STRESS DETECTION SYSTEM BY IOT INTEGRATED WITH EXTREME LEARNING MACHINE FOR EDUCATION DURING COVID 19

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ABSTRACT

The stress on university students is a major contributor to the failure of their studies, caused by many reasons such as high competition, high expectations from parents, lack of adaptability, or unable to study in time of classes, these problems can be found in the following fields of students especially in engineering, medicine, nursing or public health. This issue needs more attention during the epidemic of COVID 19, The effect of staying at home (lock down) or study from home (SFH) using distance learning paradigm causing the stress of the learners to be higher than that of normal situations. This circumstantial might be leading student to develop stress which the recognizing the above problems, the aim of this paper is developed a conceptual framework for stress monitoring using the Internet of Things (IoT) technology and Extreme Learning Machine, in order to provide consultation and assisting science students to increase student retention rates and reduce the loss of graduate students. The experimental results showed that, the proposed framework was more accurate than the Support Vector Machine and KNN respectively, with an accuracy of 93.54 percent with a sensitivity of 98.16 percent.

Keywords: Extreme Learning Machine (ELM), Internet of Things (IoT), Machine Learning, Stress Detection System, Stress Management, Online Education, COVID 19

INTRODUCTION

Stress has become an important issue which occurred the large number of people around the world (Chienwattanasook & Jermsittiparsert, 2019; Panicker & Gayathri, 2019; Jermsittiparsert, Petchchedchoo, 2021). The stress is the result of changing of the world, lifestyle that take high workloads and pressure from work, which contributes to increase our stress levels (Alberdi, Aztiria & Basarab, 2016). McEwen (2000) defines stress as ‘‘events, that are threatening to an individual, and which be licit physiological and behavioral responses”. The stress that occurs on students is a common problem and affects the academic achievement of students (Monteiro, 2014; Sripongwiwat, 2018). The stressful affect very student in daily life due to their need to complete many examinations and homework, and to meet deadlines creates enormous stress; this stress can affect a critical impact on learning and the memory process (Jo€els, 2006; Schwabe, et. al., 2012; Sripongwiwat, 2018; Monteiro, Balogun & Oratile, 2014). These effects are extremely complex and interesting, as they affect both positive and negative sides. For example, enhancing and damaging effects on memory (Sripongwiwat, Bunterm &Tang, 2018) and it effect the activity outline of the major physiological stress respond system (Sripongwiwat, 2018; Vogel, & Schwabe, 2016). Students can face and cope with stressful conditions based on their perceptions and responses to the situation (Sripongwiwat, 2018).

Stress is a part of life, it can happen to everyone, all ages, both in normal conditions and in times of illness. Especially in science students who have very high expectations for academic performance, a small mistake may make this group of children feel badly or severely impaired. Resulting in stress until the body releases more bad hormones resulting in rapid deterioration of the body as the psychological aspects, it causes. Particularly during the coronavirus (COVID-19) pandemic that cause of student lock down at home or study from home (SFH) via by distance learning. This circumstantial might be leading student to develop stress which from both internal and external factor. The manner in which student confront stressful events depends significantly on whether and how they perceive and react to the situations (Monteiro, 2014). Students diverge significantly their response to a stressful situation (Garcia, 2010; Monteiro, Balogun, & Oratile, 2014). The result of stressful of the student includes depression and anxiety, expressing behaviors such as aggression and antisocial acts (Garcia, 2010; Zimmer-Gembeck & Skinner, 2008). It is essential that teachers minimize stressful of the student. With the advance of technology has been developed the Emotional Detection System (EDS) as a tool for investigate stress level. Therefore, it is requirement to study the Stress Detection System (DSD) by using Internet of Things (IoT) technology. With awareness of stressful surveillance in science students, the researchers have the idea of developing a framework to monitor stress symptoms in students using the Internet of Things and the Extreme Learning Machine.

