e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-11, Issue-1 (February 2021)
https://doi.org/10.31033/ijemr.11.1.6

Design of Microsleep Alerting System of Pilot to Reduce Air Accidents

M.S. Prabhu
Assistant Professor, Department of Aeronautical Engineering, Hindusthan Institute of Technology, INDIA

Corresponding Author: prabhu@hit.edu.in

ABSTRACT

The pilot's micro sleep often caused by fatigue and/or drowsiness receives increasing attention for the last few years, especially after it became evident that pilot's micro sleep also one of the major factor causing serious aircraft accidents.

The system comprises EOG, EEG and IR module. EEG measures the electrical activity of the brain called brain wave pattern through intrusive electrodes. EOG tapes the electrical potential of eyeball movements and the IR module senses the eye blink frequency. Then all these signals are applied to a robust signal processing unit and microcontroller. When an indicating feature corresponds to the micro sleep events are detected, the warning system is activated. This envisioned micro sleep alerting system would continuously monitor the alertness of the pilot and provides immediate warning signal, when micro sleep detected with high certainty.

Keywords— Brain Wave**,** Microcontroller, Microsleep, Sleep Alert

I. INTRODUCTION

The pilot's microsleep often caused by fatigue and/or drowsiness receives increasing attention and also one of the major factor causing serious aircraft accidents. This work proposes the general framework for detecting the behavioral micro sleep events and the alerting system in the cockpit through aural warning.

The system comprises MEG, which measures the electrical activity of the brain called brain wave pattern through non-intrusive electrodes. This envisioned MEG/EEG based micro sleep alerting system would continuously monitor the alertness of the pilot and provides immediate warning signal, when micro sleep detected with high certainty.

This work helps to prevent the occurrence of any catastrophic failure or casualty resulting from pilot's micro sleep due to drowsiness and overload. The main advantage of this system includes accurate prediction of the theta event and state of the art alerting system. The key requirements for a successful countermeasure warrant low cost system, low false alarm, and compatibility.

Microsleeps are brief, unintended episodes of loss of attention associated with events such as blank stare, head snapping, and prolonged eye closure which may occur when a person is fatigued but trying to stay awake to perform a monotonous task like driving a car or watching a computer screen.

Microsleep episodes last from a few seconds to two minutes, and often the person is not aware that a micro sleep has occurred. While in a microsleep, a person fails to respond to outside information. During a micro sleep, a pilot might not be aware of flashing alarm lights in the cockpit.

Microsleeps are most likely to occur at certain times of the day, such as pre-dawn hours and mid-afternoon hours when the body is programmed to sleep. Microsleep periods become more prevalent with cumulative sleep debt.

Researchers have tried to quantify microsleep times and episodes in an attempt to develop a diagnostic tool like the commonly used multiple sleep latency test. However, this has proven difficult and at this time there is no agreed-upon clinical tool for assessing microsleep.

There is some evidence that parts of the brain are sleep briefly during the day when a sleep-deprived person is awake. Animal studies show that in sleep-deprived individuals slower brain wave activity typical of sleep (delta, < 4 Hz; or theta, 4–7 Hz) leaks into periods during which the animal may be moving around with eyes open.

II. MAJOR ACCIDENTS CAUSED DUE TO MICROSLEEP

More than three years after Air France Flight 447 plunged into the southern Atlantic Ocean, killing all 228 people on board. The lack of speed, wind or direction information also prevented the Autopilot system from functioning, said air accident investigator. But this was also one of the major accidents caused due to the microsleep. Two pilots underwent microsleep by 2 AM and thus the accident occurred due to it. Similarly, the Air India Express flight from Dubai to Mangalore in southern India overshot a hilltop runway, crashed and plunged over a cliff, killing 158 people instantly. Eight people survived the crash. The panel examined information contained in the digital flight data recorder and the cockpit voice recorder of the aircraft, which were found at the crash site. The panel said that Glusica reacted late and did not follow

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-11, Issue-1 (February 2021)
https://doi.org/10.31033/ijemr.11.1.6

many standard operating procedures during the landing. Glusica was suffering from "sleep inertia" after his nap and was "disoriented" when the plane began its descent at Mangalore airport.

III. OUR APPROACH

The Idea is to prevent the occurrence of any catastrophic failure or casualty resulting from pilot's micro sleep due to drowsiness and overload using the technique MEEG (MAGNETIC ELECTRO ENCEPHELOGRAM). The main advantage of this system includes accurate prediction of the theta event and state of the art alerting system. The key requirements for a successful countermeasure warrant low cost system, low false alarm, and compatibility. But, practically it is very expensive to implement and hence we use the combination of EEG (ELECTRO ENCEPHELOGRAM), EOG (ELECTRO OCULOGRAM), IR (INFRA RED) Module to detect microsleep of the pilot.

