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Blue Eyes - Human - Operator Monitoring System

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***Abstract*— Imagine yourself in a world where humans interact with computers. You are sitting in front of your personal computer that can listen, talk, or even scream aloud. It has the ability to gather information about you and interact with you through special techniques like facial recognition, speech recognition, etc. It can even understand your emotions at the touch of the mouse. It verifies your identity, feels your presents, and starts interacting with you .You ask the computer to dial to your friend at his office. It realizes the urgency of the situation through the mouse, dials your friend at his office, and establishes a connection.**

The BLUE EYES technology aims at creating computational machines that have perceptual and sensory ability like those of human beings. It uses non-obtrusive sensing method, employing most modern video cameras and microphones to identify the users actions through the use of imparted sensory abilities.

1. INTRODUCTION

BlueEyes technology was developed and successfully tested-implemented by one group of Poznań University of Technology (Poland) recently. Although it is not commercially applied but on the basis of their implementation and resources, the overall view of the technology is given in this report.

What is BlueEyes and what not?

BlueEyes – Bluetooth technology and the movements of the eyes. Bluetooth provides reliable wireless communication whereas the eye movements enable us to obtain a lot of interesting and important information. This required designing a Personal Area Network linking all the operators and the supervising system.

BlueEyes system provides technical means for monitoring and recording human-operator's physiological condition. The key features of the system are:

- Visual attention monitoring (eye motility analysis)
- Physiological condition monitoring (pulse rate, blood oxygenation)
- Operator's position detection (standing, lying)
- Wireless data acquisition using Bluetooth technology
- Real-time user-defined alarm triggering
- Physiological data, operator's voice and overall view of the control room recording
- Recorded data playback

For example, a BlueEyes-enabled television could become active when the user makes eye contact, at which point the user could then tell the television to "turn on".

IBM says...

"Blue Eyes uses sensing technologies , such as video cameras and microphones, to identify and observe a user's actions, and to extract key information, such as where the user is looking and what the user is saying verbally and gesturely. These cues are analysed to determine the user's physical, emotional, or informational state."

Why BlueEyes ?

Human error is still one of the most frequent causes of all artificial disasters. Today human contribution to the overall performance of the system is left unsupervised. Since the system is made to perform automatically, an operator becomes a passive observer of the supervised system, which causes drop to awareness. It therefore is crucial to assure that the operator's conscious brain is involved in an active system which will supervise over the whole work time period. It is possible to measure indirectly the level of the operator's conscious brain involvement using eye movement analysis. In large control rooms, wiring the operator to the central system is a serious limitation of his mobility and disables his operation. The wireless link between the sensors worn by the operator and the supervising system offers new way to system overall reliability and safety.

System overview

The most important parameter in this system is saccadic activity (Saccades are rapid eye jumps to new locations within a visual environment assigned predominantly by the Conscious attention process.)**,** which enables the system to monitor the status of the operator's visual attention along with head acceleration, which accompanies large displacement of the visual axis (saccades larger than 15 degrees). Complex industrial environment can create a danger of exposing the operator to toxic

substances, which can affect his cardiac, circulatory and pulmonary systems. Thus, on the grounds of plethysmographic signal taken from the forehead skin surface, the system computes heart beat rate and blood oxygenation.

BlueEyes system checks above parameters against abnormal (e.g. a low level of blood oxygenation or a high pulse rate) or undesirable (e.g. a longer period of lowered visual attention) values and triggers user-defined alarms when necessary. Recording facility seems helpful to reconstruct the course of operators' work and provides data for long-term analysis.

This system consists of a mobile measuring device and a central analytical system. The mobile device is integrated with Bluetooth module providing wireless interface between sensors worn by the operator and the central unit. ID cards assigned to each of the operators and adequate user profiles on the central unit side provide necessary data personalization so different people can use a single mobile device (DAU – Data Acquisition Unit).

The tasks of the mobile Data Acquisition Unit are to maintain Bluetooth connections, to get information from the sensor and sending it over the wireless connection, to deliver the alarm messages sent from the Central System Unit to the operator and handle personalized ID cards.

Central System Unit maintains the other side of the Bluetooth connection, buffers incoming sensor data, performs on-line data analysis, records the conclusions for further exploration and provides visualization interface. The priority of the central unit is to provide real-time buffering of incoming sensor signals and semi-real-time processing of the data, which requires speed-optimized filtering and reasoning algorithms.