To bridge in the gap, the aim of this paper the aim of this paper is developed a conceptual framework for stress monitoring using the IoT technology and Extreme Learning Machine (ELM) in order to provide consultation and assisting science students to increase student retention rates and reduce the loss of graduate students during COVID 19 pandemic in Thailand.

LITERATURE REVIEW

In order to obtain a system for detect stress of the learners, the research team reviewed relevant research as follows:

Stress in Education

1. Stress definition and type

Many studies have definite stress in various term such as McEwen (2000) that defines stress as ‘‘*events, that are threatening to an individual, and which elicit physiological and behavioral responses*”. Mishra, et. al. (2011) also defined as ‘‘*the emotional, cognitive, behavioral and physiological reaction to aversive and noxious aspects of work, work environments and work organizations. It is a state characterized by high levels of arousal and distress and often by feelings of not coping*”. However, stressful situation and bringing their organism back to balance such as homeostasis (Jo€els, 2006; Schwabe et. al., 2012). Stress is defined as a relationship between the person and the environment that is appraised by the person as relevant to his or her wellbeing and in which the person’s resources (Houghton, 2012). According to Hamaideh (2011) stress is personal, physiological and emotional reactions against stimulus. Thawabieh & Qaisy (2012) defined stress as the situation by which the individual suffers from physical and psychological hypertension resulted from factors that can't be handled and exceeds human ability to cope with. Stressors refer to the factors or stimulators that cause psychological physical stress. Some scientists classify these stressors according to their frequency or duration (Hussien, 2006).

Several experts identified that stress linked to the personal behavior and fluctuations in psychopathology development (Grant, 2010; Sripongwiwat, Bunterm, & Tang, 2018; Tessner, 2011; Zimmer Gembeck, & Skinner, 2008). Stress type can be distinguished into three types (1) acute stress is the most common short-term and come suddenly and it is not considered harmful (Bakker & Pechenizkiy, 2011; Sripongwiwat, 2018) (2) episodic stress appears when people overloaded with responsibilities and schedules. The stressful situations might be occurred more frequently, this associated with an actual stressful and disordered life (Bakker, 2011; Sripongwiwat, 2018). Finally, (3) chronic stress, which is the most harmful, takes place when stressors are persistent and long-standing, such as family problems, jobless or poverty (Colligan & Higgins, 2006; Sripongwiwat, 2018).

Stress in Education

Stress is play important roles in education both teacher and student. Stress led the student to externalizing behavior such as aggressive and disruptive acts (Zimmer-Gembeck & Skinner, 2008; Sripongwiwat, Bunterm, & Tang, 2018). The stress in education research has been increasing around the world, particularly in Thailand. Sripongwiwat et al., (2018) conducted a survey to study the influence of learning stress among secondary school students in a school in Northeast Thailand, founded that there are six differences, which consists of stress about studying (academic-related), interpersonal relations (Interpersonal-related), the inner relationship (intrapersonal-related), learning and teaching (learning and teaching), relationship with teachers. The results showed that there were significant differences in the learning of all six subjects between junior and senior high school. Specifically, the stress that was involved in education was significantly different between men and women. The results of this research play an important role in the body of knowledge in designing lesson plans and formulating appropriate strategies for managing student stress during learning. University students may constitute a particularly vulnerable population for mental health problems considering challenges commonly associated with transitions to adulthood and the frequent economic and material difficulties of this population (Huskya, 2020).

The study of stress and anxiety among university students in France during Covid-19 found that, the sample increased anxiety as well as moderate to severe stress during study from home (SFH). The impact of the COVID-19 pandemic on the mental health of students in locked-down colleges remains obscure (Li, Fu, Fan, Zhu, & Li, 2021). The explore influencing factors for the psychological impact of COVID-19 on Wuhan college students, post-traumatic stress symptoms, to inform evidence-based strategy development to ameliorate such adverse impacts. The findings suggest the harshness of the psychological impact of COVID-19 that student lost loved and suffered from family financial loss should be taking care. Moreover, the effecting of COVID-19 is distressing people have anxiety, depression, and stress symptoms, therefore it needs to establish a mental health support system that can address this issue.

