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SMART SHOES FOR FLAT FEET

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Abstract: This paper proposes the smart shoes classifying a normal, Plano-valgus foot and Toe walking in autism, and to provide the information to paediatrician. Therefore, we propose a prototype smart shoe for temporal identification and correction for child with abnormal walking patterns consisting of uneven pressure distributions. We focus on identifying and providing feedback for it abnormal walking patterns. This smart shoe including force sensitive resistor sensors, coin vibrators, Memory storage, a microcontroller (18F2520), a GPS, a GSM, a power supply, and a Smart Software application on a Smartphone (like thing show, pocket IOT Internet of things).

Keywords: Force sensor resistor, coin vibrator, GPS, GSM, Microcontroller, walking pattern, software application.

INTRODUCTION

Flatfoot is defined as a dynamic deformity, which involves flattering of the medial arch. This deformity may originate from both posterior tibial tendon insufficiency and failure of the capsular and ligamentous structures of the foot Flatfoot, also called pes planus or fallen arches, is a postural deformity in which the arches of the foot are collapsed and the entire sole of the foot lays against the ground, either completely or nearly completely [1]. The structure of flatfoot is related to the biomechanics of the lower leg and affects its functionality. People with flat feet have either a very low arch or no arch at all. This means that one or both feet may be flat on the ground. A human foot has 33 joints, over 100 muscles, tendons, and ligaments that hold 26 different bones together. Arches provide a spring to the step and help distribute body weight across the feet and legs. The structure of the arch determines how a person walks. Arches must be tough and flexible to adapt to stress and various surfaces. The feet of people with flat feet can turn inward while standing and walking. This is known as pronation and can cause the feet to point outward.

This smart shoe is specially made for children challenged with **Plano-valgus feet** and **Toe Walking in Autism.** The smart shoe uses FSR to detect the uneven foot pressure while walking, this data is then stored in the mobile application and can be monitored by the paediatrician as well as the parents. If the threshold goes below 20 then it is detected by application and the vibrator start to vibrate and alerts the patient. Four FSR's are placed on the the soul of the shoe at positions top, bottom, left, right. A vibrator is placed near each FSR.A microcontroller (PIC18F2520) acts as the brain of the shoes. The real time data recorded by the shoes is sent to the server in intervals of 42 seconds & the GPS send location data in every 1. second.

DESIGN OF SHOE:

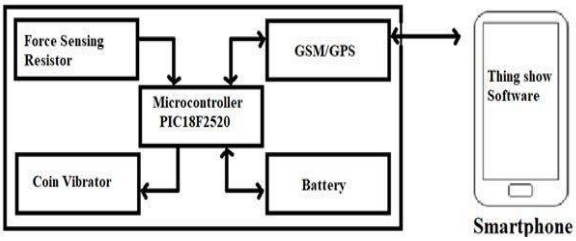

Fig. 1 Block Diagram of smart shoe

To this the entire shoe consists of the following items on a per shoe basis.

- Four pressure sensors to record the pressure acting on different areas of the foot.
- Four vibrators to inform the child of the abnormal patter detected.
- A small memory storage capacity of pressure sensor dada.
- A processor to activate and deactivate the vibrators.
- A GPS to transmit the dada to the smart phone and receive instruction for processor.
- A GPS will give location of the child wearing the shoes.
- A battery for power supply 4.2V

1. Li-ion cells

Fig.2 Li-ion cells

This is an ultra-fire BRC 18650 battery 5000Mah rechargeable 3.7V lithium-ion battery cell with a capacity of 5000mah. However, it should be noted that the nature of Li-ion cells prevents them from having a genuine capacity of more than 3000mah in a18650 form. These are only DIF purposes and are not designed for industrial use.

2. REGULATOR IC 7805

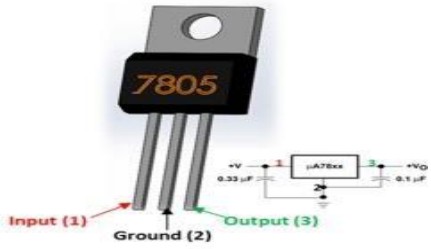

Fig.3 REGULATOR IC 7805

Voltage regulators are very common in electronic circuits. They provide a constant output voltage for a varied input voltage The name 7805 signifies two meaning, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. so our 7805 will provide a +5V output voltage.

The output current of this IC can go up to 1.5A. but, the IC suffers from heavy heat loss hence a Heat sink is recommended for projects that consume more current. For Example if the input voltage is 12V and you are consuming 1A, then (12-5) * 1 = 7W. This 7 Watts will be dissipated as heat.

3. DRIVER IC ULN2003

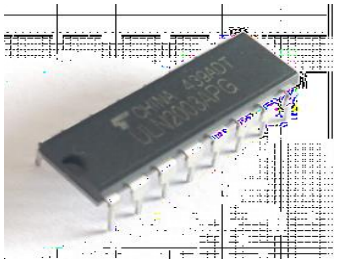

Fig. 4 DRIVER IC ULN2003

ULN2003 IC is one of the most commonly used Motor driver IC. This IC comes in handy when we need to drive high current loads using digital logic circuits like Op-maps, Timers, Gates, DRIVERS, PIC, ARM etc The ULN2003 is a 16-pin IC. It has seven Darlington Pairs inside, where each can drive loads up to 50V and 500mA. For these seven Darlington Pairs we have seven Input and Output Pins. The ground pin, as usual is grounded and the usage of Common pin is optional.

