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TITLE OF INVENTION	WIRELESS SENSOR PILLOW FOR SLEEP MONITORING AND GESTURE RECOGNITION SYSTEM USING EMBEDDED CONTROLLER
FIELD OF INVENTION	BIO-MEDICAL ENGINEERING
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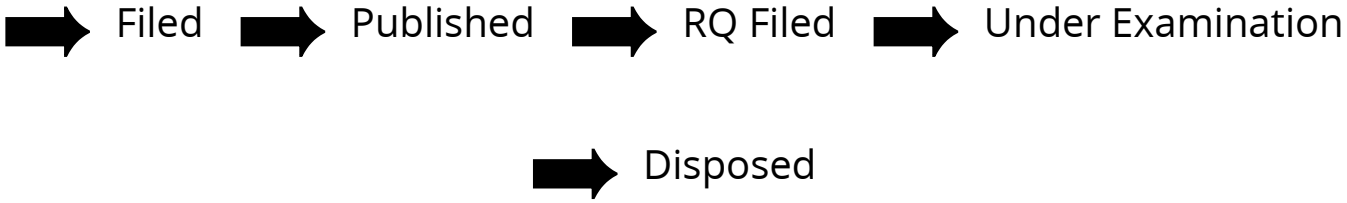

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FORM 2

THE PATENTS ACT, 1970
(39 of 1970)
&
THE PATENT RULES, 2003

Complete Specification

(See section 10 and rule 13)

1.Title of the Invention :

WIRELESS SENSOR PILLOW FOR SLEEP MONITORING AND GESTURE RECOGNITION SYSTEM USING EMBEDDED CONTROLLER

2. Applicants

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3. Preamble to the Description :

The following specification particularly describes the invention and the manner in which it is to be performed.

4. DESCRIPTION

Field of the Invention

The present invention is related to the field of electronic devices.

Background of the invention

Patient monitoring systems are gaining their importance as the fast-growing global elderly population increases demands for caretaking. These systems use wireless technologies to transmit vital signs for medical evaluation. In recent years, there is increasing concern about quality of life during human's activities. Physical and psychical conditions are hidden in the body movements.

For humans in general, the patterns of their body movements are often visibly distinct between when they are in good or bad health. Moreover, during the body movement the heart, lungs, blood vessels, and blood stream are working together as a primary source of the force acting on the head and body as called cardio-respiratory system.

Sleep is a part of life that we spend around one-third of our lives on the bed. Quality of sleep can be known by monitoring some physiological parameters during sleep. A pillow that allows our head, neck, and shoulders to arrange in a proper alignment is very important for a restful sleep. The disorder sleep patterns can cause many diseases. Because respiration and heartbeat movement can indicate sleep disorder, numerous research works have been done to monitor these signals from the sleepers, especially the elderly and disabled people who are bedridden and need for continual health care. The motions of their body in

the pillow and on the bed can be tracked in order to provide them required motion assistance. The data can also be used by doctors to provide suggestion to patients. Thus, it is believed that physical and psychical conditions under sleeping can be estimated by measuring the head and body movements. For example, cardio-respiration activity and twitch movements were measured based on such principle. Nowadays, there are several commercially available monitoring devices, but these products are limited in that sensors or electrodes need to be attached to the head and body surface which can be quite disturbing to the patient.

Detailed Description of the invention

In recent years, there is an increasing concern about the quality of life during human activities. It is said that the physical and psychical conditions are hidden in the body movements. For humans in general, the patterns of their body movements are often visibly distinct when they are in good or bad health. Moreover, during body movements, the heart, lungs, blood vessels and blood stream are working together as a primary source of the force acting on the head and body as cardio-respiratory system. In this invention, we have developed a sleep monitoring and gesture recognition system for bed-ridden patients based on polysomnography which will be useful for monitoring the patient's condition by healthcare personals and/or relatives. In particular, we present the sensor pillow system that employs wireless networks based on low-cost ZigBee technology and a sensor array of Force Sensitive Resistors (FSR) based on Polymer Thick

Film (PTF) device for classifying and recognizing sleep posture. This invention also proposes a simple motion model that explains the change of the head pressure distribution. In addition, we can detect some physiological parameters like body temperature during the sleep stages and wakefulness as well as record cardio-respiratory activity as related to different physiological factors. The integration of the sensor system and wireless technology with computer software could make this healthcare monitoring system a commercial product valuable for point-of-care applications.