IV. ELECTRO ENCEPHELOGRAM

An electroencephalogram (EEG) is a test that measures and records the electrical activity of your brain. Special sensors) are attached to your head and hooked by wires to a computer. The computer records your brain's electrical activity on the screen or on paper as wavy lines. Certain conditions, such as seizures, can be seen by the changes in the normal pattern of the brain's electrical activity.

Electroencephalography (EEG) is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations that can be observed in EEG signals.

The brain's electrical charge is maintained by billions of neurons. Neurons are electrically charged (or "polarized") by membrane enabled transport proteins that pump ions across their membranes. Neurons are constantly exchanging ions with the extracellular milieu, for example to maintain resting potential and to propagate action potentials.

The pairs of electrodes are placed either above and below the eye or to the left and right of the eye. If the eye is moved from the center position towards one electrode, this electrode "sees" the positive side of the retina and the opposite electrode "sees" the negative side of the retina. Consequently, a potential difference occurs between the electrodes. Assuming that the resting potential is constant, the recorded potential is a measure for the eye position

V. ROLE OF IR SENSOR IN MICROSLEEP

The basic principle of IR sensor is based on an IR emitter and an IR receiver. IR emitter will emit infrared continuously when power is supplied to it. On the other hand, the IR receiver will be connected and perform the task of a voltage divider. IR receiver can be imagined as a transistor with its base current determined by the intensity of IR light received. The lower the intensity of IR light cause higher resistance between collector-emitter terminals of transistor, and limiting current from collector to emiiter. This change of resistance will further change the voltage at the output of voltage divider. In others word, the greater the intensity of IR light hitting IR receiver, the lower the resistance of IR receiver and hence the output voltage of voltage divider will decreased. Usually the IR emitter and IR receiver will be mounted side by side, pointing to a reflective surface. The further distance away between emitter and receiver decrease the amount of infrared light hitting the receiver if the distance between the sensor and a reflective surface is fixed.

VI. HARDWARE REQUIREMENTS

Operational Amplifier

An operational amplifier (op-amp) is a DC-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output. An op-amp produces an output voltage that is typically hundreds of thousands of times larger than the voltage difference between its input terminals. Operational amplifiers had their origins in analog computers, where they were used to do mathematical operations in many linear, non-linear and frequency-dependent circuits. Characteristics of a circuit using an op-amp are set by external components with little dependence on temperature changes or manufacturing variations in the op-amp itself, which makes op-amps popular building blocks for circuit design.

The op-amp is one type of differential amplifier. Other types of differential amplifier include the fully differential amplifier(similar to the op-amp, but with two outputs), the instrumentation amplifier (usually built from three op-amps), the isolation amplifier (similar to the instrumentation amplifier, but with tolerance to common-mode voltages that would destroy an ordinary op-amp), and negative feedback amplifier (usually built from one or more op-amps and a resistive feedback network).

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-11, Issue-1 (February 2021)
https://doi.org/10.31033/ijemr.11.1.6

Voltage Follower

Voltage Follower or Voltage Buffer is used to isolate an input signal by using an op-amp circuit with the input signal fed to the non-inverting terminal.

Filters

Electronic filters are electronic circuits which perform signal processing functions, specifically to remove unwanted frequency components from the signal, to enhance wanted ones, or both.

Micro Controller

A microcontroller is a complete microprocessor system built on a single IC. Microcontrollers were developed to meet a need for microprocessors to be put into low cost products. The microcontroller contains full implementation of a standard MICROPROCESSOR, ROM, RAM, I/O, CLOCK, TIMERS, and also SERIAL PORTS. Microcontroller also called "system on a chip" or "single chip microprocessor system

PIC Controller

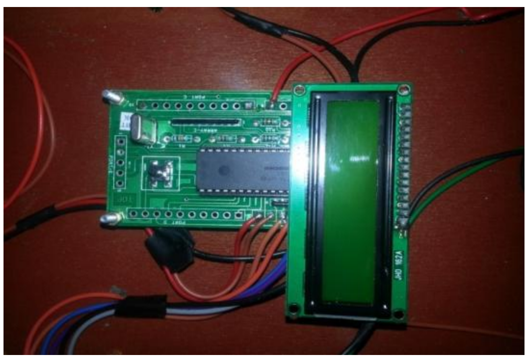

Figure 1: PIC16f877 with LCD

The microcontroller that has been used for this work is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complimentary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

Analog to Digital Converter (ADC)

The PIC Controller consists of inbuilt ADC. There are two types of analog to digital converter is present in this IC. In this work10-bit ADC is used. The ADC module can have up to eight analog inputs for a device. The analog input charges a sample and hold capacitor. The output of sample and hold capacitor is the input into the converter. The converter then generates a digital result of this analog level via successive approximation. The A/D conversion of the analog input signal results in a corresponding10-bit digital number

Buzzer

A buzzer or beeper is a signaling device. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound.

