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A Prototype for Temperature Sensation System for Arm Amputee Handicap

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ABSTRACT

The upper limb disability experience includes both the loss of functional skills as well as a hand's sensation. Sensation ability, it's very important to human experience and helps him to reach a good interaction with surrounding. Also, Feedback from robot arm is very important for understanding the protection for the robot arm and providing contact between human and arm. Research studies to regain sensation through many technics This paper proposed a heat sensation system, this system transfers the heat at the end of each robot arm finger to a specific position. The heating pad is used to generate similar temperature at fingers. System sensation was tested and evaluated to reach the desirable response. The results show the ability of the system to transfer temperature on a healthy position at handicapped.

Keywords:

biomedical engineering; embedded system; Temperature sensation; prototype; handicap.

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1. INTRODUCTION

Limb loss is much more common than many people realize, and the numbers are growing. War one of the factors that increased the ratio. There are an estimated 1.7 million people in the United States living with limb loss, and 50,000 to 100,000 new amputations occur per year [1]. And the number much more in other countries .However, about 21% of handicaps with upper limb loss disability don't use any artificial arm because they think it does not provide their needs. About 85% of them consider the lack of sensation as a factor to their think [2]. As a result of these, researchers interesting increases to reach better results to enhance the functionality of the artificial limbs. The Sensory Feedback helps the amputees to have some sense besides the visual judgments.

R. Prior[3] proposed stimulator signal-based grasp force, sensed by transducers connect to the grip. Amount of force determine the parameter of the pulse width and pulse repetition rate of a stimulator. C. Cipriani [4] used vibrotactile system as a stimulation to the users.it is containing an DC motor when it turns, generates mechanical vibration of the skin. Amount of mechanical vibration proportional to the grasping force.

M. Paul[5] uses a Peltier module and pressure feedback unit as a stimulation to the amputees. Peltier module provides a sense of heat or cold where this module resulting cooling on a surface and heated on the other simultaneously. Surfaces state cold or hot can be changed by reverse current direction. pressure feedback unit based on McKibben pneumatic artificial muscle.it receives pressurized air from an air pumps through air channel when it receives triggering in its control circuit. Amount of air pressure determines amount of pressure on the arm which is proportional to feedback from the system.

Some surgical techniques proposed to provide a sense of touch. B. Nghiem [7] discussed latest innovations in sensory feedback Also explores the future of prosthetic sensory feedback using innovative technologies for neural signaling.

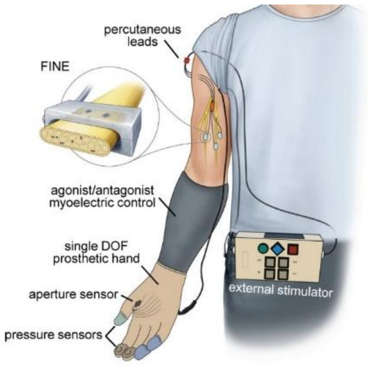

Figure 1: schematic diagram of a Home system for sensory restoration [6].

Graczyk [8] Implanted peripheral nerve cuff electrodes delivered artificial somatosensory feedback of touch and proprioception corresponding to sensors on a hand prosthesis as shown in the figure 1. force-sensitive resistors located on artificial arm thumb, index, and middle fingers. In the artificial hand, an opening sensor was mounted to measure the opening span of the hand. Analog signals were sent to the neurostimulator by the sensors. The neurostimulator analyzes the incoming pressure and opening data to produce pulse stimulus trains which sent to the implanted stimulation points of the subject.

This paper proposed a prototype to transfer temperature sensation from a robot arm to other healthy parts in handicap. Articlepresented in the following structure of sections: **Introduction –The Structural Design– The Proposed Methodology - Results and Discussions – Conclusions**.

2. THESTRUCTURAL DESIGN

Sensation system based on three main components: temperature sensor, heating pad and some electrical components.

The LM 35sensor, as shown in the figure 2, is a low-cost integrated circuit temperature sensor. Its output voltage linearly proportional to the change in the temperature that senses. LM 35 can be characterized by its ability to directly output the relation to input in Celsius (Centigrade).So no need for any external calibration or add a specific amount of voltage from the output. Sensors output produces Linear relation + 10.0 mV/°C scale factor with typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°Cover a full −55 to +150°C temperature range [9].it is operating with a voltage range between 4 to 30 volts.

(a) (b)

Figure 2: (a) Lm35 pinout
(b) Lm35 sensor

Heating Pad, as shown in the figure 3, is a new model for an electrical heating system. it's fabricated to provide a heating system characterized by safe requirement and energy saving with DC supply. Heating Textile composed of metal conductive and fabric. The metal conductive yarn is very fine, the finest can reach 0.27 mm in diameter, and solid [10]. The conductive metal yarn is properly integrated by textile processes with the fabric. The heating pad is superior in softness, lightness, thinness and durability which make it suitable for wearable applications. It is warm to a specific temperature as long as; it is provided by the appropriate voltage. Electrical components support the system like an operational amplifier, MOSFET, optocoupler , etc.