Emotion Detection System

Emotion is the procedure of the linked mental and behavioral, it leading to action, appraisal experience, physiological reaction, and facial expression (Panicker & Gayathri, 2019; Reisenzein, 2007). Emotion including cognitive (appraisal), autonomic nervous system (arousal), motor (expression), motivational (action tendencies) and monitor (feeling) this occur in internal and external stimulus (Scherer, 2000). The Emotion Detection and Stress Detection that start

from (1) presence of stress deal with physiological aspect, (2) stress detection deals with research aspect (3) stress management that tackles the psychological aspect (Panicker & Gayathri, 2019).

Technology for Stress Detection

1. Internet of Things (IoT)

The Internet of Things (IoT) is "The Internet of all Things", meaning that devices, things, and everything are linked to the internet. IoT is the interconnections of digitally augmented physical objects (Atzori, Iera & Morabito, 2016; Bocken, 2019). IoT is connected with the smart object that interact and communicate with the environment and the data recorded by smart devices, about device use and performance, (Korteum, et. al., 2010; Lightfoot, Baines, & Smart, 2011; Bocken, Ingemarsdotter & Gonzalez, 2019). IoT technology allows humans to control and use various devices through the internet network, such as turning on-off electrical devices (Ordering to turn on electricity in the home by connecting control devices such as mobile phones via the internet), cars, mobile phones, or agricultural tools through the internet network.

The IoT applied to educational as the tools to integrate with smart device to support learning. The study of Al-Turjman, Nawaz & Ulusar (2020) shown that the IoT creates intelligent networks that integrated the internet, various sensors and data processing together. This brings to apply IoT to study about brain wave signal that effect with stress. The research about ECG and EEG signals which is part of this research are important inputs for diagnosis disease in human such as heart disease, or neurological diseases. While (Saleem, & Chishti, 2019) present ideas on how to use deep learning to analyze data from the Internet of Things.

2. ESP32

There are several hardware devices that connecting to the IoT. Especially the ESP32 microcontroller as a high-performance microcontroller that is commonly used for the IoT, it can use standard tools for developing programs for Arduino to write programs to control ESP32 using the language that makes ESP32 popular (Andreas, et. al, 2019). That's because it is a control board that combines all electronic devices in one, with two cores. One core to use the wireless function and another core to run the uploaded program. In addition, ESP32 also has Wi-Fi and blue modules tooth and 36 GPIO. Among other things, the ESP32 microcontroller has a fairly large memory, and low power consumption. In Kodera (2018) explained that, the ESP32 is a microcontroller that is widely used all over the world, and he has chosen to use the ESP32 board for antenna systems.

3. Extreme Learning Machine

With the advance of artificial intelligent (AI) technology that apply Extreme Learning Machine concept for brain wave research. Extreme Learning Machine algorithm, abbreviated as ELM (Huang, Wang & Lan, 2011) which is a forward feed Neural network that has a higher calculation speed than that of the traditional artificial neural network. It has been shown the application of ELM in order to detect and classify ECG records, they applied the wavelet transform method and genetic algorithm to improve the efficiency of classification performance, which is different from our concept of applying ELM with the EEG signal to brain and emotions of humans (Diker, et. al, 2019).

