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WIRELESS FOOT PLANTAR PRESSURE SYSTEM

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ABSTRACT

The wireless foot planter project is a research effort to centrally record and analyse impact force on foot to reduce running injuries and prevent Foot Strike. Despite all the money that has been dispensed into reducing running injuries by designing better shoes, the ideal way to reduce running injuries may be simply to find a way to see the impact force and pressure in different parts of the foot while running. The goal of this project is to display the maximum pressure in different parts of foot while running and to inform the person if they run on their heel and also in the angle the swing their leg or foot, which using this project could be corrected so we get maximum benefits and performance from the player. This information is based on the plot of the force applied range of their running for both recorded and real time. The approach is to design a circuit to collect data output from sensors, and then transfers it to the web server and to make it a fail proof concept a data logger is added which stores the data in case of internet failure.

Keywords: Planter, Running Injuries, Sensors, Web server, data logger

INTRODUCTION

Plantar pressure systems available on the market or in research laboratories vary in sensor configuration to meet different application requirements. Typically the configuration is one of three types: pressure distribution platforms, imaging technologies with sophisticated image processing software and in-shoe systems.

In-shoe foot plantar sensors have paved the way to better efficiency, flexibility, mobility and reduced cost measurement systems. For the system to be mobile and wearable for monitoring activities of daily life, the system should be wireless with low power consumption. Wireless in-shoe foot plantar measurement systems have potential application to data transfer communication systems, miniaturized biomedical sensors and other uses. However, existing wireless plantar systems has limitation in distances. The sensors should be in proximity distance with processing and analysis unit of the system which limits the practicality of using wireless plantar systems in taking on-field measurements.

For compact, low cost wireless applications an on-chip antenna is a practical solution. On-chip antenna implementation is feasible with the assistance of rapid scaling of low cost complementary metal-oxide-semiconductor (CMOS) technology. The feasibility of creating circuits and systems to operate at high frequency bands and subsequently reducing the antenna size using on-chip antennas has been discussed in his paper.

METHODOLOGY

This projects uses strategically placed piezoresistive force sensor inside shoe and accelerometer sensor to calibrate the force applied on the foot and the angle of ankle. The analogue signals from the sensors are converted to digital reading and transmitted to a web server using a Wi-Fi device and displayed in graphical format on real time basis. These digital data is also stored in a SD card as a backup.

The on board Arduino MEGA microcontroller board acts as the brain for this project which does all the above functionalities. This microcontroller board is powered by light weight lithium polymer battery makes it truly wearable and portable. The LCD display displays X, Y, Z coordinates of the accelerometer which can be used to calibrate or set the "Zero error". This LCD can be removed from the system once the initial values for X,Y and Z coordinates are set.

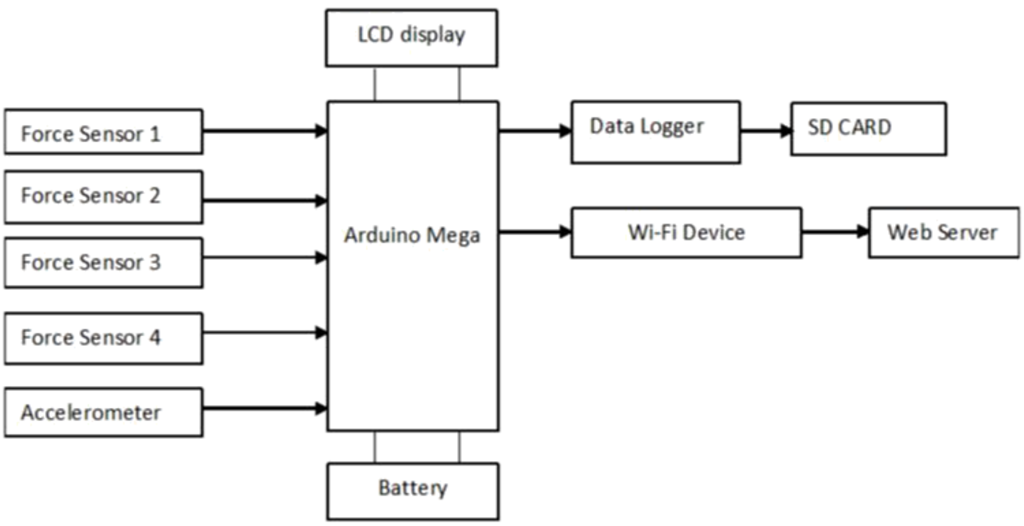

Figure 1: Block diagram

DESIGN

The main part of design is to program the Arduino MEGA microcontroller board to collect analogue signals from four multiple force sensors and one accelerometer sensor, check the availability of network and to record data to SD card or transmit to webserver. C++ programming language is us to build this program.