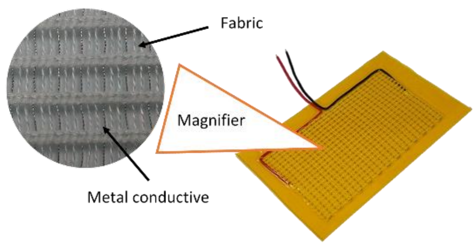

Figure 3: heating pad.

3. THE PROPOSED METHODOLOGY

The proposed system usesa temperature sensor as feedback and reference for each finger, as shown in the figure 4, constructing a closed loop temperature control [11] . LM35 temperature sensors are connected to the end of each finger of the artificial arm. they sense the temperature and convert it to a voltage. This voltage works as a reference to control the heat pad. Another temperature sensor is connected to the heat pad to measure its temperature. Also, it provides a feedback signal to the controller. A comparator is used to compare the reference voltage and the feedback voltage. Comparator outputs controls the switching circuit which controls the Heat Pad. As a comparator, the LM324 operational amplifier IC can be used. This

IC has on a single chip four separate operational amplifiers. The operational amplifier act as a comparator in the system. On the other hand, the switching circuit is constructed from two main parts. First, the optocoupler provides a level of protection between the control circuit and the actuation circuit, it is an electronic component that uses light to pass electrical signals between two isolated circuits. Second, MOSFETSwitch Module controls the temperature of the heating pad. MOSFET can increase or decrease the temperature of the heating pad using a pulse width modulation source from a controller circuit.

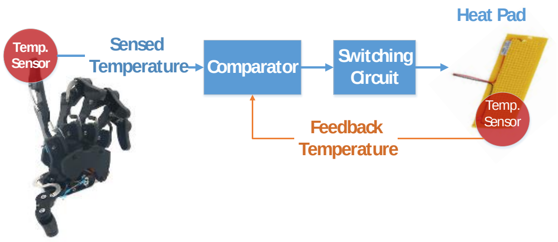

Figure 4: block diagram circuitry for a single finger sensation.

Five feedback control systems implemented for each robotic arm's fingers. The proposed armband, as shown in figure 5, contains five heat bands that work as actuation for the control system. the system is supported by power using lithium battery. Feedback signals of the proposed armband are processed by Arduino to protect the human arm from burn. Also, to protect the robot arm from failure caused by overheating.

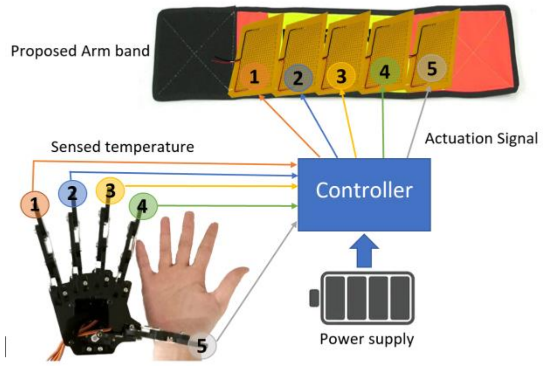

Figure 5. block diagram for all fingures band sensation system.

4. RESULTS AND DISCUSSIONS

This section illustrates the implementation of the real-time sensation system.which is successfully testing the hardware implementation of the system and assessing the performance. The arm temperature signal is abruptly changing to different temperature levels. It is important to remember that the temperature characteristic does not change rapidly, so the experimental results consideres a small change in temperature. This is shown in Figure 6 . here the temperature level is changed from 48-to-56 Celsius. The results show that the heating pad temperature tracks reference temperature from the robot arm. In addition, Figure 7 has shown a fast change in the reference signal from 45-to-60 Celsius. The result shows track to the reference temperature.at last, Figure 8 has shown a fast rabid change in the reference signal from 45-55-50 Celsius.The experimental results demonstrate that the designed system has the ability to track the change in the sensed temperature. The heat pad temperature is directly proportional to the change in the sensed temperature. Response time for the system depends on the response of the temperature sensors and the heat pad. Temperature sensor response is linear.the Heat pad time response is the most effective factor in the hole time response. As a result, the designed system has the ability to transfer the change in the temperature from robot arm figures to armband. Figure9depicted the prototyped of figures sensation circuit.

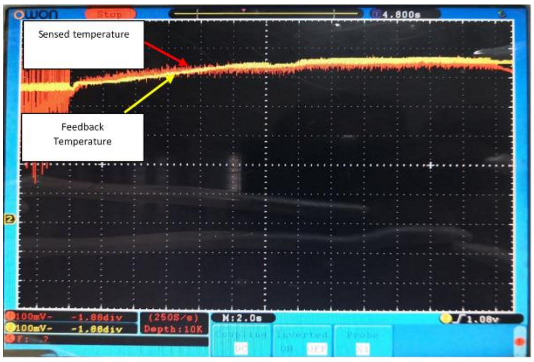

Figure 6 : system response for temperature level changing from 48-to-56 Celsius.

