

Stress Detection using Convolutional Neural Network and Internet of Things

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Abstract: Survival amid today's highly competitive world has become an integral and inevitable part of life. People from all walks of life today find it extremely difficult to cope with their hectic schedule, work pressures, and compete with their peers that often results in stress. Prolonged exposure to stressful environments could severely disturb emotional and psychological wellbeing in humans thereby resulting in long term health implications. The advent of Artificial Intelligence (AI) and Internet of Things (IoT) in the modern era has proved to be extremely effective in prompt and precise detection and diagnosis of stress based on certain predefined/ specified algorithms which could immensely aid in timely diagnosis and treatment of stress related disorders. Studies reveal that by integrating IoT and AI backed by deep learning (DL) technologies it is possible to proactively detect stress much before its implications could manifest on human health. This study investigates the effectiveness and viability of AI backed DL techniques and IoT in prompt and precise detection of stress in humans.

Keywords: Stress, Artificial Intelligence (AI), Deep Learning (DL), Internet of Things (IoT)

1. Introduction

Modern lifestyle has its own implications on varied components of lives of individuals due to various challenges and uncertainties imposed by unprecedented situations of life. People from all walks of life today are used to stressful conditions of life due to extreme competition and performance oriented work environment that consistently demands for optimal performance and productivity regardless of industry or location. Exposure to such a consistently stressful environment often leads to varied adverse symptoms that primarily include but not limited to insomnia, fatigue, depression and other conditions that severely degrade psychological and emotional wellbeing of individuals exposed. Overcoming such critical conditions requires prolonged duration of time and relaxation which may not be possible for people that need to work every day. However, prompt detection and diagnosis of implications of stress on one's health could certainly deliver anticipated health benefits without having to incur substantial treatment costs, time and efforts and without being off work. This is extremely important in today's hectic life packed by various inevitable and indispensable tasks and activities essential for peaceful sustenance. Plethora of academic research literature exists on the online platform suggesting the detrimental effects of stress on varied key aspects of life including relationships, profession, and social health. This is mainly due to lack of adequate relaxation or sleep that results in poor functioning on vital organs of the body such as heart that later manifest into critical problems if untreated in time [1]. It has been found through studies that negligence towards health due to exposure to prolonged stress could lead to serious long term adverse implications which, if untreated in time, could permanently damage critical aspects of an individual's life such as relationship breakages.

Various studies have been conducted to investigate on mechanisms that can proactively detect and diagnose stress related disorders on human health. Traditional approach to medicine lays emphasis on psychological symptoms to detect and diagnosis diseases whereas on the contrary advancements in science and technology are playing a key role in developing Artificial Intelligence (AI) backed system that could precisely detect stressful conditions much before its psychological symptoms could manifest on patient's health. Studies conducted by Bhat et al. suggested that integration of IoT with deep learning techniques using appropriate methods could not only allow in proactively and precisely detecting and diagnosis stress but also play a key role in treatment of stress and associated disorders long before actual symptoms of the disease manifests in psychological form [2].

Studies conducted to examine the behaviour of heart in athletes revealed that consistency and disciplined schedule that mainly included timely and regular exercises insured improved performance of the heart. On the contrary slight deviation from the regular schedule showed variations and depletion in the performance of heart rate due to overstrain thus indicating a direct link between an individual's regularity of schedule and health [3] [4]. This it can be aptly inferred that any task or activity that disturbs normalcy does impact adversely on the health however it all begins from the mental health since mind the primary receptor of physiological health. Researchers therefore are keen to proceed on developing technologies that could read facial expressions of stress and proactively detect stress even before any adverse physiological ailments manifest. Recent advances in medical

technologies indicated that appropriate integration of IoT with machine learning (ML) methodologies or techniques could prove immensely useful in prompt and proactive detection of stress based on patient's facial expression as face is the primary indicator of emotional, psychological and mental wellbeing and clearly depicts an individual's state of being. This is because a person's emotional state can be aptly inferred from their expressions of happiness or sorrow. A person in a happy state of mind would show positive facial expressions such as smile, while on the contrary a person in sorrow would show signs of frowning face indicating despair. Thus, facial expression could serve as a tool for detection and diagnosis of stress and aid medical practitioners in early treatment of stress and prevention of varied associated psychological or mental diseases.