Figure 2: Buzzer

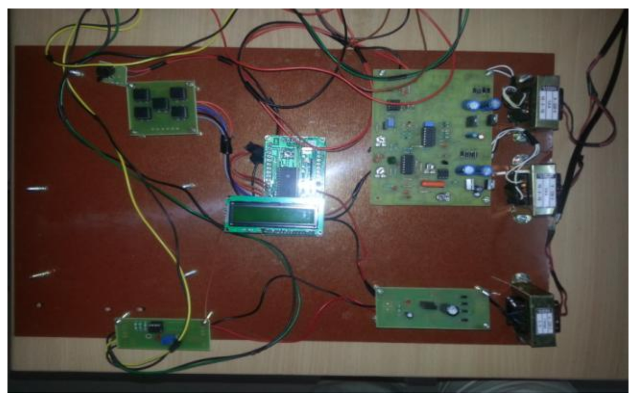

Figure 3: Designed MSAP KIT

VII. SOFTWARE REQUIREMENTS

There are two software that are used in this system. They are

- MP Lab Tool
- Embedded C

These two software were used to fuse the input into the PIC Controller which would detect the micro sleep of the pilot.

VIII. RESULT AND DISCUSSION

Thus with the combination of EEG, EOG and IR Module, The Micro sleep of the pilot would be detected with which would help to avoid many accidents which occur due to it. The signal from EEG, EOG and IR reaches the microcontroller and the microcontroller checks for the

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-11, Issue-1 (February 2021)
https://doi.org/10.31033/ijemr.11.1.6

micro sleep signal and activates the alarm system. The alarm activation is given to cockpit, crew members and to the ground through FMS.

- If the pilot encounters micro sleep, prolonged eye closure and slow, downward movement of eye will a occur.
- Two electrodes were stuck above and below the eye each.
- The IR module with goggle were worn by the experimenter.
- The EOG sensed the downward eye movement.
- The IR module detected the amount of time the eyes closed.
- Both inputs are sent to PIC 16F877
- If the eye closure exceeds the preset time and if the EOG value satisfies the predetermined value, the micro controller will activate the alarm.
- The operation of kit checked by experimenting it with many people. When the eye closure and down movement detected, the piezo electric buzzer was activated and it made louder sound.

IX. CONCLUSION AND FUTURE WORK

This work ensures high accuracy and low false alarm in the micro sleep detection.

Also this work has involved only the combination of EEG, EOG and IR. But the usage of MEEG in practical would provide a greater accuracy in determining the micro sleep signal.

- Since both EOG and IR module used, accuracy in finding the Micro sleep events improved.
- The EOG reading will differ with each pilot, since they are bio signals.
- But in our work, provision to preset the EOG value is incorporated.
- This work would surely help in reducing human lapses during the flight.
- The IR module has been designed to be fitted with pilot navigator goggle.
- Apart from cockpit bound warning, rest of the crew and ground terminal also could receive the warning tone. This work increases the situational awareness to pilot. On the whole, as a contingency control it would prevent any Air crashes from occurring due to pilot's fatigue and Micro sleep.

We have implemented only EOG and IR module. If EEG is included additionally then the accuracy would be much improved. Since the electrodes are intrusive in nature, MEG can be used.MEG employs only non intrusive electrodes. So that electrodes touching the scalp is averted.

REFERENCES

[1] Bergasa L., Nuevo J., Sotelo M., & Vazquez, M. (2004). Real-time system for monitoring driver vigilance. *IEEE Intelligent Vehicle Symposium*, 78–83.

[2] D' Orazio, T. Leo M., Spagnolo P., & Guaragnella, C. (2004). A neural system for eye detection in a driver vigilance application. In: *7th International IEEE Conference on Intelligent Transportation Systems*, 320–325.

[3] Duda, R. & Hart, P. (1972). *Use of the hough transformation to detect lines and curves in picture*. Available at: https://dl.acm.org/doi/10.1145/361237.361242.

[4] https://dl.acm.org/toc/cacm/1972/15/11.

[5] Fleiss, J., Cohen, J., & Everitt, B. (1969). Large sample standard errors of kappa and weighted kappa. *Psychological Bulletin, 72*, 323-327.

[6] https://psycnet.apa.org/record/1970-01528-001.