A Non-Contact Approach to Evaluate the Effect of Mindfulness Meditation

Jaspreet Singh*
Sant Longowal Institute of Engineering and Technology, Punjab, India
Email: jassi.mehrok330@gmail.com

In this world of highly distressing and tiresome activities, one must have some sort of mental capability and self-regulation for better living.Due to rapid healing response, the medication is often preferred and recommended by most people. But, it may lead to the development of drug-resistant strains and other health problems. In contrast, meditation is a natural remedy, which strengthens the physiological and psychological capacities of the body. Moreover, it ismental health training that helps to overwhelm the negative mental states, such as anxiety, tension, stress, and depression. From the spiritual point of view, while involved in the meditation, repeating mantras with closed eyes help get into the deep state of subconscious mind. Some of the ancient records indicate that the historical root of meditation are the ancient Indian texts – the 'Vedas'. In today's modern era, several meditation techniques were developed based on the secular contemplates unlike the religious perspectives of antiquity era. The secular meditation not only focuses on the spiritual growth but also emphasizes on the healthcare perspectives such as stress reduction, relaxation, and regulation of blood pressure.

So far, many studies have reported the clinical benefits of meditation such as preserving the brain from aging, reduction in anxiety, increased pain tolerance, and improved concentration. Theelectroencephalography (EEG) and neuroimagingtechniques like magnetic resonance imaging (MRI) and positron emission tomography have successfully been used to monitor the effect of several types of meditation techniques on the brain. Some studies have reported that the meditation

* Mr. Jaspreet Singh, Ph.D. Scholar from Sant Longowal Institute of Engineering and Technology, Punjab, is pursuing his research on "Thermographic Evaluation of Superficial Organs for Various Diseases using Active and Passive Thermal Imaging." His popular science story entitled "A Non-Contact approach to Evaluate the Effect of Mindfulness Meditation" has been selected for AWSAR Award

practice remarkably increases the body temperature, where the contact-type thermal sensors have been used for measurement. But, to some extent, the recording procedures of these techniques might be uncomfortable to the meditators. Primarily, the artefact-free physical connections are required for an effective recording of EEG and body temperature, where it becomes hard to sustain such connections for a long session of meditation. During MRI, the lie-down procedure in a narrow tunnel must be followed, which not only confined the physical movement but also causes fear in a person's psyche. Moreover, it is a computationally expensive technique and it requires clinical experts or radiologists for analysis. However, these techniques could sufficiently cover the research context but are not feasible to use in self-training and biofeedback systems. Besides, it is not always possible to have experts for the successful conduction of meditation. To address this problem,an infrared (IR) thermographybased automatic approach has been developed which evaluatesthe effect of mindfulness meditation on the thermal profile (or temperature fluctuations) of forehead region. The IRthermographyis a radiometric approach, which measures the surface temperature of objects based on the emitted IR radiations. Primarily, it is a non-contact and human-friendly technique which requires minimal settings for data acquisition without violating the meditation procedure.

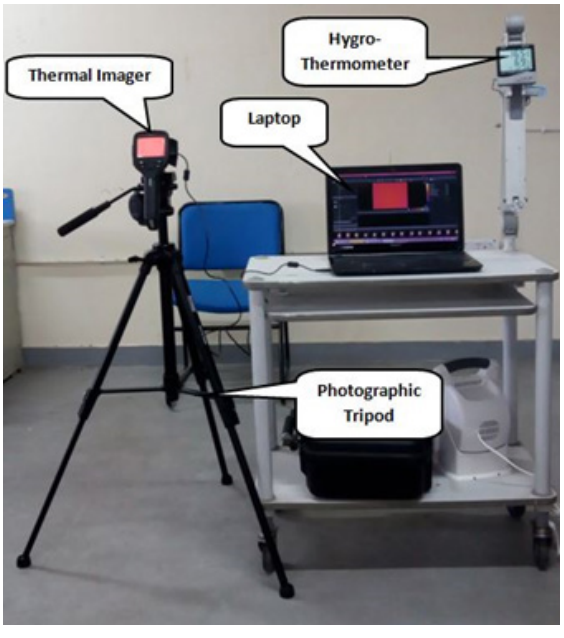

Figure 1Shows the experimental setup for thermal data acquisition.