This study aims to investigate the effectiveness and viability of AI and IoT backed machine learning system using CNN model for prompt and accurate detection and diagnosis of stress based on facial expression. The study shall employ a literature review based research and discuss a proposed CNN based model for the research theme.

2.Literature Review

Recent research on applications of Convolution Neural Network (CNN) based models in integration with internet Of Things (IoT) showed encouraging outcomes in precisely detecting and diagnosing stress symptoms based on specified bio-algorithms. Studies suggested that facial expressions could serve as a key algorithm in detection of stress due to meaningful messages decipherable from facial expressions such as sorrow, depression and anxiety [5]. Studies conducted by Shafiei et al suggested that CNN proved immensely useful in precisely deciphering the psychological or mental conditions of individuals affected by chronic ailments such as depression and anxiety due to cancer like chronic factors. The study that mainly employed a CNN based LSTM model showed a high accuracy levels in assessing patient mental health using CNN models based on certain specified bio-algorithms such as eye stimuli, pupil size movements and ocular momentum. The study evaluated the mental health of psychologically instable individuals based on their ocular sensory reactions to external stimuli that showed promising outcomes with over 90 percent of accuracy in psychological wellbeing, anxiety levels and hope of affected patients [6].

A comprehensive study by Li and Liu strongly emphasized on the need for further research and adoption of deep learning models in accurate stress detection and diagnosis. The research employed DL techniques to examine the mental health of individuals suffering from varied stress related disorders. Using DL based dual CNN models the study designed stress and emotion detection algorithms based on which a systematic analysis of sensor measured psychological signals was carried out. As revealed by the study, DL based CNN attained an astonishingly accurate results of over 99.80 percent and over 99.55 percent for binary and 3 class classification. This showed a significant breakthrough in research and a further advancement in the domain strongly suggesting the viability and reliability of DL techniques in prompt and accurate detection of varied psychological ailments. The authors emphasized that appropriate configuration of DL methodologies using specified algorithms would prove immensely useful in diagnosing variety of psychological symptoms due to the fact that DL methods are capable of detecting emotional and psychological signals relating to varied health conditions [7].

A systematically developed study by Venkataraman and Parameswaran revealed that emotional and mental disturbances could serve as the key inputs in detection and diagnosis of stress related disorders in patients suffering from anxiety and depression. Their study revealed that SVM classifier could be effective classifier in the diagnosis of symptoms [8]. Another study indicated that significance of use and applicability of CNN based model in accurate detection and diagnosis of images for the research theme. An interesting study on CNN revealed that face recognition could serve as an important input for researchers in precise detection of varied mental symptoms including depression and anxiety [9].

A comprehensive study conducted by Yashaswini et al revealed that use of deep learning techniques with IoT embedded with sensors could promptly detect stress based on individual's facial expressions. The study primarily used pulse sensor for detecting facial expression of participants. Training the CNN with appropriate method and deep learning algorithms was done to ensure appropriate anticipated outcome of study. Cameras to capture facial expressions of participants enables in obtaining the required data for apt interpretations of stress symptoms. The cameras mounted on the PCs proved immensely useful in capturing participant's facial expression during the work hours. Specified algorithms such as eye movements, movements and distance between eyebrows, and other algorithms were used to aptly decipher participant's mental health condition during work [10]. Using CNN backed DL techniques for image classifications and accurate interpretation it was possible to accurately detect symptoms of stress. The study strongly suggested that further research on the subject could revolutionize the field of medical diagnostics and open new doorways of opportunities for DL based applications in the domain [5].

An insightful study on CNN based and IoT integrated using android smart phone revealed varied uses and advantages of the technology in promptly detecting and diagnosing stress levels and identifying the mental condition of the individual. The research showed that appropriate algorithms and selection of right CNN model not only improved the accuracy and performance levels but also opened new opportunities of research in medical diagnostic field using deep learning systems. The study concluded that peculiarity of advanced CNN algorithms to

accurately classify, recognize and detect anomalies in images proved immensely useful for the diagnosis of varied health symptoms based on predefined protocols [11].