PROPOSED SYSTEM:

In this invention, we have developed a sleep monitoring and gesture recognition system for patient based on polysomnography which will be useful for patient communication with healthcare personals and/or relatives. In particular, we present the sensor pillow system that employs wireless networks based on low-cost ZigBee technology and a sensor array of Force Sensitive Resistors (FSR) based on Polymer Thick Film (PTF) device for classifying and recognizing sleep posture. These sensors exhibit a decrease in resistance with an increase in the force applied to the active surface.

To demonstrate the proposed concept, we have constructed a sleep monitoring system consisting of a pillow-embedded sensor array, a wireless sensor network and PC software for real-time on-pillow motion tracking. Wireless network based on low-cost ZigBee technology was used to transfer data from the pillow to a computer. ZigBee is a technique based on the IEEE 802.15.4 standard that enables the communication device to operate using ultra-low power

consumption. Therefore, ZigBee technology is very appropriate for implementation of a low-cost network where a large number of pillows can be connected simultaneously. A basic requirement of a sleep monitoring system is an algorithm that can distinguish between sleep stages and wakefulness. The resulted gestural data could provide useful information for sleep medicine and health research. In addition, we can detect some physiological parameters like body temperature during the sleep stages and wakefulness as well as record cardiorespiratory activity as related to different physiological factors.

The integration of the sensor system and wireless technology with computer software could make this healthcare monitoring system a commercial product valuable for point-of care applications.

BASIC ARCHITECTURE:

The basic Architecture is provided in the Annexed Fig 1. The pressure sensor array on the pillow can monitor the patient's head and shoulder positions during sleep. The gestural system in this study consists of three primary components as follows: (1) FSR sensor pillow as the input devices; (2) Wireless network devices based on low-cost ZigBee technology for acquiring and wirelessly transmitting data of the force sensing resistors from the pillow to PC or display device; (3) Software to classify gesture movements.

BLOCK DIAGRAM:

The general block diagram of the sensor pillow system is shown in the annexed figures. The pressure calculated by the several array points on the pillow helps in calculating the Cardio-Respiratory Rate (CRR) of the patient. The output from the sensors is fed to a signal conditioner where the inputs are processed and given to an embedded controller. The datafrom the embedded controller is transmitted via Zigbee to the monitoring unit where it is constantly monitored by healthcare personnel or to their family members.

Force Sensitive Resistors:

A force-sensing resistor is a material whose resistance changes when a force or pressure is applied. They are also known as "force-sensitive resistor" and are sometimes referred to by the initials "FSR". A force sensitive resistor is used here in order to measure the pressure distribution on the head of the patient and convert it into an equivalent resistance. The pressure and resistance are inversely proportional. Force-sensing resistors consist of a conductive polymer, which changes resistance in a predictable manner following application of force to its surface. They are normally supplied as a polymer sheet or ink that can be applied by screen printing. The sensing film consists of both electrically conducting and non-conducting particles suspended in matrix. The particles are sub-micrometer sizes, and are formulated to reduce the temperature dependence, improve mechanical properties and increase surface durability. Applying a force to the surface of the sensing film causes particles to touch the conducting electrodes, changing the resistance of the film. As with all resistive based sensors, force-

sensing resistors require a relatively simple interface and can operate satisfactorily in moderately hostile environments. Compared to other force sensors, the advantages of FSRs are their size (thickness typically less than 0.5 mm), low cost and good shock resistance. However, FSRs will be damaged if pressure is applied for a longer time period (hours). A disadvantage is their low precision: measurement results may differ 10% and more.

