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Designing Of WSN Based Embedded System Using Wearable Sports Sensors: A Theoretical Approach

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***Abstract*—The advent of wearable textile-based sensors has paved, an easy and efficient, way for physiological monitoring. Athletes are not required to carry monitoring devices separately. Instead, the technology of using fabrics as sensors, enable them to be monitored with the help of garments that they wear. In the present paper, we tend to propose an embedded system design to monitor physiology and body kinematics in a cost effective manner with minimum energy conservation. Also, we aim at proposing a system which is small in size. For that purpose, our proposed Embedded System consists of Xadow micro-controller (dimension 25mm*20mm) with sensors and actuators useful for health monitoring in physical education**

Keywords—Embedded Systems, Microcontroller, Xadow, wearable sensors, e-textiles

I. INTRODUCTION – Physical education is an integral part of the society, not only because it is a source of recreation, but also it is beneficial for maintaining a good heath. Earlier, the source of monitoring physiology and body kinematics of sports person was the coach's observation. It is quite obvious that human observations and monitoring accompany a lot of error, so with the help of the proposed Embedded System, it is possible to monitor body kinematics, sweat pH levels, heart rates, etc easily with accuracy.(1)

Wearable sensors are integrated into wearable objects or directly with the body in order to monitor the body's physiological response and body kinematics. Application of such sensors requires textile based sensors, which are comfortable, wearable and straightforward to use. The Embedded System comprising such sensors and a washable wearable control board can prove very effective in monitoring the physiology of an athlete. There are several types of sensors which are used in sports activites. pH sensors are responsible for real time sweat analysis. This includes a fabric channel dyed with pH sensitive indicator giving colorimetric response. In addition, LED can be used which detects the color change and provides real time signals. Thus coach can monitor the sweat pH level of the player time to time. Also, temperature sensor is used to keep track of temperature changes. While it is not exactly like a thermometer, the concept of the sensor is similar, i.e. it provides a reading of the body temperature. (2)

3 axis accelerometers are used to track movement in every direction. An accelerometer sensor takes inertial measurements of velocity and position. Usually on three axes, it can sense inclination, tilt, and orientation of the body, also. Naturally, this is very important for any fitness tracker as most steps taken by the individual will be actually recorded by this sensor. Gyroscope measures orientation and rotation. A gyroscope can be used for navigation and measurement of angular velocity. A 3 axis gyroscope can be paired up with a 3 axis accelerometer to provide a '6 degree of freedom' motion tracking system. This combination can be used to get a better grip on the 3D workout motions that an individual may perform, for more reliable fitness tracking. Altimeter is used for altitude measurements for mountain climbing. Pressure altimeters are actually an advanced version of the aneroid barometer. Where the barometer shows the measurement of pressure, the altimeter shows the height as there is an exact correlation between them. Bio-impedance sensor checks the resistance of the skin to a small electric current. The galvanic skin response is a method of measuring the electrical resistance of the skin and interpreting it as a certain activity of the body. It is also known as electro-dermal response or psycho galvanic reflex. That does not mean that the embedded system will be giving shocks, but some of them may use this sensor to collect data for heart rate. Optical sensor uses light on the skin to measure the pulse. The sensors can be used to measure the rate at which blood is pumped through the capillaries, thereby measuring the heart rate. Fabric strain or pressure sensors are helpful in measuring breathing rates by detecting the expansion and contraction of the ribcage. Modified foams coated with the conducting polymer polypyrrole (PPy) or loaded with carbon encased within a pocket in a garment or chest-strap at ribcage can detect such movement (3)

Touch sensor has been common nowadays for displays and IoT projects with control boards like Arduino, Xadow, etc. They can be found in lamps, touch screens of smart phones, and other wide arrays of applications as well. A touch sensor is an electronic sensor used in detecting and recording physical touch. Also known as tactile sensors, it's a small, simple, low-cost sensor made to replace old mechanical switches.(4)

II. WORKING PRINCIPLE

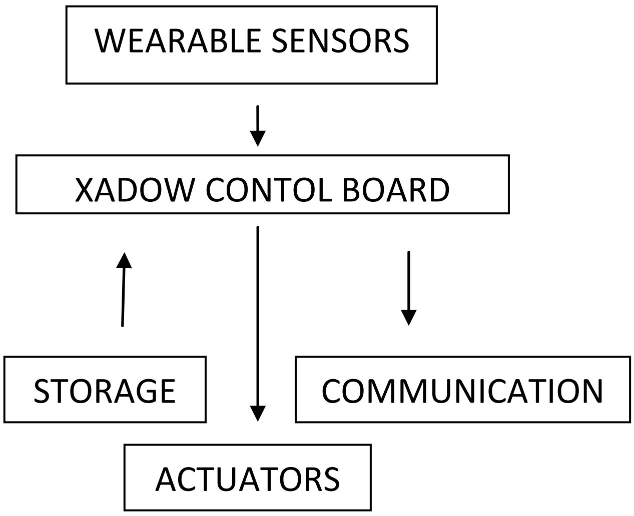

Figure 1

III. MATERIALS AND METHOD

This section gives knowledge about the structure of the proposed framework. Sensor part in figure 1 is for sensing and analyzing the data from the body of the athlete. Xadow micro-controller will collect and process the data from sensor and it will store it into its flash memory. Server and mobile phone can receive the data from the controller using Wi-Fi and GSM module respectively.

