IJEE 0973-7383 Volume-9 • Number-2 June -Dec 2017 pp. 28-30 available online at www.csjournals.com

# Design & Development of Smart Wearable System to Recognize Transition of Sleeping Postures during Night Using Bend Sensors

Ms. Amisha Beniwal, Mr. Naveen Yadav, Mr. Vikrant Verma, Dr. Vivek Kumar
Department of EEE, BRCM College of Engineering & Technology, Bahal
amishabeniwal.b@gmail.com, naveen_yadav@yahoo.com, vvikrant@brcm.edu.in, kvivek@brcm.edu.in

**Abstract:** This paper presents methods for comfortable sleep measurement at home. Existing medical sleep measurement systems are costly, disturb sleep quality, and are only suited for short-term measurement. As sleeping problems are affecting about 30% of the population, new approaches for everyday sleep measurement are needed. So those physiological parameters can be measured. Based on the parameters, the quality and quantity of sleep is analyzed and presented to the user. Also an e-health system for sleep measurement in the home environment is described here. The system measures sleep automatically. Such easy-to use sleep measurement may help individuals to tackle sleeping problems. The user can track important aspects of sleep such as sleep quantity and learn how different lifestyle choices affect sleep. So an embedded system has been proposed using flex sensors that will be capable of monitoring the different sleeping postures when someone wear it before going to bed for a sleep. The system will detect wrong sleeping positions by monitoring the positions of head, hand and leg joints and alert the user wearing it.
**Key-Words:** Flex Sensors, MEMS, Accelerometer, Microcontroller.

## INTRODUCTION

Improper spinal alignment can affect the muscles, joints, organs and nerves and cause back and neck pain, as well as remote body pain. This situation can, be prevented and cured by attention to how we position our body in our sleep environment. This thesis presents methods for comfortable sleep measurement at home. Existing medical sleep measurement systems are costly, disturb sleep quality, and are only suited for short-term measurement. We present sleep measurement methods that are based on measuring the body with practically unnoticeable and wearable flex/ bend sensors installed in the night suits. In the second part of the thesis, we describe an e-health system for sleep measurement in the home environment. The system measures sleep automatically, by uploading measured flex sensor signals to a web service. The sleep information is presented to the user in a web interface. Such easy-to use sleep measurement may help individuals to tackle sleeping problems. The user can track important aspects of sleep such as sleep quantity and nocturnal heart rate and learn how different lifestyle choices affect sleep. The wrong sleeping positions can affect our whole body, causing immediate pain and long-term damage. Considering this, a system designed to detect such change in orientation would be of great benefit. Currently, no such system exists. This project therefore identified the potential of flex sensors and accelerometers to measure and sends the data to a data logger using a microcontroller. Based on the parameters, the quality and quantity of sleep is analyzed and presented to the user. Preliminary tests prove the choice to be suitable, and after a more rugged prototype was built, human tests have been planned for the near future. This project has made significant progress in its objectives, but some tasks remain unfinished. Future works to be completed include completing human trials, a wireless interface and a self-calibrating system.

## OBJECTIVE OF STUDY

The objective is to design and develop a low cost, rugged and wearable intelligent prototype system to detect the improper sleep positions without obstructing the sleep. The prototype system should be state-of-art technology based and it should respond by continuously monitoring the human limbs like leg knees, elbows, spine, neck and head. The proposed embedded system employs flex sensors and accelerometer to measure the bend angles, head orientations and spine alignment during sleep. The system will inform the user by providing real-time alerts as like alarms, beeps, vibrations or creating a log of the whole night sleep period. The system will provide the easy home remedies to cure various sleeping disorders and maintain proper health.

## SCOPE OF STUDY

The system find a positive response in the human society as the system provides a quick and easy way to stay fit and healthy by monitoring and rectifying our sleeping positions. As we know, the wrong sleeping positions can affect our whole body, causing immediate pain and long-term damage. Poor sleep posture interacts with existing conditions to make them worse. Improper spinal alignment can affect the muscles, joints, organs and nerves and cause back and neck pain, as well as remote body pain. This situation can, however, be prevented and cured by attention to how we position our body in our sleep environment. The possible sleep reasons for neck or back pain are having too little room in bed, curling too tightly for internal organ comfort and improper body alignment. Sleeping on our stomach, even for short periods, can result in back and neck pain because of the exaggerated position of the cervical and thoracic spinal curves. Realigning our spine in bed can afford immediate relief from neck and back pain.