3. Proposed Model

The study proposes a unique combination of deep learning based CNN model embedded with IoT due to the fact that its combination is deemed ideal for data recognition, data gathering, data analyzing and appropriate interpretation of the obtained information. The peculiarity of deep learning to precisely detect and identify appropriate imagery based on systematic classification of images is the basis of this study. CNN model comprising of three layers, namely, Convolutional layer, pooling layer and Fully connected layer remain critical for image processing and refinement hence CNN is deemed ideal for the study.

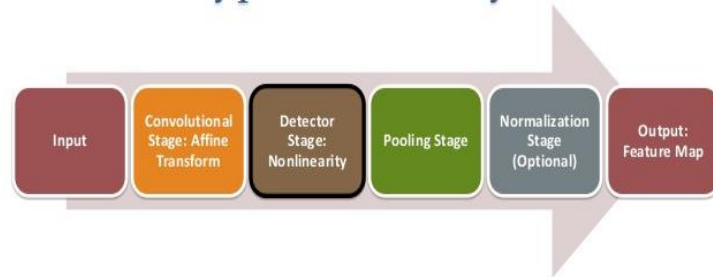


Figure.1 showing the workflow of CNN

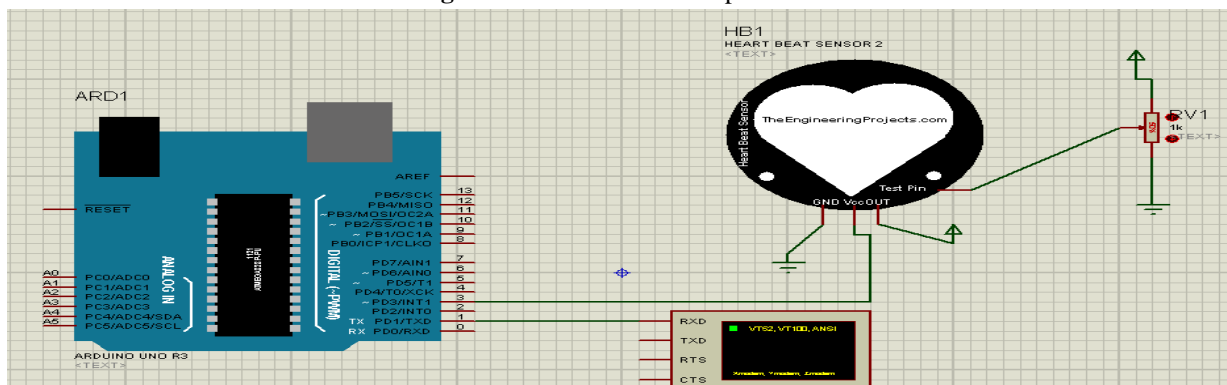
For the IoT implementation, Arduino Mega is employed which a microcontroller is based on AT mega 2560 microcontroller. It consists of a USB cable for linking between board and computer. It consists of 54 and 16 digital and analog pins respectively. Pulse sensor is used to detect pulse rate Inter beat interval is used to compute pulse of heart rate.



Figure.2 Arduino Uno

WiFi module is employed for accessing the microcontroller wirelessly. As can be seen from the image herein camera captures the person's image and using CNN model it aptly processes the image to predict if the individual has any stress symptoms. If the forecast is true, then connection to WIFI is established then it links to the pulse sensor that reads the pulse with contact of fingertip. Recorded data is transmitted to server that checks if obtained value is higher to the threshold value and then confirms the stress symptom on user webpage

Figure.3 Architecture of Proposed Model



4.Conclusion

To conclude, the use and applications of a revolutionary model using CNN, IoT, and sensor proved extremely effective in prompt detection and diagnosis of stress in individuals working on computers. As CNN models are highly effective in image classification and precise recognition of image variations, it can thus prove to be very significant in diagnosis of various ailments based on the early signs such as facial expression among individuals exposed to stressful environments.

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