performance at a fraction of the power demand of CISC (complex instruction set computing) devices.

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Fig: 6.1 Brain Wave Canalization

It stores the entire architecture. It is an orthogonal instruction set. It is mostly executes single-cycle execution. It has enhanced power-saving design.

Its configuration are 64 and 32-bit execution states for scalable high performance. It has a hardware virtualization support.

The simplified design of ARM processors enables the more efficient multi-core processing and easier for coding by developers. While they don't have the same raw computation throughput as the product of x86 market leader Intel, ARM processor sometimes exceeds the performance limit of Intel processors for application that exists on both architectures



Fig6.2: ARM 7 Module.

The RS-232(X) is a communication cable, commonly used for the transferring and receiving the serial data between the two devices. It supports both synchronous and asynchronous data for transmissions. Many devices in the industrial environment are using RS-232 communication cables. Rs-232 cable is used to detect the difference of two signal levels between the logic 1 and logic 0. The logic 1 is represents by the -12V and logic 0 is represents the +12V. The RS-232 cable works at a different baud rates like 9600 bits/s, 2400bits/s, 4800bits/s etc. The RS-232 cable has important two terminal devices namely Data Terminal Equipment and Data communication Equipment. Etc.,

7. CONCLUSION

Brain signals can be used as the communication source especially for people with disabilities. So, for each blinking of an eye, the brain waves will vary accordingly, the captured brain signals from Bluetooth plays as the important input aspect of this project. Then the signals are transmitted through ARM7 controller, finally transmitted to ZigBee module which is connected to modules. For the assumption, left eye blinking is used to operate the fan and right eye blinking is used to operate bulb etc., in this work, the devices used here are cost-effective, highly power consumable, gives accurate results. The electrode used here is used to transmit brain waves into electrical signals. So, now people with disabilities who can't operate the home devices on their own, can use this brain wave sensor belt which is not dependent on others.

The drawbacks of earlier using brain wave sensor have multiple electrodes. Since multiple electrodes are used, it will generate EEG paste which is very harmful to human body. In order to overcome this problem, we have proposed a project having brain wave sensor with a single electrode which in turn no harm to human body... In this belt, we are having an inbuilt Bluetooth for communicating the signals (brain waves).

In future enhancement, we can improve this project by enabling concentration module. Though now we are operating the devices with the help of an eye blink, this can be improved further by using concentration level of the brain. Here no need to blink the eye for operating the devices. Instead, we need to concentrate on a particular device to operate on its own.

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