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RESEARCH ARTICLE

IT EMPLOYEES STRESS DETECTION BASED ON YOLO DEEP LEARNING ALGORITHM

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Abstract – Stress related disorders are extremely prevalent among workers in the corporate sector. The high demands and extended work hours of IT employment have led to an increase in stress among IT workers. In this paper a novel STress DEtection on it employees using YOLO deep learning (STEP-YOLO) has been proposed for detecting the Stress on IT Employees. Initially, the input images are pre-processed in this pre-processing image acquisition and image processing are done to enhance the image. The features are extracted from the pre-processed image it extracts the feature whether they are happy, sad or neutral. Finally, the objects are detected using the YOLOv5 technique to detect the stress on IT employees. The proposed STEP-YOLO achieves an accuracy rate of 99.35% and an overall accuracy rate of 0.94%, 1.61% and 0.7% which is comparatively higher than the existing methods such as UBFC-Phys, PSS and SAD. The proposed method takes 0.18 milliseconds to detect the stress on IT employees which is comparatively less than the existing methods respectively.

Keywords *– YOLOv5, Deep Learning, Stress Detection, IT Employees.*

1. INTRODUCTION

One of the main manifestations of human life is stress. Stress plays a significant part in people's lives [1]. Numerous illnesses, including cancer, heart disease, lung issues, breathing difficulties, and other conditions, can be brought on by stress [2]. The growth in global population has led to a rise in people's stress levels. Stress is a prevalent condition among all people these days. Systems for managing stress are essential for identifying stress levels that impact our socioeconomic status [3]. A quarter of the population experiences mental health problems, such as stress, as per the World Health Organization (WHO) [4]. Human stress manifests as mental and financial difficulties, unclear thinking at work, poor working relationships, hopelessness, and, in severe cases, death [5]. The IT industry is always introducing new products and services in order to stay competitive. Furthermore, this poll indicates that over the previous year, employees' stress levels have increased [6]. Even though many businesses offer their employees advantages related to mental health, the issue still exists. We'll start by examining how stressed-out workers are at work [7]. The investigation will employ machine learning and images to analyze stress patterns and identify the key variables affecting each person's stress threshold. One in four voters suffer from stress, a mental illness, according to the WHO [8].

Employers can better educate their staff to handle stressful situations before they arise by implementing the Stress Detection System. Stress identification may occasionally require differentiating between a "stressed" and a "relaxed" situation, even while office workers are focused on their work [9]. Employees have their heads photographed, and they receive survey questions with a similar standard format and style. There is less physical strain, which results in time and cost savings [10]. Using our laboriously created questionnaire, this organizational method can help reduce employee stress. The use of stress monitoring software can enhance people's health as well as the welfare of society [11]. Thus, the development of scientific tools capable of analyzing physiological data and automatically estimating human stress levels is imperative. Health issues like obesity, heart attacks, diabetes, asthma, and other ailments can be brought on by stress. Every hour, a student in a different part of the nation ends their life [12]. A machine learning technique in artificial intelligence allows a system to learn and adapt without the need for explicit programming (AI). Making computer programs that can learn for themselves is known as "machine learning," a branch of computer science [13]. Digital signal processing, which considered the Galvanic skin response, blood volume, pupil dilation, and skin temperature, was used to assess earlier work on stress detection. Previous studies on this topic have used a range of physiological indicators and visual cues to quantify stress levels in focused individuals [14]. The following people have successfully completed the main contribution of the work:

- In this paper A novel STEP-YOLO has been proposed for detecting the Stress on IT Employees.
- Initially the input images are pre-processed in this pre-processing image acquisition and image processing are done to enhance the image.

- Then the features are extracted from the pre-processed image it extracts the feature whether they are happy, sad or neutral.
- Finally, the objects are detected using the YOLOv5 technique to detect the stress on IT employees.

The remaining portion of the research study was set up in this manner. In Section 2, the research is described using existing literature; In Section 3, the STEP-YOLO, a proposed approach for predicting coffee quality, is thoroughly explained; and in Section 4, the experiment's outcomes are discussed. Section 5 explains the outcome of the procedure and what comes next.

2. LITERATURE SURVEY

In 2020 Bobade, P. and Vani, M., [15] proposed a number of deep learning and machine learning techniques that employ multimodal datasets collected from physiological and wearable motion sensors to identify stress in individuals, which can shield a person from a variety of health issues caused by stress. The accuracy of the binary and three-class classifications were assessed and compared using machine learning techniques. With accuracy ratings of 84.32% and 95.21%, this model successfully completed the three-class and binary classification tasks.