Brainwave and Electrode placement for the proposed EEG device

The Alpha brainwave has a frequency of around 7-14 cycles per second (Hz). This lower wave frequency is the most frequently occurring in a happy child and in adults who have trained themselves to be calmer, it can mean a state of equilibrium in a comfortable state, which is slowed down by contemplation, not responding to stimuli as well. Quick temper lesser frequency means that we think slowly, rhythmically, with melodies, giving our mind time to think and become more systematic. From our literature review about alpha waves, we found that on days when we have a lot of activity, there will be a rather severe alpha wave around the frontal lobe. While the same alpha waves, if found in the occiput region, will indicate the best resting conditions (Zhang et. al, 2017). While the Theta brainwaves have a frequency of around 4 - 11 cycles per second (Hz), which is a period in which the brain slows down a lot. Usually found during sleep or have a high level of relaxation Behavior level under the frequency of the wave is the manner in which the person thinks about it to solve the problem. Found both the conscious and unconscious characteristics appearing to be creative resulting in insightful thoughts and looking optimistic resolute and resolute have the potential for long-term memory and awareness. To bridge in the gap, we designed our headset device with the best alpha wave point at Fp1, Fp2 and the theta wave at F7, F8 based on details in (Jo€els, Pu, Wiegert, Oitzi & Krugers, 2006).

RESEARCH METHODOLOGY

The proposed stress monitoring framework is shown in Figure 1. Acquisition of brainwave data from all subjects acquired from headset devices. This device uses the ESP32 board as the main processing circuit. Because we are interested in specific brainwaves related to human anxiety, stress, and pressure. Therefore, we designed our brainwave measuring devices to focus on measuring alpha and theta waves only. When the subject is under stress and pressure conditions, the signals from four electrodes are sent through the ESP32 board to computer and filtered the frequencies to the alpha and theta frequencies before collecting them as data for training with the class label assigned.

To determining the emotional state of the subject, when the participants gather equipment at their head, brainwaves from four channels will be sent through the ESP32 board to the computer, it has to be filtered to the frequency of Alpha and Theta range using Notch Filter. After filtering, the signals from 4 channels will be compared with the training data and predict the class label. In this research, we compared the efficiency of brainwave classification of 5 science students, divided into 3 women and 2 men. By specifying the parameters of the candidate algorithms as follows. The KNN algorithm assigns K=3, the SVM algorithm assigns the kernel value to RBF. The results obtained from three methods are shown in Table1.

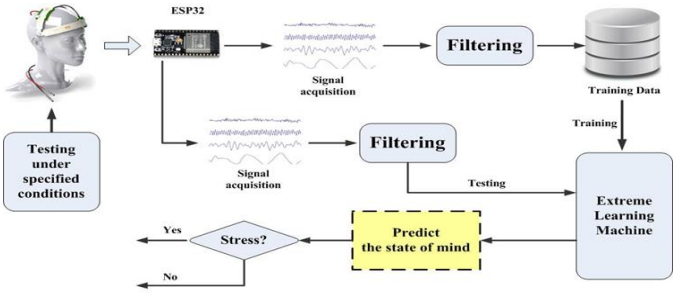

FIGURE 1

THE PROPOSED STRESS MONITORING FRAMEWORK, BASED ON INTERNET OF THINGS AND EXTREME LEARNING MACHINE

RESEARCH RESULTS

Research experiment is conducted using Intel Core i5-7200U CPU @2.50 GHz, with 8GB RAM. The implementation is performed using MATLAB 2015a (64-bits). To evaluate classification performance, accuracy, and sensitivity have been utilized.

FIGURE 2
SYSTEM TESTING WITH STUDENT IN COMPUTER SCIENCE DEPARTMENT

Technology and Digital Program, Faculty of Liberal Arts and Sciences, Sisaket Rajabhat University, with subjects that need to be calculated and using English language.

