Modelling and measurement of a wireless foot plantar pressure

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ABSTRACT

Foot plantar pressure is the pressure fields that act between the foot skin and its supporting surface that humans experience during daily activities. Information derived from such pressure is important for diagnosing lower limb problems, footwear design, sport biomechanics performance and injury prevention. This paper presents the design and implementation of a wireless data acquisition (DAQ) for foot plantar pressure sensors. The system is intended for an in-shoe wireless pressure measurement system.

The objective of this DAQ is to be a system which can be integrated into a shoe with the ability of wireless transmission to an external on body receiver. Such device provides low power consumption, convenient and comfortable testing system simulating a range of normal daily life activities.

***Key words* –**Foot plantar pressure, pressure sensor, wireless system.

I. INTRODUCTION

The last two decades have witnessed an explosion of interest in electronic devices and microelectronic components in various fields of application. Biomedical and Sport Biomechanics research and their applications have benefited enormously as a result of the microelectronic development. There are many scientific literatures addressing the use of microelectronic device system for solving problems related to healthcare and sport. One area that has attracted a fair bit of attention by researchers from both biomedical and sport related applications is the analysis of foot plantar pressure distributions. In fact, the interface pressure between foot plantar surface and shoe soles is one of several key parameters frequently measured in biomechanical research. Foot plantar pressure is widely used in various applications, for example, footwear design, sports performance analysis and injury prevention, improvement in balance and diagnosing lower limb diseases. Based on the evidence, it could be said that it is crucial to devise techniques capable of accurately and efficiently measuring foot pressure.

The plantar pressure systems available in the market or in research laboratories vary in sensor configuration to meet different application needs. Commonly, the configuration is divided into three types: pressure platforms, imaging technologies with image processing software and in-shoe systems.

II. BACKGROUND SURVEY

Feet are the important segments of the human body and they are the main form of interaction with the environment during locomotion. Thus, it is important to diagnose a foot problem at an early stage for prevention, risk management and well being. One way to determine one's foot health is by examining the foot plantar pressure. This parameter is widely used in various applications. Therefore, it is important that accurate and reliable foot plantar pressure measurement system is developed. One of the earlier applications of plantar pressure was the evaluation of footwear. Lavery et al. [2] in 1997 determined the effectiveness of therapeutic and athletic shoes with and without viscoelastic insoles using the mean peak plantar pressure as the evaluation parameter. Since then there have been many works undertaken applying foot pressure measures for example, Mueller [3] applied plantar pressure for the design of footwear for people without impairments (i.e. the general public). Other published works worth bringing up are paper by Praet and Louwerens [4] and Queen et al. [5]. Praet and Louwerens found that rocker bottom shoes are the most effective method for reducing the pressure underneath a neuropathic forefoot. They claimed the rocker would decrease pressure under the first and fifth ray (metatarsal head), which are the locations where ulceration most often occurs in patients with cavovarus deformity. Queen et al. argued due to the differences in plantar loading between men and women, that future shoe design for the prevention of metatarsal stress fractures should be gender specific. With regard to applications involving disease diagnosis, many researchers have focused on foot ulceration problems due to diabetes and resulting excessive foot plantar pressure. It is estimated diabetes mellitus to cost over $1 billion per year worth of medical expenses in the United State alone [6]. Diabetes is now considered an epidemic and the number of patients is expected to increase from 171 million in 2000 to 366 million in 2030 [7]. In addition, foot ulcer among the elderly is increasing at an alarming rate, and the risk is further increased by pathologies such as Alzheimer's disease, congestive heart failure, chronic obstructive pulmonary disease, cerebral vascular accident, diabetes mellitus, deep venous thrombosis, hip

fracture, hip surgery, limb paralysis, lower limb oedema, malignancy, malnutrition, osteoporosis, Parkinson's disease,
rheumatoid arthritis, and urinary tract infection [8].

The improvement in balance is important both in sports and biomedical applications. Notable mentions for sports application are soccer balance training [9] and forefoot loading during running [10]. While for biomedical and healthcare areas, it can relate to the gait instability in the elderly community. Therefore, foot plantar pressure information can be used for improvement of balance among the elderly [11]. Based on the above discussion, it could be said that it is crucial to devise techniques capable of accurately and efficiently measuring foot pressure for general purposes application or specific ones.

III. PROPOSED WIRELESS DAQ SYSTEM ARCHITECTURE

The proposed architecture is as shown in the block diagram below. It consists of a transmitter and receiver.

Transmitter part consists of a power supply unit, microcontroller, Bluetooth, lcd and accelerometer.
The power supply unit consists of a step down transformer which will step down 230V ac to 0-9V. This ac voltage is then rectified to dc by rectifier, here we have used bridge rectifier. The output of the rectifier is then filtered by a capacitor and then regulated output is given to the microcontroller.