First stage of the program is to check connectivity or availability of all sensors and modules once powered ON. First it checks connectivity of all four FSR 402 thin film force sensor, then check the connectivity of accelerometer sensor, later checks for the availability of ESP 8266 Wi-Fi module.

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The second stage of the program is to read data from sensors and based on the availability of Wi-Fi module and availability of network the data is written to SD card in CSV format or transmitted to a web server.

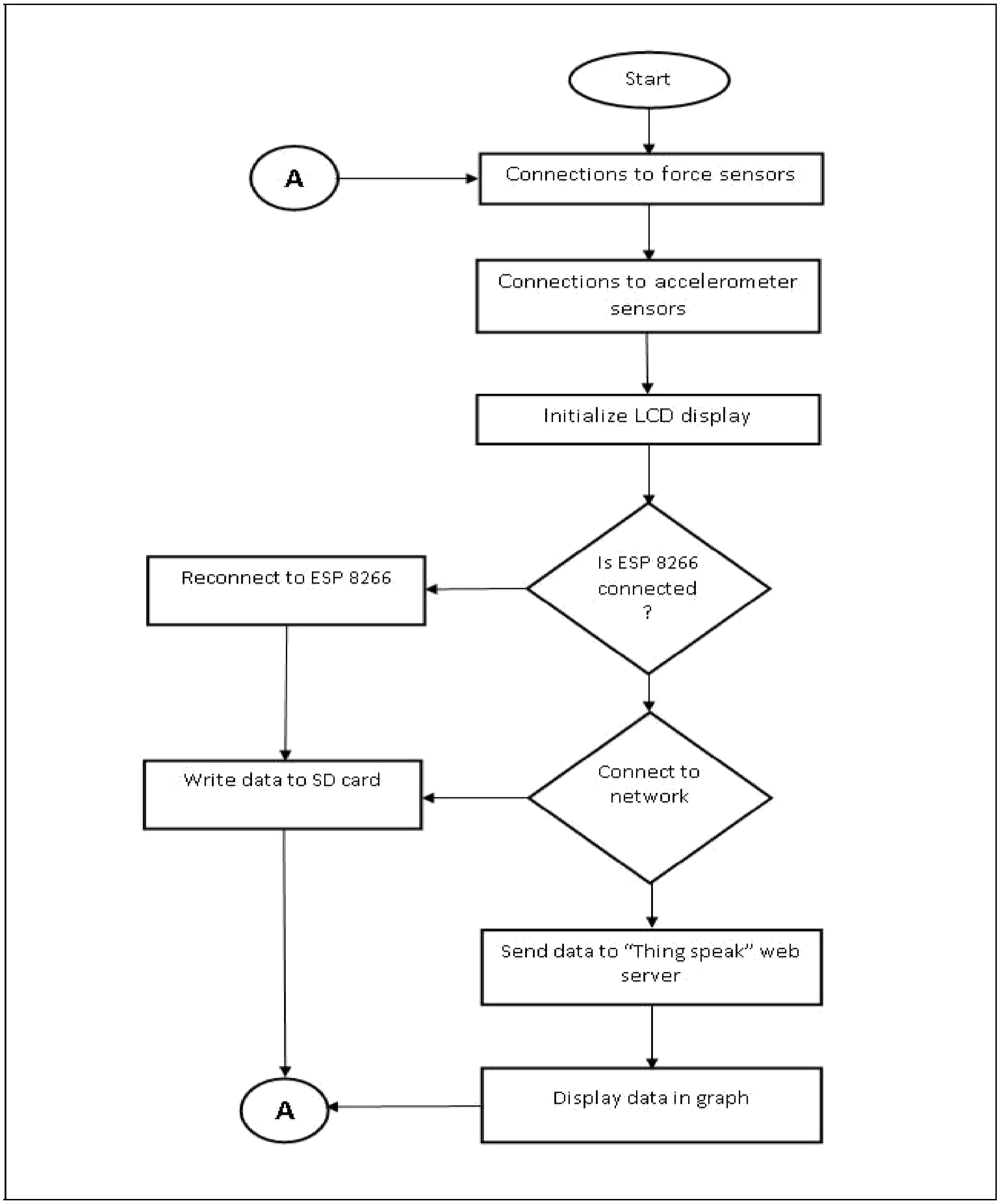

Figure 2: Work flow

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When the microcontroller board is powered ON, it loads the program and initializes all sensors and modules connected to the microcontroller board. When force is applied on FSR 402 sensors, it sends analogue signals in range 0-5 Volt. Lesser the force lower the voltage, higher the force higher the voltage. This analogue signals are received by Arduino analogue pins and converted into 10 bit digital signals (2^10). This digital values are imported as variables in the program and logics in the program transmit the digital data via ESP 8266 (Wi-Fi module) using SPI protocol (Serial Peripheral Interface protocol) to web server. If the Wi-Fi module is not connected or network is not available then "CSV" module of the program is invoked and data from the sensors are written to SD card in CSV format.

