Fabrication and Testing of Thermal Pain Inducer

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ABSTRACT
This work aims to design and fabricate a Thermal Pain Inducer in order to create thermal pain on the human subjects. A heat in the range between room temperature and 50˚C is generated using a power source and heating coil arrangement. A heating coil of nichrome material is placed in a box of 1.5cm each side. The 5 sides of box are covered with insulating material and one side is covered with thermal conducting (copper) material. The subjects are exposed to generated heat through this side only. The temperature of the coil is measured by Pt 100, type of Resistance Temperature Detector. The fabricated thermal pain inducer has been tested with human subjects and it performs well, but it is important that major skin damage should not occur. This fabricated device will be useful in pain measurement research area for developing a good pain measure.

Keywords – inducer, pain measure, thermal pain

1. INTRODUCTION
The International Association for the Study of Pain defines pain as "An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage"[1].

Pain, may be the burning sensation after your finger touches the hot vessel or pricking sensation in your back after you might lift some heavy object. It can also be described in many other ways. But, there is no standard procedure to follow to measure the amount of pain objectively; there is no particular test which can accurately measure the intensity of pain. Now a days the physicians find that the best aid to analyze the pain is the patient's oral description of the type, period, and location of pain; subjective measurement [2] [3].

Treating pain in patients offers a special challenge to physicians since evaluating the level of pain is not a simple task. Moreover pain in younger patients requires special notice, because children are always not able to describe the amount of pain what they are experiencing. Without knowing the amount of pain, some pain killers might be consumed by the sufferers at higher level. Over dosage of such pain killers may lead to vast side effects like nausea, dizziness, somnolence and vomiting [4]. Thus for proper medication and correct dosage, physician should know the quantity of pain. This can be accomplished by measuring physiological changes [5]. This kind of research area requires a pain inducing tool, as we should not analyze the level of pain in a patient with actual pain for research purpose. Here comes the necessity of pain inducer.

The pain stimulators could be of either mechanical or thermal type, which cause skin irritation by heating the skin to painful temperature. By imposing mechanical pain physiological changes is measured [6] [7]. It is obvious that various physiological changes will happen when pain is applied to the subject's skin.

Here an attempt has been made to fabricate the safe and controlled thermal pain inducer in order to develop a thermal pain on the human subjects and to evaluate whether thermal examinations distinguish between the patients. This device is restricted to maintain the temperature between 30˚C and 50˚C [8] [9] [10]. This methodology has been used in human research on pain. No clinical tests were made, and it is thermally stimulated pain in Laboratory. The developed inducer was tested with few subjects in laboratory setup. The goal of pain management is to get better functionality, enabling individuals to do their work, to attend classes, or participate in other activities. Patients and their physicians have a many options for the treatment of pain; some are more successful than others. Developing improved pain treatments is the primary goal of all pain research area.

2. METHODOLOGY
Thermal pain inducer is developed, for inducing thermal pain on subjects and it consists of a Temperature source container, power source and temperature controller. Temperature source container (coil and sensor) is used for producing thermal energy which consists of sensor and coil. The current is passed through the coil (which is kept inside Temperature source container) for producing heat energy. The temperature change is made possible by passing various range of current through the coil. During stimulation, known amount of thermal energy is applied to move in to the skin through the heat sink, which is the bottom portion of temperature source container.

2.1 Block diagram description
Block diagram of Thermal pain inducer is shown in Fig.1. Thermal energy is generated by passing current through the coil (iron box setup).

A dedicated power supply unit (in volts) is used to generate the required current to the nichrome coil. Both the sensor and copper face (for heat transfer) are contained in temperature source container. The coil temperature is measured by a sensor which is connected to the temperature controller (TC 303 SELEC). Temperature controller maintains the temperature of the coil according to the preset value.