In 2021 Sabour, R.M., et al [16] introduced a new dataset called UBFC-Phys that was gathered from subjects experiencing social stress both with and without contact. The objective of this is to exhibit the dataset, which makes available to the public, as well as the experimental findings of stress recognition and the comparison of contact and non-contact data. The application of remote PRV features resulted in an accuracy of 85.48 percent for stressed state detection.

In 2022 Mohan, L. and Panuganti, G., [17] focus on using the Perceived Stress Scale (PSS) for stress detection. The PSS approach is used because it is a simple questionnaire with proven psychometric features. The findings of this study, which employed the Random Forest, Logistic Regression, and SVM methodologies, indicate that only approximately 9.6% of workers are stress-free. The logistic regression approach yields the maximum prediction accuracy of 99 percent based on the experimental results.

In 2022 Giannakakis, G., et al [18] proposed a unique deep-learning pipeline to identify facial action units automatically. This focuses on identifying and analyzing automatic AUs as quantitative markers to differentiate between neutral and stressed states in videos. The suggested technique is used on the SRD'15 stress dataset, which has four different types of stressors associated with neutral and stressed states. Experimental detection of the stress-related AUs showed that, in contrast to neutral states, stress significantly increases their intensity, resulting in a more expressive human face.

In 2022 Yang, K., et al [19] Proposed a knowledge-aware mentalization module that considers the most pertinent knowledge aspects by utilizing dot-product attention. The research has potential applications for various mental health issues and makes it easier to identify and analyze stress and depression in social media data. This approach delivers new state-of-the-art performance on all datasets, with an average improvement of 2.07%, as demonstrated by the experimental findings, with F1 scores of 95.4% on Depression Mixed, 83.5% on Dreaded, and 77.8% on SAD.

In 2023 Hamdi, E., et al [20] proposed a stress detection deep learning model trained and tested on the Stress Annotated Dataset (SAD). In the stress detection test, the model produces competitive results, suggesting that data augmentation greatly enhances performance. It is possible to investigate the impact on the stress detecting location by implementing various textual data augmentation processes that provide more data samples. The accuracy increases from 6.1% to 10.4% when different data augmentation strategies are implemented.

In 2023 Patel, A., et al [21] proposed a cutting-edge artificial intelligence (AI) technique based on deep learning (DL) that develops a model for the identification of emotional stress levels using electroencephalogram (EEG) data. The suggested method is verified using the publicly accessible Database for Emotion Analysis using Physiological Signals (DEAP), a benchmark dataset. The outcomes demonstrated that the CONVlD+BiLSTM outperformed the traditional shallow learning techniques and offered the greatest emotion recognition accuracy of 88.03 % among the various built deep learning models.

3. PROPOSED METHOD

This method a novel STress DEtection on it employees using YOLO deep learning (STEP-YOLO) has been proposed for detecting the Stress on IT Employees. Initially, the input images are pre-processed in this pre-processing image acquisition and image processing are done to enhance the image. The features are extracted from the pre-processed image it extracts the feature whether they are happy, sad or neutral. Finally, the objects are detected using the YOLOv5 technique to detect the stress on IT employees.

3.1. Pre-Processing

Pre-processing images is an essential stage in computer vision and image analysis that highlights the best and most valuable images for subsequent tasks. A series of stringent methods for improving the caliber and value of images for future evaluation tasks are included.

3.1.1. Image Acquisition

Image acquisition for stress detection is the process of employing specialized imaging equipment to collect visual data that can reveal physiological or psychological stress signals. This usually consists of thermal cameras, high-resolution cameras, or other sensors that may pick up on minute variations in skin tone, face expressions, or motions. In order to precisely capture the important elements, the method needs to guarantee ideal lighting and placement. As the foundation for further research utilizing algorithms intended to identify stress indicators, the quality and accuracy of the obtained images are vital. Reliable stress detection and assessment are made possible in this situation by effective image acquisition, which facilitates applications in user experience research, workplace monitoring, and healthcare. Block Diagram of the proposed STEP-YOLO method shown in Figure 1.