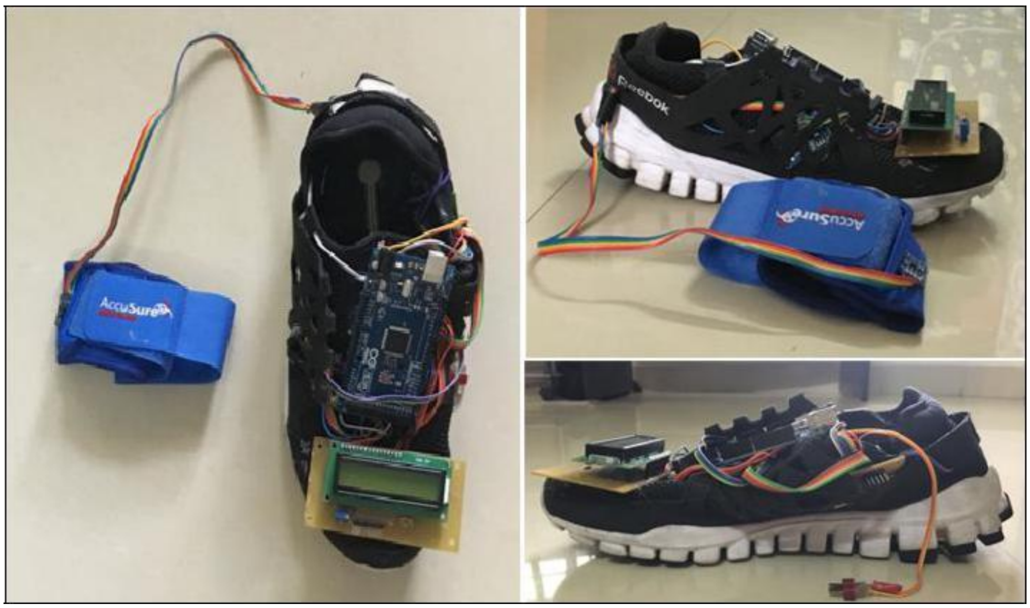

Figure 3: Wireless foot plantar pressure sensing system Main components used in this project are listed in below table.

S. No.	Component	Description	Quantity
1	Arduino MEGA 2526	Microcontroller board with ATmega2560 microcontroller	1
2	FSR 402	Single zone Force Sensing Resistor	4
3	XC4478	3 axis accelerometer module	1
4	ESP8266	WiFi wireless transceiver module	1
5	JHD162A	LCD display module	1

Table 1: Important components

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RESULTS

After design and development of the projects tests were done to check the functionality of the wireless foot plantar pressure sensing system.

Condition 1: Walking on even surface with network connection.

This test was conducted by walking on an uneven surface by wearing the wireless foot plantar pressure sensing system after connecting the system to an internet hot spot. Real time data was displayed in the web portal in graph format.

Figure 4: Graph output in web portal for test condition 1.

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Condition 2: Walking on uneven surface with network connection.

This test was conducted by walking on an uneven surface by wearing the wireless foot plantar pressure sensing system after connecting the system to an internet hot spot. Real time data was displayed in the web portal in graph format. As expected there was notable difference in the accelerometer data comparing to the first test.

