International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 03, March-2015

Pedobarography Analysis System

Sangram Malekar, Akshay Kolte, Rakesh More
Department of Electronics Engineering
K. J. Somaiya Institute of Engineering and Information Technology,
Mumbai, India

***Abstract*—It is well known that a large portion of hospital admissions of diabetic patients is for the medical and surgical treatment of foot problems mainly plantar/underfoot ulcerations. The problems with plantar ulceration in diabetic plantar foot pressure which may cause further injuries. The accurate measurement of plantar foot pressures has proven to be of particular importance in the evaluation and management of the insensitive foot. These measurements yields clinically useful scientific data that, in conjunction with standard clinical examination enables the clinician to predict the site of future ulceration and monitor the care of the diabetic patient with peripheral neuropathy.**

Pedobarography analysis system is a system used to measure foot pressure characteristics during gait (walking cycle) thus providing clinical data for correct diagnosis and treatment of underfoot disorder. Otherapplications of pedobarography analysis are to evaluate patients before and after surgery, monitor degenerative foot disorders, shoe insole designing for patients etc.Most of the equipments available today for pedobarography analysis and plantar foot pressure measurements are bulky and cumbersome to handle. Also most of the pedobarography technologies are imported, hence expensive and out of reach to the general population.

Such low cost pedobarographic analysis system would make state of the art treatment available to all the medical institutions and clinics in India and to all potential patients at affordable price.

Key Words: Pedobarography, neuropathy, ulcerations

I. INTRODUCTION

Millions of dollars are spent annually for treatment of foot impairments and disorders especially of the elderly population. Such systems are is fast gaining ground in sports
industry for early diagnostics and treatment of ankle and foot related injuries. There is a wide market available for pedobarography related technology in India for evaluating patients gaitcycle before and after surgery, determining the degree of pronation and supination in diabeticpatients , designing of insoles of the shoe, early diagnosis of injuries in athletes , etc. We intend to cater to this potential market comprising of patients having foot/gait disorders, diabetic patients and sports industry by developing a low cost, easy to use system .As most of the pedobarography technologies are imported they are expensive. This system will be cheaper, the treatment cost for the patients will decrease and making state of the art healthcare for foot related problems affordable to common man.

II. METHODOLOGY AND PLAN OF WORK

This system will consist of in-sole pressure sensors rather than force plates or pressure mats for easy use. The pressure data will be sent to the computer wirelessly for evaluating further parameters like force vs. time graph , pressure vs. time graph , center of pressure(COP) , net peak pressure (NPP) at different parts of the foot, etc. Also a camera (webcam) would be present to capture live video feed of the person/patient walking with the pressure sensor insole. The video camera will be interfaced with the computer so that the video feed can be viewed by the analyst/doctor. Thus the doctor present will get pedobarographic data and synchronized video feed of the walking patient in real time.

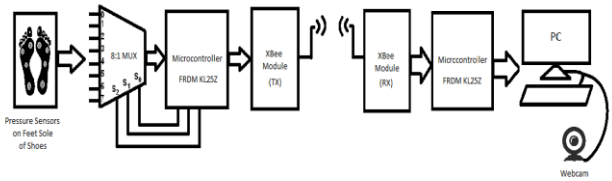

Fig. 1. Prototype block diagram

From figure 1; force sensors (force sensitive resistors) are placed and embedded at various key regions of the foot sole. Up to 8 force sensors will be placed. The signal conditioning circuit will filter out the noise present in analog force readings for high S/N (signal to noise ratio). The Analog signals from these 8 force sensors will be multiplexed and the output of the multiplexer will be connected to one ADC channel input .Thus analog force readings are applied to the A/D converters of the microcontroller (KL25Z) via multiplexing. Analog signals are converted into digital signals. Further by knowing the areas of different in-sole regions the corresponding pressure readings are obtained from their digital force readings.

The digital pressure readings are then transmitted wirelessly via XBee module. The circuitry till the transmitting XBee module is attached to the ankle of the walking patient. Due to longer range and high reliability of XBee modules the patient can walk freely. The pressure readings received by the receiver XBee module are then given to microcontroller. The microcontroller then

transmits these readings serially (via USB) to the PC. Software (preferably MATLAB) on the PC will then produce pressure vs. time graphs of various regions of the foot and compute various other parameters like step duration, cadence, etc. The data can also be stored in PC for future assessments.