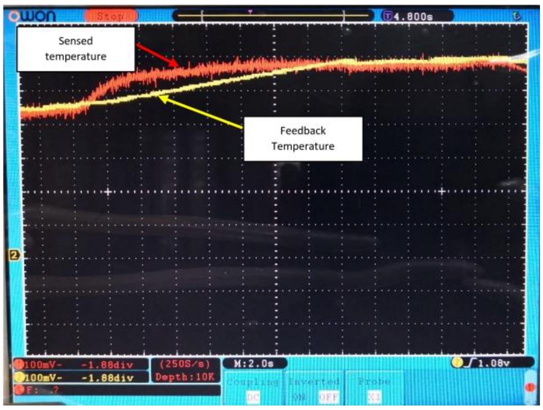

Figure 7: system response for temperature level changing from 45-to-60 Celsius.

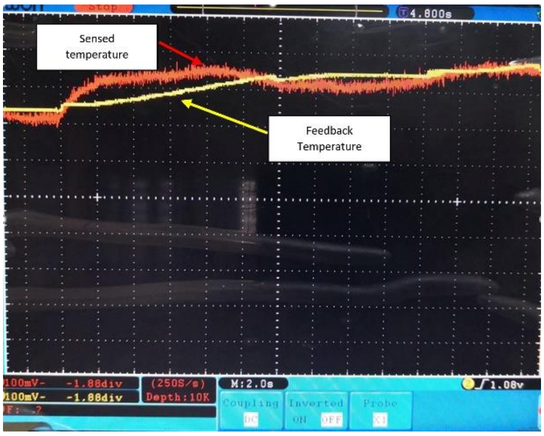

Figure 8. response for fast rabid change in the reference signal from 45-55-50 Celsius.

5. CONCLUSIONS

This paper investigatesa method of enhancing the amputee's experience to deal with a robot arm. At the same time, to provide a better sense of interacting with an object that has a different temperature. The experimental results show that the sensation systemhas the ability to track temperature changing at the finger. At the same time, the ability to generate the same temperature on the desirable position on the amputee body. It is easy to apply the methods described in this paper to many robot arm systems.

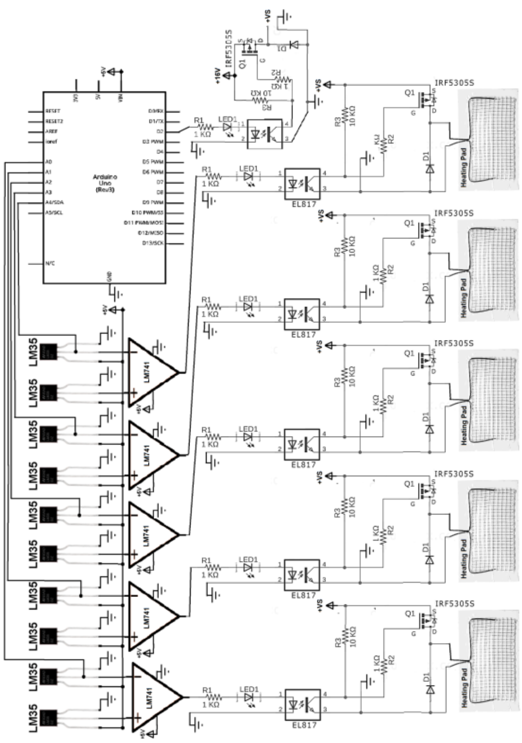

Figure 9: the prototype figures sensation circuit.

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التصميم السريع لنظام التحسس الحراري لذوي الاعاقة ببتر اليد

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الملخص

تشمل تجربة إعاقة الطرف العلوي كلاً من فقدان المهارات الوظيفية وكذلك الإحساس في اليد. القدرة على الإحساس ، من الامور المهمة للغاية لتجربة الإنسان وتساعده على الوصول إلى تفاعل جيد مع المحيط. أيضًا ، تعد المعلومات القادمة من ذراع الروبوت مهمة جدًا لفهم حماية ذراع الروبوت وتوفير اتصال بين الإنسان والذراع. الدراسات بحثية لاستعادة الإحساس قدمت من خلال العديد من التقنيات.هذا البحث قدم نظام احساس بالحرارة ، حيث يقوم هذا النظام بنقل الحرارة من نهاية كل إصبع بذراع آلي إلى موضع معين. يتم استخدام وسادة التدفئة لتوليد درجة حرارة مماثلة في الأصابع. تم اختبار نظام الإحساس وتقييمه للوصول إلى الاستجابة المرغوبة. تظهر النتائج قدرة النظام على نقل درجة الحرارة في وضع صحي عند المعاقين.

الكلمات الداله :

الهندسة الطبية , نظام مطمور , نظام الإحساس بالحرارة ,بتر اليد.