LCD is interfaced with microcontroller to display the values of accelerometer sensor .There are total four sensors which are connected to the microcontroller. When the supply is ON the values of the sensors are displayed on the LCD and then transmitted to the receiver using Bluetooth.
Receiver part consists of a power supply unit, Bluetooth , MAX 232 and RS232.

The power supply unit is same as the transmitter. The output of the Bluetooth is given to MAX 232 which is then displayed on pc using RS232 port. First we need to open VB to initialize the Bluetooth modules, once Bluetooth is initialized then we open LABVIEW and after setting the COM port we can see the output waveforms of the four sensors as shown in the simulation results.

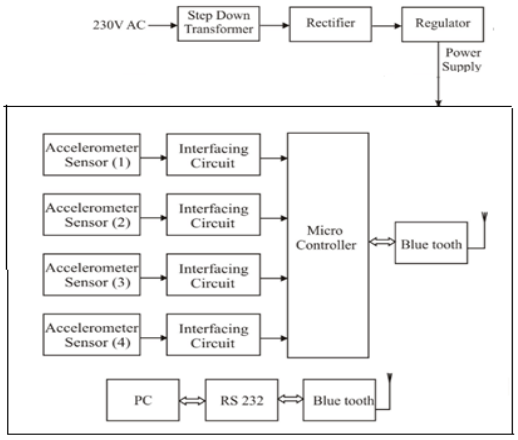

Fig 1 The Proposed block diagram

IV. IV SIMULATION RESULTS

Initialization of the Bluetooth modules through visual basic by using AT commands