The Figure 1 represents the block diagram of the proposed Embedded System. In this the body temperature, heart rate, blood pressure, sweat pH, etc can be sensed by the sensor and it will send the data to micro-controller where the data is processed and stored. Whenever the micro-controller encounters the abnormal values of any parameter it will alert the coach by sending SMS. This communication can be done by using the GSM module. RTC can also be used to set the alarm for particular exercise or training timings for physical education.

This embedded system can be attached to a fabric and can be worn on arm or thighs with ease and comfort, it's minimized size will make it very easy to use and handle.

A MICROCONTROLLER

XADOW Control Board - When it comes to the best wearable control board, Xadow is the best control board that is available in the market due to its analog/digital pins and wireless communication. Another advantage it has is it can be washed that enables a permanent connection with a textile and textile fibers. Flexible conduction lines could also be made of any conductive ink and conductive polymer. It features high performance and low power consumption, which makes your project small and portable, especially suitable for wearable projects.(1)

The on-board controller **ATmega32U4** has 32K Flash and 2.5K SRAM and 1K EEPROM, it can be also used as a USB slave module. This Board can be powered either from the on-board USB connection or a Lithium battery. Also, there is charge circuit on this module that one can charge the Lithium battery through the USB port.

Programming for the Xadow control board can be done in C/C++ language.

Figure 2 XADOW Main board

B. SENSORS

DS18B20 Temperature Sensor Module - It has Multi-drop capability which simplifies distributed temperature sensing applications. Also, thermometer resolution is user-selectable from 9 to 12 bits. It converts temperature to the 12-bit digital word in 750ms (max.)It has user-definable nonvolatile (NV) alarm settings. Along with this, a supply Voltage of 3 to 5.5 Volts, temperature Range 55 to +125°C, measuring Accuracy ±0.5°C and a resolution of 9bits to 12bits, Figure 3 (7)

Pulse rate sensor - Pulse Sensor is a low cost, very small size a plug-and-play heart rate sensor for Arduino compatible boards and Xadow control board. It can be used by athletes to easily incorporate live heart-rate data into their records during their training period and thereafter too. It's noticeably faster and easier to get reliable pulse readings, Figure 4 (3)

Sweat pH sensor - A fabric channel dyed with a pH sensitive indicator which has a colorimetric response can be used. LEDs positioned above the channel are used to detect colour change, using a paired LED approach. This approach makes it possible to collect and analyze sweat directly in real-time, using moisture-wicking fabrics that are typically used in sports clothing .Figure 5 (5)

Figure 3 DS18B20 Temperature Sensor Module

Figure 4 PULSE-RATE Sensor

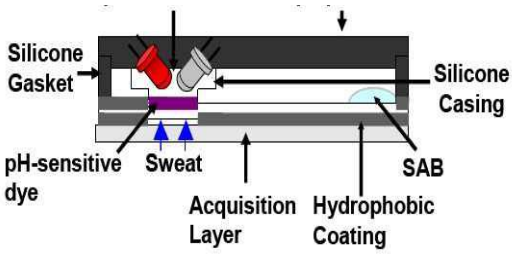

Figure 5 Sweat Ph Sensor

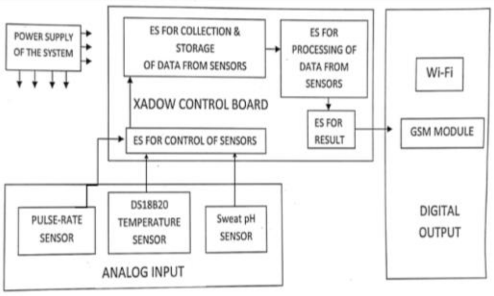

Figure 6 : Block cum Signal Flow diagram of proposed embedded system comprising Wearable Sports Sensors

Figure 6 denotes the block cum signal flow diagram of the proposed system. In addition to these sensors, nano-biosensors, such as gold nanowire electrodes or nano-structured textile electrodes (3) and composite piezoelectric films can also be used in the system. The system can also incorporate an infrared emitter-detection system for plethysmography and temperature sensors. Such system will prove to be a multichannel wearable wireless textile-based nano-biosensor that can monitors ECG and blood pressure also.