**IMPLEMENTED SYSTEM**

The objective is to design and develop a low cost, rugged and wearable intelligent prototype system to detect the improper sleep positions without obstructing the sleep. The prototype system made is state-of-art technology based and it responds by continuously monitoring the human limbs like knees, elbows, spine, neck and head. The implemented embedded system employs flex sensors and accelerometer to measure the bend angles, head orientations and spine alignment during sleep. The system will inform the user by providing real-time alerts as like alarms, beeps, vibrations or creating a log of the whole night sleep period. The system will provide the easy home remedies to cure various sleeping disorders and maintain proper health.

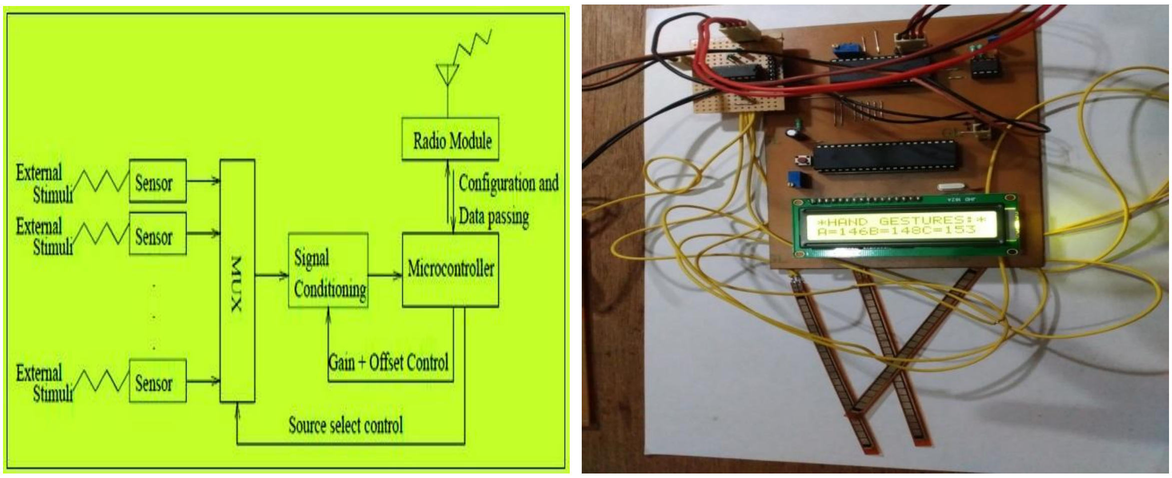


Figure-1: Architecture Overview of Proposed System

The system has been implemented around a widely used Atmel microcontroller AT89S52. The operational features is well explained below.

**Accelerometers:** Inertial sensors are basically force sensors to sense linear acceleration along one or several directions. The common operation principle is based on a mechanical sensing element which consists of a proof mass (or seismic mass) attached to a mechanical suspension system with respect to a reference frame. Inertial force due to acceleration or gravity will cause the proof mass to deflect according to Newton’s Second Law. The acceleration can be measured electrically with the physical changes in displacement of the proof mass with respect to the reference frame. We are using the accelerometer ADXL335 module to provide the analog information of 2-axis (in the positive and negative direction i.e. X+, X-, Y+, Y-). The voltage signal from the accelerometer is being fed to an ADC and then to the microcontroller for further processing.

**Flex Sensor:** Flex Sensors are analog Resistors. They work as variable analog voltage dividers. Inside the flex sensors are carbon resistive elements within a thin flexible substrate. When the substrate is bent the sensor produces a resistance output relative to the bend radius. The flex-sensor's resistance is proportional to length, i.e. 4.5"/10KΩ & 2.2"/25KΩ. It will only change resistance in one direction. An unflexed sensor has a resistance of about 10KΩ. With a bent of 90 degrees the resistance increases to 30-40 KΩ. Require 5V input and outputs 0V to 5V signals with change in resistance values according to the bend.

**Signal Conditioning Unit:** The ADC0808/ ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. It offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. The input which is to be converted to digital form can be selected by using three address lines. The default step size is 19.53mV corresponding to 5V reference voltage. ADC0808 needs an external clock to operate and for this we employed 555 Timer to generate 312 KHz clock pulse.

**MCU (Microcontroller Unit):** The system is built around an eight bit microcontroller i.e. AT89S52 supporting the following features 40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA, built-in UART module.

