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"MICROCONTROLLER BASED FLAT-FOOT DETECTOR USING LOAD CELLS"

Physics

T. N. Ghorude Department of Physics N.B. Mehta Science College, Bordi – 401701 India.

N. S. Shah Department of Physics N.B. Mehta Science College, Bordi – 401701 India.

V. D. Thakur Department of Physics N.B. Mehta Science College, Bordi – 401701 India.

ABSTRACT

Flat-feet is a deformity where a persons feet may roll to the inner side when they are standing and walking. This is known as overpronation, and it may also cause the feet to point outward. A flat-feet will distribute the body's pressure differently than what a normal feet does. This knowledge is used here to develop a microcontroller based device that is capable of detecting flatfoot in a person more conveniently than the traditional wet-mud method.

In this project, Microcontrollers paired up with load cells help to understand the pressure distribution of a person's feet and hence, provide a quick and effective way to deal with this problem, which is often ignored and neglected in our society but can do great harm to the body posture and joints with increase in age.

KEYWORDS

Flat-Feet, Microcontroller, Pressure, Load Cells.

INTRODUCTION

A typical human foot has 33 joints, which hold 26 different bones together. It also has over 100 muscles, tendons and ligaments. When people have flat feet, their feet may roll to the inner side when they are standing and walking. This is known as overpronation, and it may also cause the feet to point outward [2].

When a person has flat feet, there is usually a gap beneath the inner part of the foot when a person stands, as the arch rises off the ground slightly. Things to know about flat feet include the following:

- Children can get flat feet, but they usually outgrow the condition.
- Adults who develop flat feet usually have an underlying condition that is affecting their feet.
- The symptoms include pain, swelling, or stiffness affecting the arch of the feet, legs and sometimes the back. [2]
- When flat feet cause symptoms, simple devices and exercises can help minimize discomfort.

I present here a technique for examining the pressure distribution over the entire human foot with the help of load cells in order to provide a quicker and effective way for doctors and orthodopedics to diagnose flat feet in a person and treat them accordingly.

Our project is to make a simple and purely mechanical device to measure the weight/pressure distribution of a person's feet by placing it on a combination of load cells and then judging by its outcome, whether a person is suffering from flat feet or not.

Theoretical background

"Gait is a significant factor that affects human health. In particular, flat feet can cause changes in alignment conditions of the foot, ankle, leg, pelvis and spine. The existing method of feeding back the degree of gait or activity does not consider the severity of the subject and is insufficient for qualitative evaluation or training of gait. The significance of this study is development of convenient detecting and long-term tracking tools that can be used by both patients and clinicians for prescreening flat feet and monitoring the progress of flat feet treatment. For wearable devices for flatfoot detection to be most effective, detection systems and algorithms must be accurate, robust, reliable and computationally-efficient. In this paper, we developed an integrated smart wearable gait-monitoring device comprised of three sensors: front force, rear force, and an ankle flex sensor. This wearable device can thus be easily and simply used both by patients and doctors to monitor the progress of flat feet and prescreen for possible gait problems in daily life."[9]

"Distribution of Foot Pressure reflects the deformations of body biomechanical design. They are caused by different reasons: degenerative, by trauma, etc., being flat foots a common pathology in Peru with high incidence. However there isn't the properly technology to detect properly this disease because is detected by a non-reliable visual way using pedoscopes. Therefore, this paper takes advantage of both systems: a direct pressure value from electronics and no problems calibration from optical systems. In regard of these reasons, prototype will use a webcam and twelve FSR (Force sensing resistor) sensors including estimation techniques, and thus obtain the foot pressure distribution."[10]A load cell converts a force such as tension, compression, pressure, or torque into an electrical signal that can be measured and standardized. As the force applied to the load cell increases, the electrical signal changes proportionally. [4]

Since the human feet, in its normal state, is designed such that the heel and the toe are the only parts touching the floor and the arch between them doesn't touch the floor, we can use this knowledge to detect flat feet problems. A person who does not suffer from flat feet will apply the pressure mostly from the toe (front) and heel (back) on to the ground and the middle of the foot has no contact with the ground, hence, no pressure.

On the other hand, a person suffering from flat feet will have equal pressure distribution from the toe, middle arch and heel onto the ground. With the help of 3 load cells, one for each part of the foot, we can know the pressure distribution of the foot of a person and therefore, on that basis, judge if a person suffers from flat foot or not.

When the weight of a foot is applied on the load cell, the load cell converts it into voltages and provides these readings in millivolts to the hx711 amplifier. The amplifier amplifies the signal and this data is processed using Arduino Uno and shown on the LCD display.