IV. CONCLUSION

The proposed idea of Embedded System based on wearable sensors implemented through a wireless network presents a proof-of-concept approach for a cost effective custom alternative to large-sized devices for wearable non-invasive, multi-parameter health monitoring. Such embedded systems are sensitive to changes in activity, skin temperature, sweat analysis and pulse rate monitoring. Monitoring trends in skin temperature provides information relevant to changes to core body temperature, making it a valuable tool for assessment of heat stress, which is a matter of concern the field of physical education. In addition to this, the method of garment-based interactions would allow person to be assessed from home on a continual basis with the remote supervision of a trained physical therapist.

The sensors presented here provide a low-cost solution to physiological sensing with the added benefit of being able to function in any setting where the wearer may choose to train. This is not only valuable for the elite athletes but also for amateurs who wish get the most from their training period and assess their progress.

The world of human-computer interaction is evolving as technology. To make the technology accessible, it must be easy to use e.g. a sports top which can collect all the physiological data, give feedback during the exercise while also saving the data for downloading later.

The sports industry has a large market for such technologies. Recent technologies on the market include the Nike plus iPod which captures running speeds and training times, Numetrex, manufacture a heart rate monitoring top, and Polar provide heart rate monitors, stride counters and GPS. Another area where sensors are increasingly being used is interactive gaming, e.g. the Wii Fit by Nintendo monitors balance for aerobic, strength and yoga training. This type of feedback could not only be useful for recreation but also for rehabilitation purposes. (6)

Textile based sensors enable technology to be integrated into clothing without affecting the look and feel of the cloth.

Future work may characterize the response and assess functionality of such embedded systems for specific applications. This will also require the development of suitable user interfaces that are straightforward and accessible. Hope this approach will prove helpful for the athletes and their coaches in physical education.

V. REFERENCES

1. MAROOF AHMED CHOUDHURY et. al; E-Textile: Review on Smart Wearable Fabric Department of MCA, ASM IMCOST, Mumbai, India, Volume: 07 Issue: 06 , June 2020

2.Shirley Coyle, Deirdre Morris, King-Tong Lau, Dermot Diamond1 1Clarity: Textile-based wearable sensors for assisting sports performance. The Centre for Sensor Web Technologies, National Centre for Sensor Research, Dublin City University, Dublin 9, Ireland shirley.coyle@dcu.ie, deirdre.morris@dcu.ie, kim.lau@dcu.ie , 2010.

3. Prashanth Shyamkumar 1,*, Pratyush Rai 1, Sechang Oh 1, Mouli Ramasamy 1, Robert E. Harbaugh 2 and Vijay Varadan Wearable Wireless Cardiovascular Monitoring Using Textile-Based Nanosensor and Nanomaterial 1,2,3 Department of Electrical Engineering, University of Arkansas, Fayetteville, AR 72701, USA; E- Department of Neurosurgery, College of Medicine, Pennsylvania State University Global Institute of Nanotechnology in Engineering and Medicine Inc, 700 Research Center Blvd, Fayetteville, AR 72701, USA Published: 19 August 2014.

4. Tao Liu et.al; A Wearable Ground Reaction Force Sensor System and Its Application to the Measurement of Extrinsic Gait Variability Department of Intelligent Mechanical Systems Engineering, Kochi University of Technology, 185Miyanokuchi, Tosayamada-Cho, Kami-City, Kochi 782-8502, Japan; Published: 16 November 2010.

5.Coris, E.E.; Ramirez, A.M.; Van Durme, D.J. Heat Illness in Athletes. Sports Med. 34, 9– 16 Fen Miao1,2, Yi He3, Jinlei Liu1,4, Ye Li1* and Idowu Ayoola- Identifying typical physical activity on smartphone with varying positions and orientations The Key Lab for Health Informatics of Chinese Academy of Sciences, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China, 2004.

6. Park, S.; Gopalsamy, C.; Rajamanickam, R.; Jayaraman, S. The wearable motherboard™: An information infrastructure or sensate liner for medical applications. Stud. Health Technol. Inform, 62, 252–258, . 1999.

7. Sean Pham, Danny Yeap Wearable Sensor System to Monitor Physical Activity and the Physiological Effects of Heat Exposure 1 Department of Mechanical and Aerospace Engineering, University of California, USA; sapham@ucdavis.edu (S.P.); dyeap@ucdavis.edu (D.Y.), Published: 6 February 2020.

8. Y.K. Kim, H. Wang, M.S. Mahmud - Wearable body sensor network for health care applications University of Massachusetts Dartmouth, North Dartmouth, MA, United States, 2016.