Table 1
CLASSIFICATION PERFORMANCES

Algorithm	Accuracy	Sensitivity
KNN	76.80%	73.10%
SVM	86.67%	87.93%
ELM	93.54%	98.16%

Table 1 show the classification performance of KNN algorithm was 76.80% (Accuracy) and 73.10% (Sensitivity), while Support Vector Machine obtained more effective in terms of accuracy and sensitivity. While Extreme Learning Machine provides both the highest accuracy and highest sensitivity than that of KNN and SVM (93.54% and 98.16% respectively). Results from applying the IoT and machine learning algorithms in this research, we found that the machine learning algorithms with high performance and high accuracy in classifying data were necessary for the psychological assessment of both secondary and tertiary learners. Extreme Machine Learning Classification was the best algorithm for classification stress in learners compared to KNN and SVM. From this research, we found that multi-tiered operations create bottlenecks in data transmission and presentation. This is because the ESP32 microcontroller board runs slower than the personal computer. Causing the need to set a proper delay time and the transmission rate between the ESP32 board and the microcomputer.

In addition, in practical we found that the size of the device should be as small as possible, with a light weight and a power supply that can be used for at least 2 hours due to the

large number of sensors attached to the ESP32 microcontroller board, and requiring a Wi-Fi connection, make the system needs more power source.

DISCUSSION AND CONCLUSION

Stress directly affects people around the world and becoming significant issue that effect quality of life. Stress can damage the quality of life at an individual level, which by all means directly affects one's personal and social life (Panicker & Gayathri, 2019). Especially, in educational dimension, stress has consequence on the ability to learn and study of the students. Since that learning stressors are universal in education and becoming very significant issue of an online learning during COVID 19 pandemic because its case of individual learning problem which laying the foundation of later career success and socioeconomic status (Sripongwiwat, Bunterm & Tang, 2018). Particularly in Thai educational system will be highly relevant for society as a whole and building grounded educational to the next generation. Subsequently, mental stress harmfully affects one's physiology, emotional health, physical health and overall wellness therefore it needs an efficient and robust Emotion Detection Systems (EDS) or Stress Detection Systems (SDS) is crucial (Panicker, & Gayathri, 2019; Bakker & Pechenizkiy, 2011). With the advance of pervasiveness of machine learning techniques and wearable technology in healthcare is a sweeping development certain to benefit the society (Panicker & Gayathri, 2019).

In this paper we have presented a new framework for stress monitoring. In order to obtain an effective framework, we integrated IoT technology and machine learning technique called the Extreme Learning Machine. The Stress Detection System (SDS) by IoT Integrated with extreme learning machine for education during COVID 19 pandemic was developing as the prototype. The Stress Detection System (SDS) was experiment with student. The result found that framework is more effective in identifying the stress state of science students than that of the KNN and SVM, with high accuracy while requires less training time than that of the Support Vector Machine. Determining brainwaves that correspond to the problem resulting in a compact, and low-power prototype device. This associate with the study of Schwabe and Wolf (2010) showed that learning under stress effects on subsequent memory performance and stress acted as a distractor during encoding, diverting attention from the learning material (Panicker & Gayathri, 2019; Sripongwiwat, 2018). This supported many studies found that an appropriate teaching and learning model is able to reduce the stress of students effectively (Bunterm et. al., 2014; Rachahoon, et. al., 2011; Rattanawongsa, et. al., 2013; Vangpoomyai, et. al., 2012; Sripongwiwat, Bunterm, & Tang, 2018). This study finding may have important implication for educational and professional setting in Thai classroom management. Finally, we point to essential extensions of current theories on the emotion and stress, particularly in the neurocognitive based teaching and learning methodology.

LIMITATIONS AND FUTURE STUDIES

As a result of this research, we found that a multi-tiered learner's cognitive or emotional state system is not the best choice, since individual differences in the computer architecture may have an effect. It affects the form of bottlenecks in receiving and processing data. Therefore, very small machine learning machines that can be run on tiny microcontroller boards like Tiny ML and Tensor Flow Lite Micro (TFLM) are the options in our next research to make these tiny microcontroller boards can classify these types of information by itself. In additional, we also found that using just one set of tests would not cover all learners in each class, because each learner has different personalities, subject aptitude, and mindset. Therefore, this type of research

will be more effective and useful for teaching and learning style if the students' specific characteristics and mindset are taken into account.

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