SIGNAL CONDITIONER:

Signal conditioners are essential to improve field received signals. Signal conditioner job starts from simple amplification to protection. For our circuit input will be 0v to 1000mv and must be amplified to 5volts. when we do amplification we would like to follow below mentioned objectives.

EMBEDDED CONTROLLER:

From the circuit it can be seen that the reference analog supply after being regulated by the 9v regulator enters the zener diode through the resistance R1 where it is again regulated to 5v since the zener diode used here has a cut off of 5v. Thus we have a double regulated completely filtered analog reference source. R2 is a potential divider used for setting the dynamic response range of the reference supply. This means that the reference 5v can be used as it is or it can be made into a fraction of the 5v for example 1v so that readings in this range can be read with more precision. This is because the ADC has 10 bit resolution which can be totally used for representing the 1v rather than 5v.

The pins 2-5, 7-10, 35 and 36 are used as the 10 channels of the ADC. To these pins the analog inputs to be processed by the ADC are given. Y1 is the crystal oscillator used. It is of 10 MHz and gives a baud rate of 9600 bits/s. The capacitors C2 and C3 are used as decoupling capacitors to remove the high frequency noise signals.

The capacitor C1 is in the off condition when power is switched off. When the power is switched on or reset then this capacitor gets charged through the resistor R2 and then through R1 this appears at the MCLR pin of the PIC. This is the memory clear pin and thus the memory is cleared and is ready for use as soon as power is switched on. S1 is the synchronous switch which is also used for the same operation and for PC and PIC synchronous operation.

Description of Drawings

Fig 1: Basic Architecture

Fig 2 : Transmitter section

Fig 3 : Receiver Section

Fig 4: Sensor pillow

Fig 5 : Force Sensitive Resistor

Fig 6 : Signal conditioning circuit

Fig 7 : Embedded Controller

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(Agent for the applicants)
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CLAIMS

We Claim :

1. A sleep monitoring and gesture recognition system for patients based on polysomnography, comprising:

   a. at least one Force sensing Resistor (FSR) sensor pillow as input device said FSR based on Polymer Thick Film (PTF) device for classifying and recognizing sleep posture;

   b. wireless network devices based on ZigBee technology configured for acquiring and wirelessly transmitting data of the FSR from the pillow to a PC or a display device;

   c. said PC or display device configured to classify gesture movements.

2. The sleep monitoring and gesture recognition system for patients based on polysomnography as claimed in claim 1, wherein, the pillow is embedded with a sensor array

3. The sleep monitoring and gesture recognition system for patients based on polysomnography as claimed in claim 2, wherein, the system is configured to detect physiological parameters like body temperature during the sleep stages and wakefulness as well as record cardiorespiratory activity.

Dated this 18th September 2020.

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ABSTRACT

WIRELESS SENSOR PILLOW FOR SLEEP MONITORING AND GESTURE RECOGNITION SYSTEM USING EMBEDDED CONTROLLER

The present invention is a sleep monitoring system consisting of a pillow-embedded sensor array, a wireless sensor network and PC software for real-time on-pillow motion tracking. Wireless network based on low-cost ZigBee technology is used to transfer data from the pillow to a computer. ZigBee technology is very appropriate for implementation of a low-cost network where a large number of pillows can be connected simultaneously. Additionally the sleep monitoring system comprises an algorithm that can distinguish between sleep stages and wakefulness. The resulted gestural data provides useful information for sleep medicine and health research. In addition, we can detect some physiological parameters like body temperature during the sleep stages and wakefulness as well as record cardiorespiratory activity as related to different physiological factors. The integration of the sensor system and wireless technology with computer software could make this healthcare monitoring system a commercial product valuable for point-of care applications.