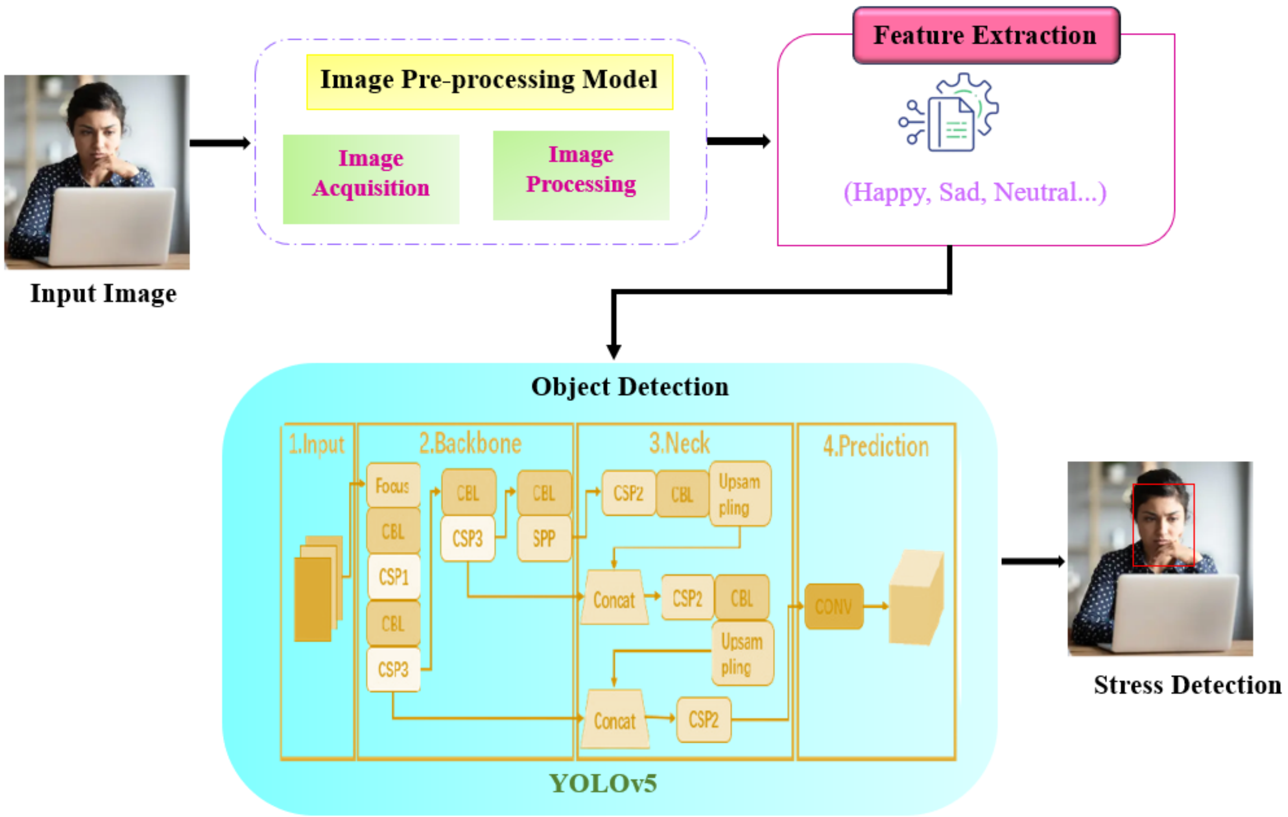

Figure 1. Block Diagram of the proposed STEP-YOLO method.

3.1.2. Image Processing

Analyzing images to find physiological or psychological signs of stress is known as image processing for stress detection. In order to identify important indicators like facial expressions, temperature variations on the skin, or micro-expressions, this procedure involves pre-processing to improve image quality, such as noise reduction and contrast augmentation, followed by feature extraction algorithms. These features are interpreted and stress levels are quantified using sophisticated algorithms, such as machine learning models and pattern recognition. In order to enable applications in fields like mental health evaluation, human-computer interaction, and occupational health monitoring, the objective is to convert raw image data into insightful knowledge about an individual's stress level.

3.2. Feature Extraction

In order to detect stress in images feature extraction entails separating out and identifying particular visual cues that are correlated with stress levels. This procedure entails the identification and examination of characteristics such as variations in skin temperature, micro-expressions on the face, and other physiological indicators. The system can efficiently analyze and measure stress levels by concentrating on these stress-related characteristics, offering insightful information for applications in psychology, healthcare, and human-computer interaction.

3.3. Object Detection

The process of discovering and identifying things inside an image is known as object detection in images. The computer vision approach is categorized into predetermined groups using this method, which additionally draws bounding boxes around the items to indicate their exact locations.

3.3.1. YOLOv5

YOLOv5 was brought presented by Ultralytics, which advanced YOLOv4 largely on its foundation. It is a detection version that achieves a good balance between accuracy and speed by leveraging the advantages of earlier iterations and several networks, including CSPNet and PANet. This YOLO model family presents a scalable way to classify recyclables into several groups. Depending on the material, construction waste can be broadly divided into four classes: wood, stone, brick, and plastic taking into account. The YOLOv5 model has been selected because to its effectiveness and accuracy in identifying objects. The Head, Neck, and Backbone are the three main architectural blocks that make up this structure.