4. PIC18f2520-8 Bit Microcontroller

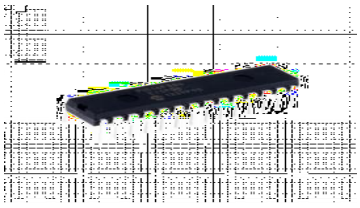

Fig.5 PIC18f2520-8 Bit Microcontroller.

PIC18f2520 is microcontroller from ‘PIC16F’ family and is made by MICROCHIP

TECHNOLOGY. It is an 8-Bit CMOS Microcontroller with nano-Watt Technology. This microcontroller is popular among hobbyists and engineers due its features and cost, PIC18f2520 is a microcontroller good for experimenting and developing applications because it has high flash memory rewrite cycle. Also there are a lot of tutorials and support available online. The controller has 16KBytes flash memory which is enough for many applications

5. GSM MODEM

Fig.6 GSM Modem

The SIM900A is a readily available GSM/GPS module, used in many mobile phones and PDA. The module can also be used for developing IOT (Internet of Things) and Embedded Applications. SIM900A is a dual-band GSM/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz. SIM900A features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.

6. GPS MODULE

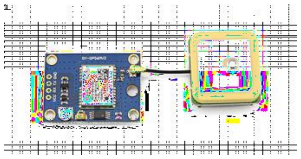

Fig.7 GPS Module

A **GPS** (Global Positioning System) module and is used for navigation. The module simply checks its location on earth and provides output data which is longitude and latitude of its position. It is from a family of stand-alone GPS receivers featuring the high performance 65 positioning engine. The compact architecture, power and memory options make **CH-65 modules** ideal for battery operated mobile devices with very strict cost and space constraints. Its Innovative design gives CH-65 excellent navigation performance even in the most challenging environments.

7. FORCE SENSOR RESISTOR (FSR)

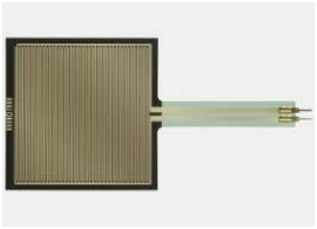

Fig.8: Force Sensor Resistor

A force sensitive resistor (FSR) is a material which changes its resistance when a force or pressure is applied in other words, force sensitive resistor it's a sensor that allow you to detect physical pressure, squeezing and weight. Usually, force sensitive resistors are very simple to be made and low cost, although they are not accurate. For this reason, basically when you use FSR you should only expect to get ranges of response instead of precise results. Therefore, while FSRs can detect weight, they cannot detect exactly how many pounds of weight are on them.

8. Haptic Motor (Vibration Motor)

Fig.9 Haptic Motor (vibration Motor)

By the definition it, refers to the haptic sense of the touch and is an advanced haptic technology that adds the **tactile feedback** right to the electronic devices through the use of vibrations. This touch-based technology has become more and more popular in handheld, portable and touch-screen enabled to the consumer, industrial and automotive electronic devices. The vibrations produced to

provide a new, deeply enhanced user experience. Haptic Feedback Actuator by Need-For-Power Motor

Prototype smart shoes:

Fig.10 Prototype Smart Shoes

Based on the required output of the shoe components selected are Microcontroller (PIC18F2520), Driver (IC ULN2003A), Force Sensing Resistor, Coin Vibrator, GSM, GPS, Battery With BMS, Miscellaneous Components By installing the components on designed PCB, the PCB is fixed on the rear end of the shoe for direct wiring of FSR and Vibrators.
The battery is placed on the left rear end of the shoe to connect easily to the PCB pins. After the completion of Smart Shoe various tests were carried out to check claimed features of the shoe like FSR data been uploaded on the server by GSM, Vibrators vibrating when the foot pressure goes below set threshold value, and the GPS providing latitude and longitude of the shoe, so at the end all test results were observed positive.

Result:
As per proposed output, the data of the FSR can be seen in the graph. The pressure monitored by each FSR can be seen in the graph. Each graph represents the separate data of FSR like top, bottom, left, right. This data of FSR is uploaded on the server by application at every 42 second interval. The location shared by GPS on the server is in longitude and latitude.

Fig.11 Result

As shown in the above graph the top graph shows the pressure either going below the threshold value of or not. When no pressure applied in the FSR the value shown in each graph is 1023. The overall data provided by each graph is used to study, whether the pressure while walking is equally distributed according to normal walking pattern or pressure goes below the threshold at any single point of FSR (Top, Bottom, Left, Right). We set the threshold value 20 and if it goes below 20 then the vibrator near that FSR gets activated and gives alert sensation by vibrating. when the children is applying more pressure on the top, bottom, left, right of the sole of their foot. The data is saved on a web application from which the clinician can access the data on mobile. The data will help paediatrician to make diagnosis processes better. so access to the foot pressure data of children can be monitored in online mobile application THING SHOW.

Conclusion & future scope:

1. We have made this smart shoes which helps the paediatrician daily monitoring and increase the therapy time by using of shoes.
2. We expect the smart shoe will help in reducing the curing time period to some extent.
3. In future we trying to make to full time working model which will work more efficiently like the walking dada will be uploaded to server every 5sec the battery backup will be increase

the appearance of the shoes would be more finished and compact.

Acknowledgment;
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