2. DATA ACQUISITION UNIT (DAU)

2.1Physiological data sensor

An off-shelf eye movement sensor-JAZZ multi-sensor was used as physiological data sensor. It supplies raw digital data regarding eye position, the level of blood oxygenation, acceleration along horizontal and vertical axes and ambient light intensity.

The eye movement is sampled at 1 kHz, the other parameters at 250 Hz. The sensor sends approximately 5,2kB of data per second.

2.2 Hardware specification of DAU

Atmel 8952 microcontroller to be the core of the Data Acquisition Unit since it is a well-established industrial standard and provides necessary functionality (i.e. high speed serial port) at a low price. The figure below shows the other DAU components.

Bluetooth module used in the this project supports synchronous voice data transmission (SCO link) .Developers had decided to use hardware PCM codec to transmit operator's voice and central system sound feedback. Codec employed reduces the microcontroller's tasks and lessens the amount of data being sent over the UART.

The Bluetooth module performs voice data compression, which results in smaller bandwidth utilization and better sound quality. Communication between the Bluetooth module and the microcontroller is carried on using standard UART interface. MAX232 Level Shifter does the RS232 ↔TTL voltage level conversion.

The alphanumeric LCD display (two 8-character lines) gives more information of incoming events and helps the operator enter PIN code.

The LED indicators show the results of built-in self-test, power level and the state of wireless connection.

2.3 CENTRAL SYSTEM UNIT (CSU)

There are four main CSU modules (see fig: system overview): Connection Manager, Data Analysis, Data Logger and Visualization.

2.3.1Connection Manager

Connection Manager's main task is to perform low-level Bluetooth communication using Host Controller Interface commands. It is designed to cooperate with all available Bluetooth devices in order to support roaming. Additionally, Connection Manager authorizes operators, manages their sessions, demultiplexes and buffers raw physiological data.

2.3.2 Data Analysis Module

The module performs the analysis of the raw sensor data in order to obtain information about the operator's physiological condition. The separately running Data Analysis Module supervises each of the working operators.

2.3.3Data Logger Module

The module provides support for storing the monitored data in order to enable the supervisor to reconstruct and analyze the course of the operator's duty. The module registers as a consumer of the data to be stored in the database. Apart from the raw or processed physiological data, alerts and operator's voice are stored. The raw data is supplied by the related Operator Manager module, whereas the Data Analysis module delivers the processed data. The voice data is delivered by a Voice Data Acquisition module.

2.3.4Visualization Module

The module provides user interface for the supervisors. It enables them to watch each of the working operator's physiological condition along with a preview of selected video source and his related sound stream. All the incoming alarm messages are instantly signalled to the supervisor. Moreover, the visualization module can be set in the off-line mode, where all the data is fetched from the database. Watching all the recorded physiological parameters, alarms, video and audio data the supervisor is able to reconstruct the course of the selected operator's duty.

3. LIMITATIONS AND FUTURE ASPECTS

The prototype has several limitations, which are not the result of the project deficiency but are rather caused by the constraints imposed by the Project Kit and small budget.

The unique feature of system relies on the possibility of monitoring the operator's higher brain functions involved in the acquisition of the information from the visual environment. The new possibilities can cover such areas as industry, transportation (by air, by road and by sea), military command centers or operating theaters (anaesthesiologists). It is intended that the system in its commercial release will help avoid potential threats resulting from human errors, such as weariness, oversight, tiredness.

4. APPLICATIONS

- Generic control rooms
  - Power station
  - Flight control centers
  - Operating theatres – anesthesiologists
- Common application
  - A simpler system version for drivers

5. CONCLUSION

Human has tremendous expectations from human being's future and present. This tends to research new and helpful technologies which can make the life more comfortable and reliable. This technology is one of them that can make so. Artificial disasters due to consciousness of human brain can be overcome from those accidents.