## ALGORITHM IMPLEMENTED

i. Initialize Analog-to-Digital Converter ADC0808
ii. Initialize Microcontroller I/O Pins
iii. Initialize LCD
iv. Provide string to display on LCD screen
v. Select an ADC Channel as the sensors are placed at different channels of this ADC
vi. Execute ADC Conversion Routine for the selected channel
vii. Save the ADC output (Measured Value) into a register
viii. Convert the ADC Binary output values to ASCII values
ix. Display these ASCII values on the LCD Screen at Channel Specific Address
x. Compare the ADC output with predefined values to check which of the following conditions is true or false:
    [Measured value = Predefined Value] or
    [Measured value > Predefined Value] or
    [Measured value < Predefined Value]
xi. Specify necessary action for a condition match
xii. Go to Step 5 and repeat the process

## RESULTS & CONCLUSION

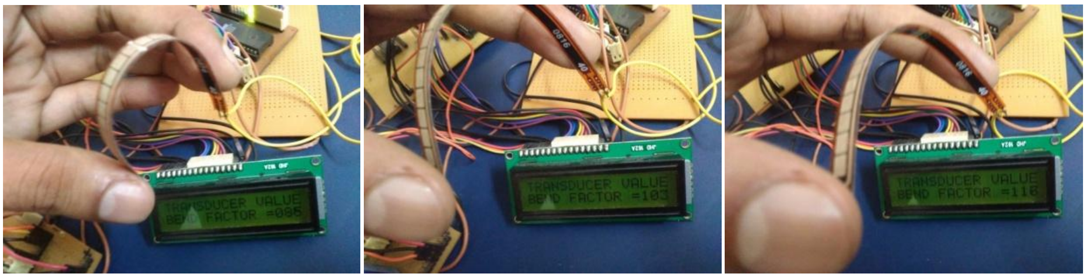


Figure-2: Snapshots of the Implemented System

Several techniques were identified as having potential to measure relative head & limb positions but Flex Sensors and Accelerometer were chosen for this system as these presents a compact, reliable and inexpensive solution to this problem. These sensors are used to measure the relative orientations of the head and other body limbs including spine, compute the resulting tilt and bend angles and transfer this data to the data acquisition system. Preliminary testing was completed by developing a small prototype employing one flex sensor and accelerometer. These tests proved its suitability and superiority to existing systems, and a more rugged version of the system has been built to prevent technical errors. This system is scheduled for human trials in the near future. This poses potential hurdles such as a higher demand for reliability, as the system isn't designed to be a commercial product. The sensitivity of surrounding equipment and the corresponding noise would be challenging considerations. Their size creates a unique set of associated engineering challenges. The ability for a system to self-calibrate and adjust to its conditions would be very advantageous in this situation.

## REFERENCES

[1] Shashank Chaurasia, K. V. N. Kavitha, An Electronic Walking Stick For Blinds, IEEE Conference, Feb. 2014, pgs-1-5, ISBN: 978-1-4799-3835-3.
[2] Rohit Sheth, Surabhi Rajandekar, Shalaka Laddha, Rahul Chaudhari, Smart White Cane -An Elegant and Economic Walking Aid, AJER, 2014, pgs-84-89, Vol.3, Issue-10.
[3] G.Gayathri, M.Vishnupriya, R.Nandhini, Ms.M.Banupriya, Smart Walking Stick For Visually Impaired, IJECS, March 2014, pgs-4057-4061, Vol.3, Issue-3, ISSN: 2319-7242.
[4] Prof.R.R.Bhambare, Akshay Koul, Siddique Mohd Bilal, Siddharth Pandey, Smart Vision System for Blind, IJECS, May 2014, pgs- 5790-5795, Vol. 3, Issue-5.
[5] Cang Ye, Soonhac Hong, Xiangfei Qian, A Co-Robotic Cane for blind navigation, IEEE Conference, Oct. 2014, pgs-1082-1087.
[6] Amjed S. Al-Fahoum, Heba B. Al-Hmoud, Ausaila A. Al-Fraihat, A Smart Infrared Microcontroller Based Blind Guidance System, Hindwi Publishing, June 2013, pgs1-7.
[7] J.Ramprabu, Gowthaman.T, Smart Cane for Visually Impaired People, IJCSIT, 2013, pgs-24-28, Vol.4 (1), ISSN: 0975-9646.
[8] S. Nithya, A. S. L Shravani, Electronic Eye for Visually Impaired Persons, IJETAE, Oct. 2013, Vol.3, Issue-10, ISSN 2250-2459.