YOLOv5 Backbone

The basis of CSPDarknet is used for feature extraction from photos containing cross-stage partial networks. which is implemented by the YOLOv5 Backbone. By quickly down sampling the dataset's photos, the focus module may pass image information into the channel without causing any missing images is more thoroughly extracting the features of the image information. YOLOv5 model simplification, enhanced feature extraction from photos, and faster detection are all possible using the modules. The SPP module may efficiently increase the backbone features' receiving range, improve the dataset image's scale invariance, promote network convergence, and increase accuracy.

YOLOv5 Neck

YOLOv5 Neck aggregates the features building a feature pyramid network with PANet and sending it to the Head for prediction. YOLOv5's bottleneck layer mixes route aggregation network (PAN) and feature pyramid network (FPN) architectures. Images with deep features have less geographical information and more semantic information. Conversely, images with shallow features contain poorer semantic information and stronger location information. Semantic information can be transferred from the deep feature picture to the shallow feature image through FPN. PAN can be used to move location information from the deep feature layer to the shallow feature layer. FPN and PAN working together may aggregate parameters from several trunk levels and detection layers, significantly enhancing the network's capacity for feature fusion.

YOLOv5 Head

The layers in the head produce predictions based on the anchor boxes in order to detect objects. The two parts of the head are non-maximum suppression (NMS) and loss function. The location loss in YOLOv5 is calculated using the full Iou (CIoU) loss function, which additionally takes loss and confidence into consideration, whereas the binary cross entropy loss function is used to establish the categorization. The sum of all the losses is the total loss. By completely accounting for the overlap area, the distance from the center point, and the aspect ratio, the CIoU loss function accelerates and increases the accuracy of the prediction box's regression.

$$f_i = 2\tau(a_i) - 0.5 + e_j \tag{1}$$

$$f_j = 2\tau(a_j) - 0.5 + e_j \tag{2}$$

$$f_r = q_k(2\tau(a_r))^2 \tag{3}$$

$$f_v = q_v(2\tau(a_v))^2 \tag{4}$$

The upper left corner of the feature map has its coordinate value set to (0, 0). The unadjusted coordinates of the anticipated Centre point are e_i and e_j. f_i, f_j, f_r and f_v stand for the updated prediction box's information. The information for the previous anchor is contained in q_k and q_v. The model's calculated offsets are denoted by the letters a_i and a_j the procedure of changing the final prediction box's center coordinate and size to match the center coordinate and size of the preset prior anchor.

4. RESULT AND DISCUSSION

This section discusses performance in terms of different assessment criteria and analyzes the experimental results of the proposed method. An i5 CPU and 4 GB of RAM were used to run the MATLAB simulator to assess the effectiveness of the proposed method.

4.1. Performance Evaluation

Evaluation measures were employed to verify the efficacy and characteristics of the proposed method. True Positive, False Positive, True Negative, and False Negative are the four basic metrics that are commonly used to assess performance. Employee facial detection is implemented through accuracy, Precision, Recall and F1-Score. The following expression was used to calculate the accuracy.

$$Accuracy = \frac{\mathcal{Tru}_{\mathcal{Pos}} + \mathcal{Tru}_{\mathcal{Neg}}}{\mathcal{Tru}_{\mathcal{Pos}} + \mathcal{Tru}_{\mathcal{Neg}} + \mathcal{Fal}_{\mathcal{Pos}} + \mathcal{Fal}_{\mathcal{Neg}}} \times 100$$

$$Precision = \frac{\mathcal{Tru}_{\mathcal{Pos}}}{\mathcal{Tru}_{\mathcal{Pos}} + \mathcal{Fal}_{\mathcal{Pos}}}$$

$$Recall = \frac{\mathcal{Tru}_{\mathcal{Pos}}}{\mathcal{Tru}_{\mathcal{Pos}} + \mathcal{Fal}_{\mathcal{Neg}}}$$

Where $\mathcal{Tru}_{\mathcal{Pos}}$ and $\mathcal{Tru}_{\mathcal{Neg}}$ indicates the True Positive and True Negative of the input detection image. $\mathcal{Fal}_{\mathcal{Pos}}$ and $\mathcal{Fal}_{\mathcal{Neg}}$ indicates the False Positive and False Negative of the input image.