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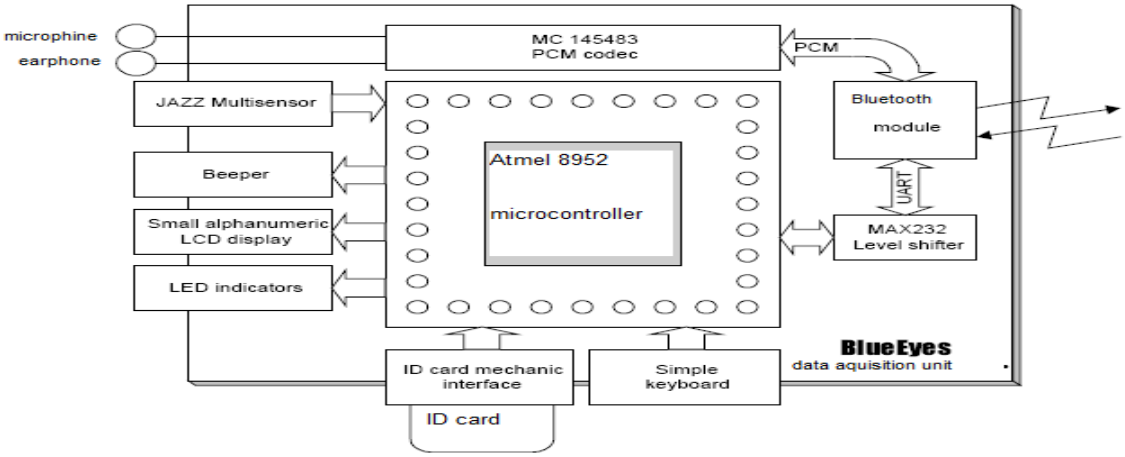

Fig 3 Hardware block diagram of DAU

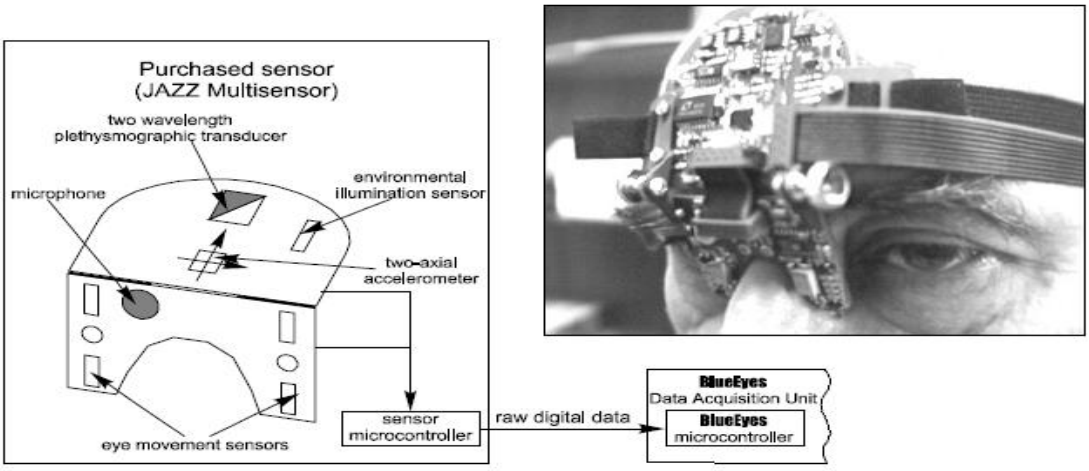

Fig 2 JAZZ multisensory

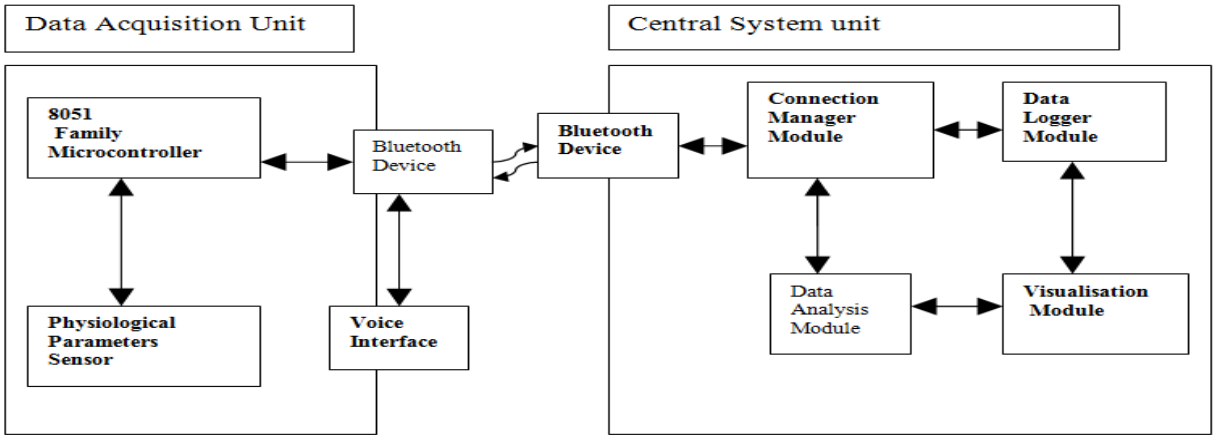

Fig 1. Overall System Diagram