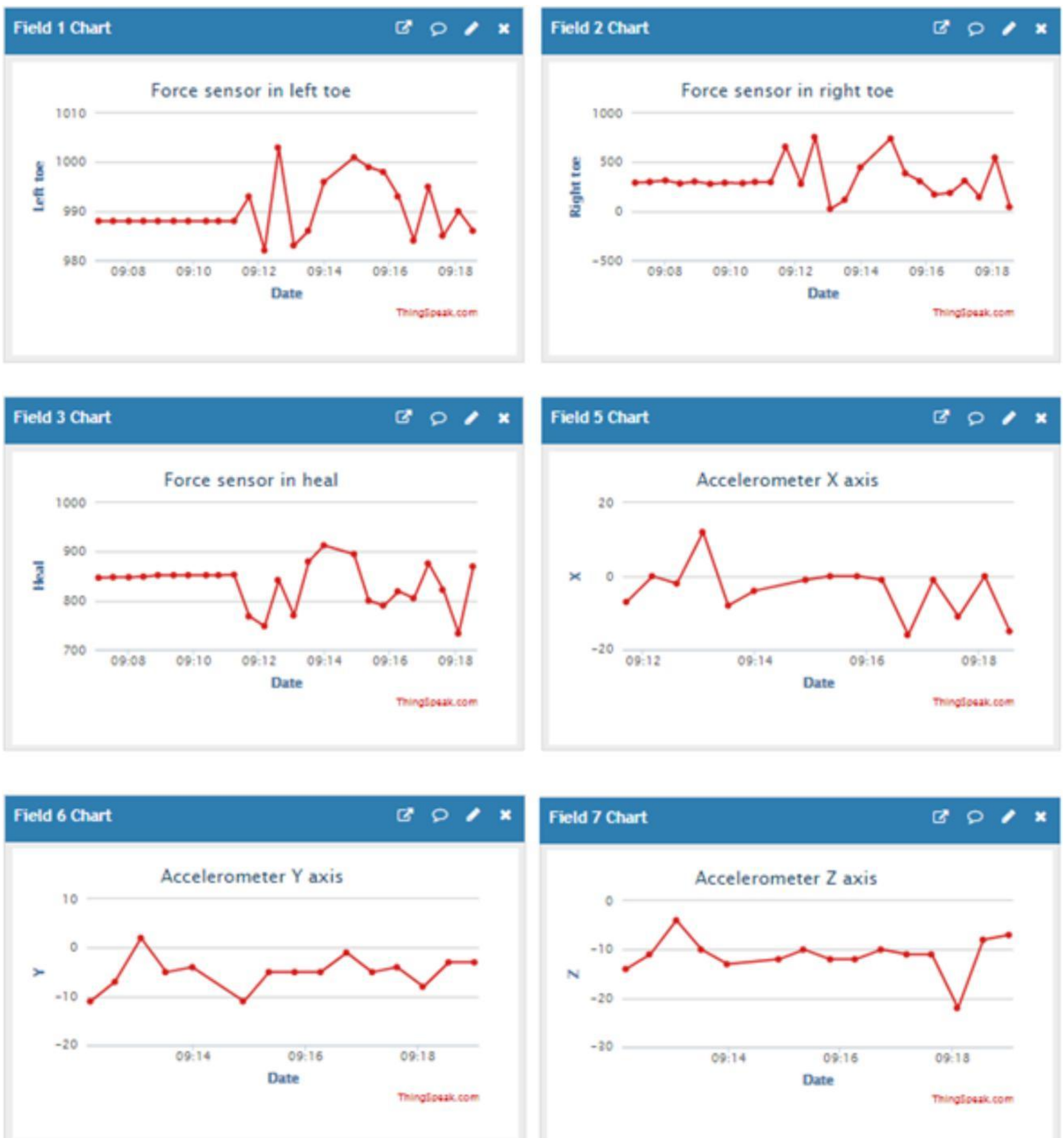

Figure 5: Graph output in web portal for test condition 2.

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Condition 3: Walking on even surface without network connection.

This test was conducted by walking on an even surface by wearing the wireless foot plantar pressure sensing system without connecting the system to an internet. As expected data were stored in SD card in CSV format.

	A	B	C	D	E	F	G
1	force1	force2	force3	force4	x	y	z
2	0	436	784	0	-2	-5	-13
3	0	58	613	0	-4	-3	-11
4	940	779	674	0	1	-7	-10
5	0	268	821	0	-8	-4	-14
6	719	847	745	812	-1	-5	-16
7	731	655	693	0	2	-5	-13
8	0	195	798	0	-10	-5	-8
9	0	197	840	0	-9	-5	-7
10	0	296	847	0	-10	-4	-10
11	0	297	852	0	-10	-5	-9
12	0	632	916	0	-3	-5	-13
13	849	838	765	0	2	-7	-16
14	0	166	811	0	-9	-4	-13
15	0	448	731	0	9	-1	-15
16	0	455	882	0	-2	-5	-15
17	0	668	716	0	10	-3	-11
18	0	189	744	0	-3	-7	-12
19	0	762	911	0	0	-4	-14
20	947	860	777	0	2	-4	-15
21	0	181	843	0	-11	-3	-13
22	0	622	721	0	10	-2	-16
23	865	837	837	0	0	-4	-15
24	0	238	766	0	2	-8	-11
25	741	155	883	0	-6	-5	-12
26	973	392	741	0	-3	1	-8
27	830	241	767	0	4	-5	-12
28	0	297	802	0	-5	-5	-9

Table 2: Offline data recorded in SD card in CSV format.

CONCLUSION

The objective of this paper is covered, which is to create a truly wireless wearable pressure sensing system with no limitation in the distance, which can be used in real time applications. This project opens up new possibilities of using this system in varies applications ranging from providing on-ground data on various natural terrain for designing customized footwear's for sports personals, to real time monitoring of force or pressure experienced by athlete's feet and angle of ankles to avoid injuries and to improve athletes performance.

This is a proto type so, more improvements should be done to this system to make it compact, lightweight and reliable. I hope this system will directly or indirectly help athletes and sports personals to improve their performance and reduce injuries.

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