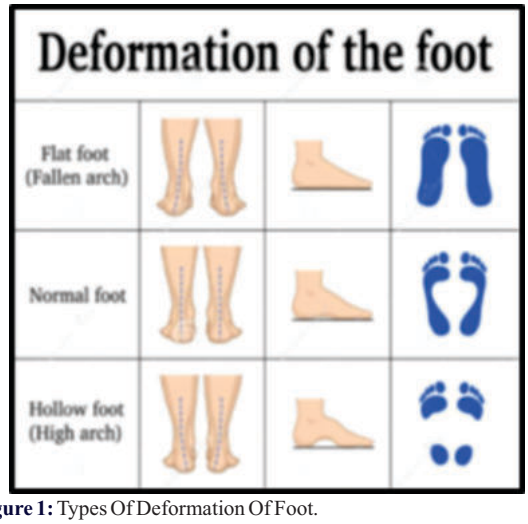

Figure 1: Types Of Deformation Of Foot.

Experimental Work

People often develop flat feet in childhood. However, the condition can

also develop in adulthood. Many people with flat feet have no symptoms but others will experience various symptoms that generally depend on the severity of the condition. [2]

This project is designed to measure the pressure/weight distribution by different parts of the human foot on the surface. This helps in detecting whether a person is suffering from flat foot condition or not. In this system, the load cells coupled with hx711 amplifier and Arduino Uno are the main parts which collect the data, process it and give the output to the LCD display which then shows the pressure/ weight distribution.

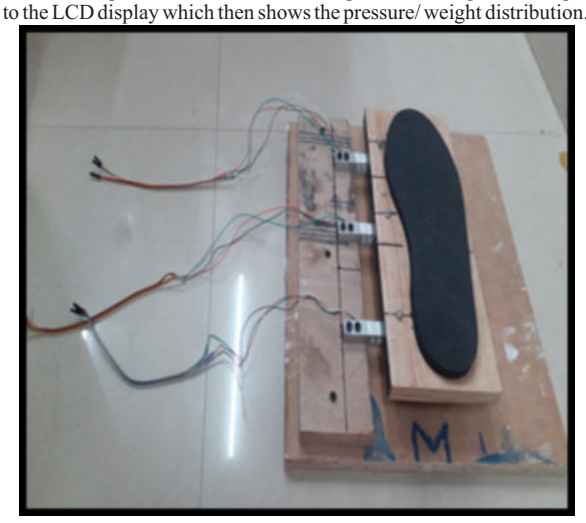

Figure 2: Flat-Foot Detector Device

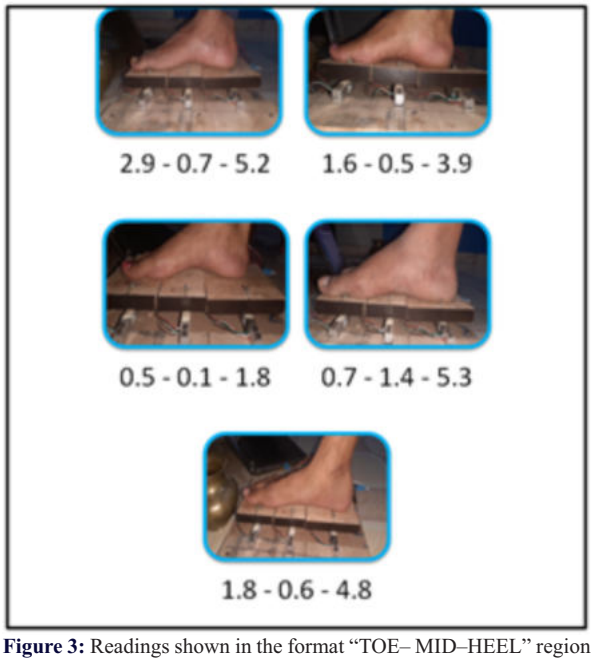

Figure 3: Readings shown in the format "TOE– MID–HEEL" region and following the S.I.Unit (KG)

RESULT & DISCUSSION

By observing the readings gained from the device, we can conclude that it is one of the best methods to detect flat-feet in a human-being accurately. The system of load cells along with Arduino Uno works meticulously to give out the required data. Due to these features, the device is best equipment for detecting flat-feet in a person and warning him of the physical abnormality quickly so that one can treat it and live a healthy and better life.

The system proposed in this paper will have the following applications:

1. It can detect flat-feet abnormality in any person having a shoe-size 5 or higher.
2. It can be used for self-assessment as well and no need for a doctor to be present
3. It can be used to test a large group of people for flat-feet quickly and effectively.
4. It runs on just a single battery, hence it is cost-effective for testing people in health check-up camps.
5. It is a small and easily portable device and can be supplied to remote areas such as villages easily.

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