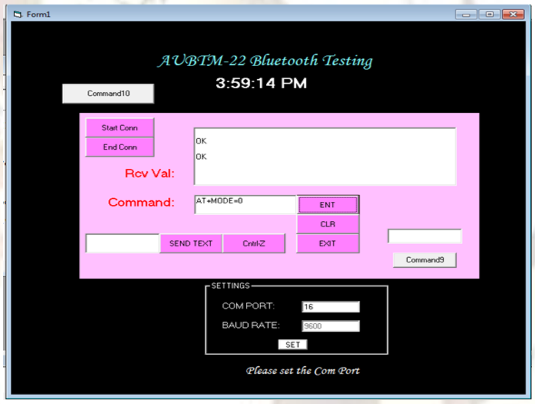

Fig 2 Initialization Window

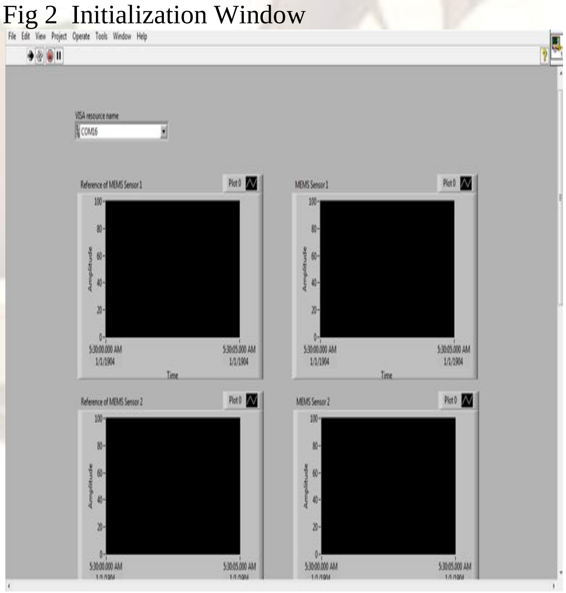

Fig 3 Window showing initial state of Sensors

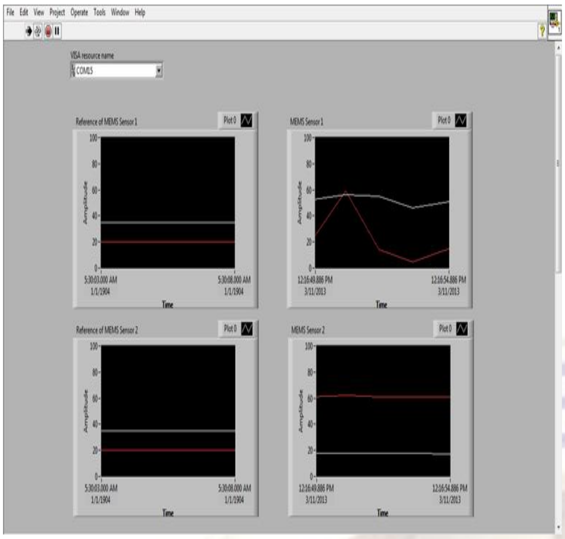

Fig 4 Output waveform of sensor 1

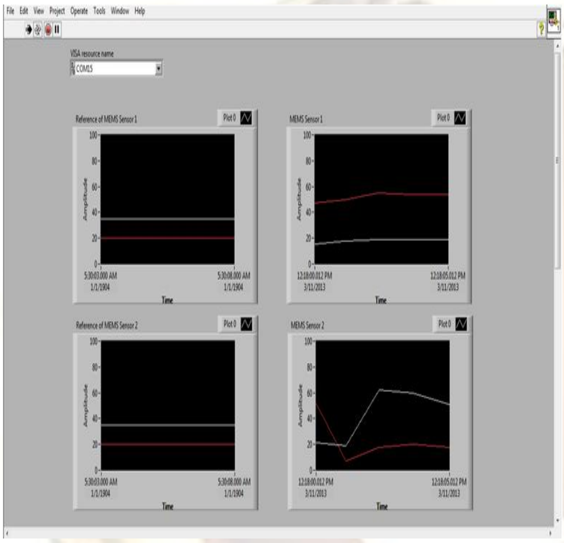

Fig 5 Output waveform of sensor 2

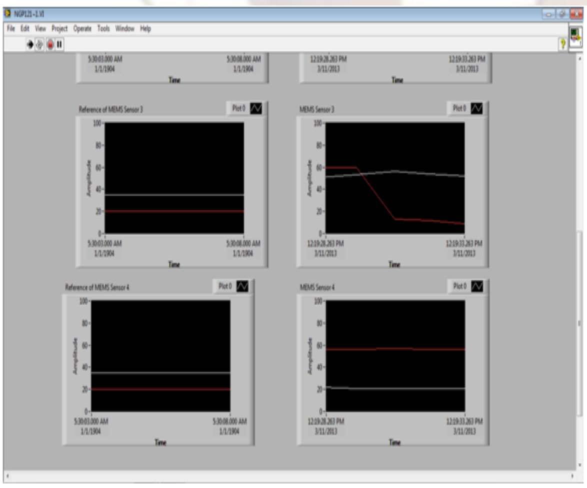

Fig 6 Output waveform of sensor 3

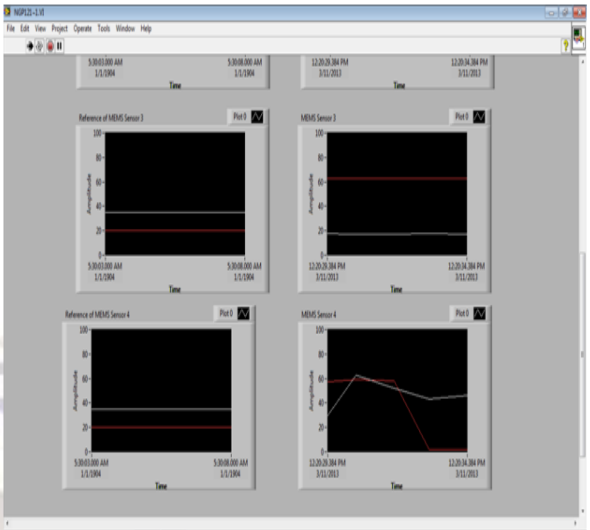

Fig 7 Output waveform of sensor 4

V. HARDWARE IMPLEMENTATION CONCLUSIONS

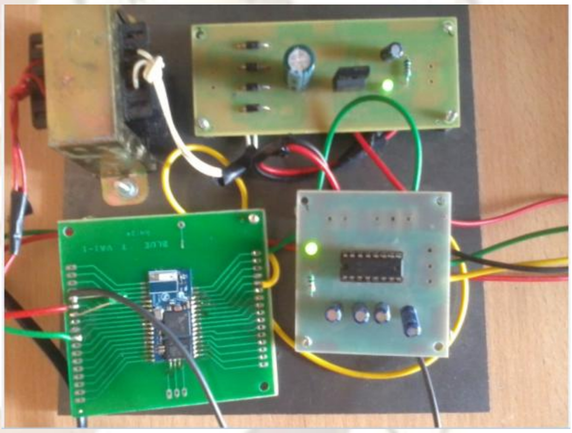

Fig 8 Receiver

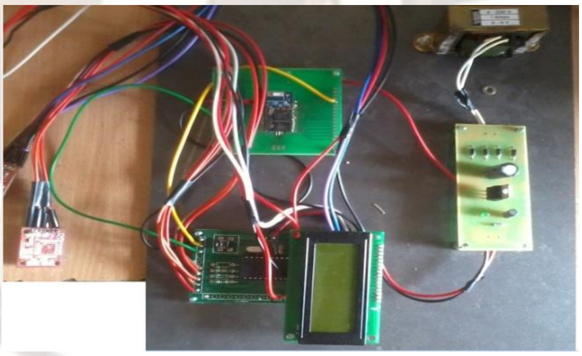

Fig 9 Transmitter

VI. IV CONCLUSIONS

The design and implementation of a wireless DAQ The system provides a good method of measuring and displaying the foot planter pressures using accelerometer Sensors. The system was interfaced with Lab view and was used to display the outputs of the sensors .With the help of the blue tooth module it was possible to obtain the data from the sensors .The system thus The system can be improved further to get the data from the sensors remotely in future.

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