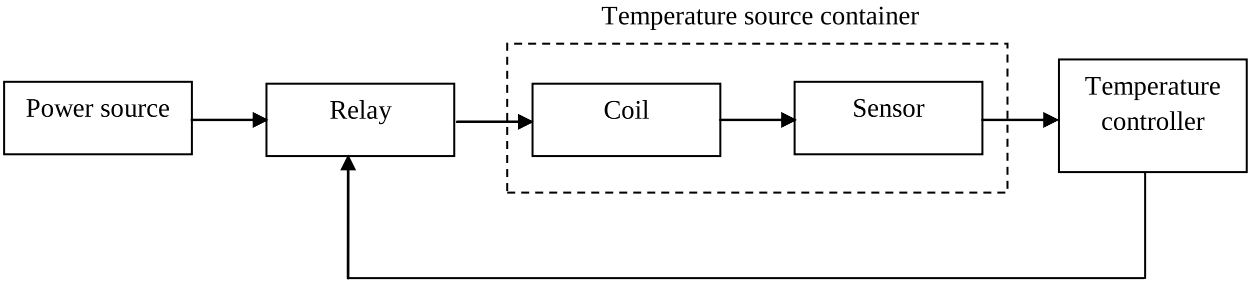

Fig. 1: Block diagram of thermal pain inducer

2.2 Hardware arrangement

The hardware arrangement of Thermal Pain Inducer is shown in Fig. 2, in which power source, Temperature source container (square box) and temperature controller are connected in series.

Fig 2: Hardware arrangement

Here a coil of nichrome is used as heat generating source (has high melting point of about 1400 °C) and it has the ability to withstand high temperatures. In order to produce the thermal energy (35˚C to 50˚C), the current (1.5V to 9V) is passed through the nichrome coil. The temperature source container of 1.5cm square box consists of six faces. Five faces are made of thermal insulator (wood) and one side is made of conducting material (copper) and it can be opened and closed with the help of adjustable screws. Inside the temperature source container, a nichrome coil is kept for inducing the thermal energy and the coil is placed near to the copper surface, which transmits this thermal pain to the thumb finger of the human subjects. Sensing part of Pt 100 sensor is kept inside the square box for measuring the temperature inside the temperature source container and the set value is to be set in the temperature controller. After reaching the desired temperature value it stops to increase and maintains the temperature. A stand is kept at the leftend of the Fig 2 for keeping the sensor at rest position for accurate measurement of temperature. Any suitable type of sensor can be used for temperature measurement of the coil; here Pt 100 RTD is preferred. The subject is asked to expose their right thumb finger to the bottom surface of the Temperature source container (copper heat sink) which transfers the heat.

2.3 Experiment

The fabricated inducer is tested with few subjects in our laboratory at various degrees. From a baseline of 30˚C, the temperature is increased to a cut out temperature of 50˚C with 5˚C increment. The temperature is recorded at each stage. A pause of 10 seconds is allowed between each 5˚C increment. Subjects are asked to tell, if the sensation felt is very severe, so that the experiment can be terminated immediately. For the first stage of the experiment, thermal energy is applied to cause pain, the set value in the temperature controller is set at 40°C and tolerance seconds of the thermal pain is noted (tender). In the second stage of the experiment, the set value in the temperature controller is set at 45°C and tolerance seconds of the thermal pain is noted. In the third stage of the experiment, the set value in the temperature controller is set at 48°C and tolerance seconds of the thermal pain is noted.

3. RESULTS

This section summarizes the results obtained by inducing and measuring the thermal pain on different subjects. The pain was induced by the developed thermal pain inducer. During 35°C, subjects have shown similar results (no pain occurring); at 40°C the pain felt is tender and at 45°C the pain felt is sharp. At 48°C the pain felt is unbearable. Thus the difference in pain sensation could be felt for different ranges, and it was worked well with the developed device.

4. CONCLUSION

A pain inducer of Thermal type was designed and fabricated that induces the thermal pain with various range of temperature. The performance of fabricated device was evaluated by inducing the thermal pain on few subjects. It was observed that the device was able to generate the temperature with various degrees, but future goal is to quantitatively measure the amount of pain. It leads to reduce the harmful side effects, caused due to the over consumption of pain killers and it requires a lot of experimental studies with physiological parameters for more number of subjects. The work can further be extended by fabricating the cold pain inducer and testing the cold pain at sub zero °C.

5. ACKNOWLEDGMENTS

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