Development and effect of the body balance to the pressure sensor monitoring

Tan Zhen Jia, Zulkifli Ahmad*, Muhammad Amirul Afiq Saidi and Mohamad Zairi Baharom

Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, 26600, Pekan, Pahang, Malaysia.
*kifli@ump.edu.my

Abstract: Plantar pressure can be formed during the static and dynamic motion. It calculated by the force divided to the contact surface area of the foot and the ground. The body balance training device is functioned to help people measure the effectiveness of physiotherapy treatment in rehabilitation pro-cess. Therefore, the objective of this study is to develop a body balance de-vice which equipped with the pressure sensor system. The design characteristics such as type of conductive layer used, resistor value, velostat size and sensors arrangement were considered in determining an optimum setting. In order to validate the device, footprint testing was performed to identify the contact surface area for sensor placement under the insole. Then, it was compared with the data obtained from the sensors according to the similar arrangement on the footprint. For real-time monitoring, a foot model was developed consist of the RGB led to indicates the level of pressure. This monitoring method is benefit for the rehabilitation as well as custom shoe selector which provided the characteristic of foot plantar.

1. Introduction

Body balance is a condition when both the plantar pressure readings provide the similar value during standing. Plantar pressure generated from the weight of the body which is acted on the body centre of gravity then transferred to the plantar foot surface area [1]. The plantar pressure will be located at those anatomical areas, which are the medial and lateral area, the medial and lateral mid-foot area, the heads of the first, second, and fifth metatarsal area, the great toe, the head of the second metatarsal area, and the lateral metatarsal head area. According to the previous research, the maximum weight from the body is located at heel for foot during standing motion.

The percentage weight distribution of heel area of left foot in standing posture is 24% and for the right foot is 24.2%, 2nd toes (4.8%/4.9%), the lateral three toes (4.1%/4.1%), anterior half of medial arch (2.1% /2.2%), anterior half of lateral border (7.4%/7.5%), posterior half of medial arch (5.8%/5.7%) [2]. They also found that when the functional location is changed, the centre of gravity and percentage plantar weight distribution pattern over various compartments of the foot is altered.

Van Deursen [3] studied that during different stages of stances, the pressure applied to the feet during dynamic motion is much higher than the standing motion, induced by different parts of the feet contacting the floor. The stance step of the gait is defined by a foot rollover. The foot would usually first move around the heel, followed by the ankle joint, then the heads of the metatarsal and hallux. The heel has greater pressure than the forefoot when moderate peak pressure has occurred [4]. The main purpose of body balance monitoring is used in medical diagnostics, rehabilitation and sports related performance. To obtain an accurate pressure reading, the pressure sensor should be flexible, thin, and have relatively high sensitivity in a broad enough pressure range, able to produce good repeatability data.

2. Methodology

2.1. Schematic Design

Fig. 1 and Fig. 2 show the single and multiple circuit schematic diagrams, respectively. The single schematic circuit is the general connectivity of a pressure sensor while the multiple schematic circuit is the combination of a pressure sensor for a shoe insole. In Fig. 1, the bottom part of the conductive layer is connected to the 5V and top conductive layer is connected to the ground. Meanwhile, it connected through a resistor in between and A0 for the analog reading simultaneously. On the other hand, cathode polarity of LED is connected to the ground and anode is connected to the digital pin on the Arduino UNO.

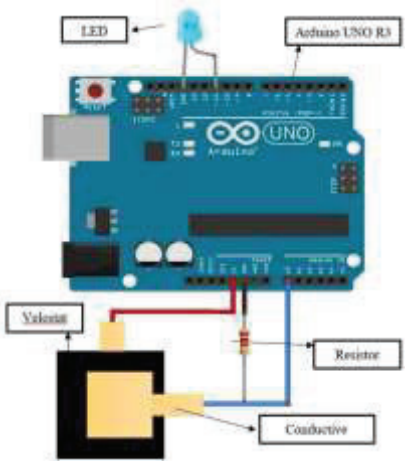

Fig. 1. *Schematic Circuit (Single sensor)*