The 18 human subjects were involved in the IR thermography-based imaging trial, where 9 meditators and 9 non-meditators were monitored during themindfulness meditation and non-exercise activities (like typing, reading and listening to music), respectively. In meditator group, there was one meditation expert with the experience of more than 15 years (by whom the start-up call was made)and the rest of them had experience of more than one and half year.The thermal imaging was performed with the aid of FLIR® E60 thermal camera, where the front view of the face was captured. The thermal images were acquired at Meditation Center and Biomedical Research lab, Department of EIE, Sant Longowal Institute of Engineering and Technology (SLIET), where the thermometer and hygrometer were used to consider the ambient conditions for controlling the room temperature and humidity (see Figure 1). Both the meditators and non-meditators were monitored for approximately minutes and thermal images were captured at a fixed time interval, known as dynamic IR thermography. Dr. Manoj Sachan, Head of meditation club, SLIET, helped to effectively acquire the thermal data for this study.

To analyse the temperature fluctuations of forehead region during meditation, the automatic algorithm has been developed and applied on the created dataset.As a result, the algorithm has sufficiently extracted the data from the forehead regions from the sequential thermalimages which further automated the process of thermal profile extraction. After successful extraction of thermal profiles, the data has been analysed subjectively and objectively to quantify the correlation between the thermal profiles of meditators and non-meditators. For this purpose, the thermal profiles have been processed to extract the features prior to the statistical analysis. Firstly, the thermal profiles have been examined objectively based on the variance in extracted features. Consequently, it is found that the thermal profiles of meditators are statistically different from those of non-meditators.

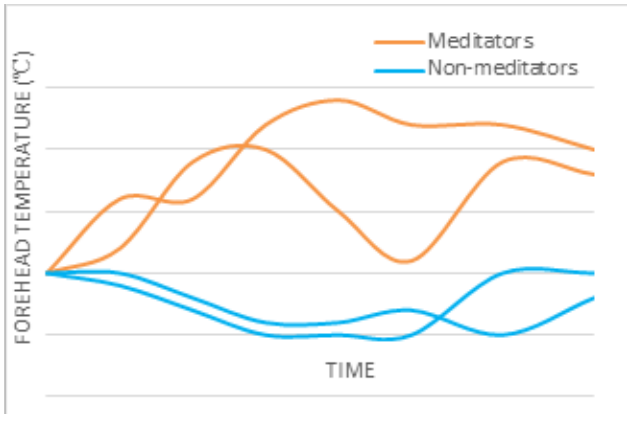

Figure 2Shows the thermal profiles of forehead regions of meditators (red) and non-meditators (blue).

Secondly, the thermal profiles have been analysed subjectively (visually) based on the dominance of positive and negative temperature peaks during the session, as shown in Figure 2. In meditator group, the dominance of positive peaks has indicated that the temperature of forehead region increases during the meditation practice as a resultant of increased blood flow in the cerebral cortex of the brain and cutaneous vessels of the face. Meanwhile, in the case of non-meditators, the thermal profiles have indicated that the forehead temperature either decreases (dominance of negative peaks) or fluctuates around the baseline temperature. In brief, the forehead temperature increases during the meditation practice and either decreases or fluctuates around the baseline during the non-exercise activities. In addition, it is observed that the key findings of subjective analysis correlate highly with the objective analysis.

This investigation shows the encouraging signs towards the application of IR thermography in monitoring the autonomic responseof the brain during the mindfulness meditation. However, the presented investigation is a preliminary as the meditation technique and number of subjects involved in the study is limited. Also, the proposed approach can potentially be used to monitor the temperature fluctuations during other types of meditations. In future, other facial landmarks such as cheek area, eye region and nasal region may also be considered for better temperature analysis during the meditation practice. Besides, the facial IR thermography can be used as a bio-trainer and bio-feedback system which assists both the meditators and novices to sustain and monitor the meditation performance quantitatively.