The following parameters will be measured in the process:

- Dynamic graphic visualization of foot pressures
- Step duration(stance duration and swing duration)
- Number of steps
- Swing Phase
- Stance phase
- Steps/min(Cadence)
- Force versus Time graph
- Peak pressure points
- Pressure versus Time graph

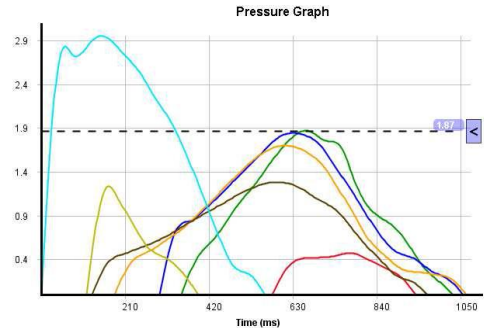

Fig. 2. Pressure versus time graph from seven different foot plantar regions

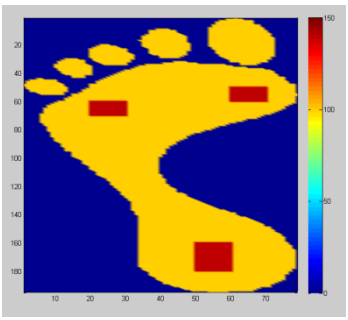

Fig. 3. Dynamic graphic visualization of foot pressures at three different plantar regions

III. SYSTEM FEATURES

Data Rate of up to 250 Kbits/s can be achieved for transmitting pressure data from foot insole to the computer for analysis ; thus making dynamic analysis possible. Range from 10-100 meters can be achieved for wireless insole wore by the walking patient depending upon the wireless RF (radio frequency) module used. Power consumption of the system will be very low by using low power smart devices and components.

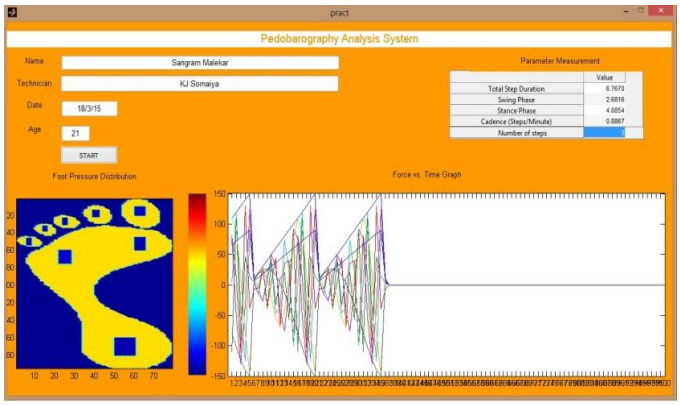

Fig. 4. Beta version of MATLAB based GUI

MATLAB will be used for analyzing the data on the pc. MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces and design for dynamic and embedded systems.

MATLAB based GUI is shown in figure 4, which analyzes the pressure readings and evaluate important gait parameters along with graphic displays of pressure versus time graph and dynamic graphic visualization of foot pressures from 8 different sensors underneath the foot.

IV. COMPARISON OF PROPOSED SYSTEM WITH CURRENT SYSTEMS

Current system:

- Currents systems are very expensive as most of them are imported and there are very few domestic companies to manufacture such systems.
- Most of the Current systems are bulky as most of these systems employ pressure mats for foot pressure measurement. These pressure mats consists of thousands of pressure cells which again makes the current system expensive. Such large numbers of pressure cells are not needed for all analyzing all the parameters.
- The development cost of the system software is the main reason for the high cost of the current systems.
- Treatments related to foot disorders are not cheap as current systems are expensive.

Proposed system:

- The prototype will be comparatively less expensive by using up to only 8 highly reliable insole pressure sensors which meets the requirements and developing the system software at academic level.
- Since the pressure sensors are embedded in shoe soles, the prototype will be compact.
- The prototype will consist of GUI (graphical user interface) and wireless link between the PC and the walking patient wearing the pressure insole making it easy to use and user friendly.
- The treatment cost for the patients will decrease as the system will be less expensive.

REFERENCES

[1] Hamill J and Knutzen KM, "Mechanical Analysis of Human Motion," in Biomechanical basis of human movement, 3rd ed. Baltimore: Williams and Wilkins, 2009.

[2] Gyusung Lee and Fabian E. Pollo. (spring 2001). *Technology Overview: The Gait Analysis Laboratory*. Retrieved from http://www.hopkinsmedicine.org/surgery/faculty/Images/01 Gait%20Analysis%20Laboratory.pdf

[3] D. Scot Malay. (1993). Application of Pedobarographic Measurements in the Evaluation and Management of the Insensitive Foot. Retrieved from http://www.podiatryinstitute.com/pdfs/Update_1993/1993_08.pdf

[4] ZigBee wireless standard, StanislavSafaric, KresimirMalaric Faculty of Electrical Engineering and Computing, Unska 3, HR- 10000 Zagreb, Croatia