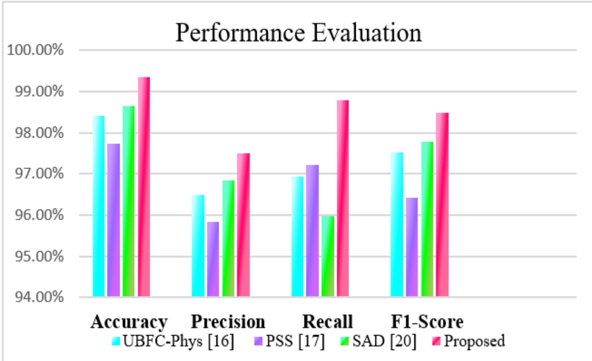

Figure 2. Performance Evaluation of the Proposed STEP-YOLO

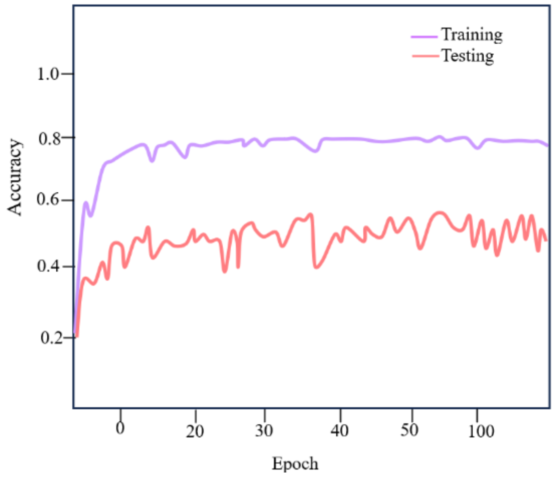

Figure 3. Accuracy Graph of the Proposed Method

Figure 2 describes the Performance evaluation of the proposed method with the existing methods such as UBFC-Phys, PSS and SAD. In this, the proposed method achieves an accuracy rate of 99.35%, a Recall rate of 98.79%, a Precision Rate of 97.51% and an F1-score of 98.48%. The proposed STEP-YOLO achieves an overall accuracy rate of 0.94%, 1.61% and 0.7% which is comparatively higher than the existing methods such as UBFC-Phys, PSS and SAD.

The accuracy and repetition of the proposed method are depicted in Figure 3. Plotting the Y-axis against the X-axis represents the overall quality of the epoch. The orange line here illustrates the testing period, and the violet line shows the training value of the proposal method.

Figure 4 describes the loss and iteration graph of the proposed method. Plotting the Y-axis against the X-axis represent the overall quality of the epoch.

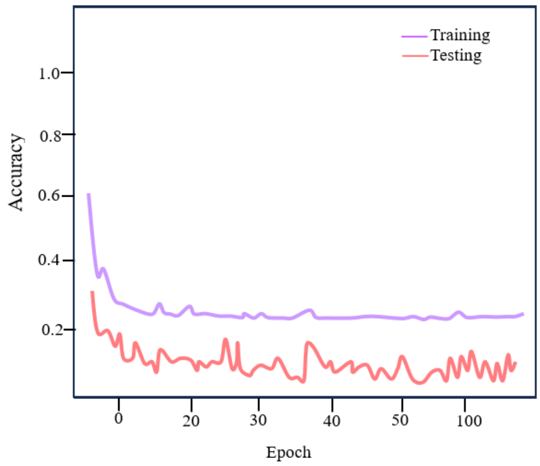

Figure 4. Loss Graph of the Proposed Method

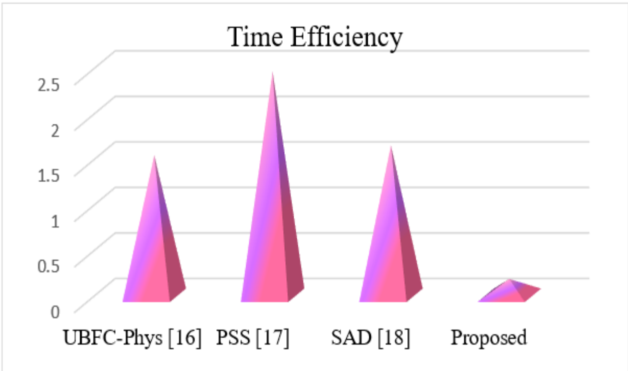

Figure 5. Time Efficiency of the Proposed STEP-YOLO

Figure 5 describes the time efficiency of the proposed and the Existing method such as UBFC-Phys, PSS and SAD. It shows that the proposed method takes 0.18 milliseconds which is comparatively less than the Existing method which takes 1.54, 2.46 and 1.65 milliseconds. This shows that the proposed method takes less time for detecting the stress in IT employees.

5. CONCLUSION

In this paper a novel Stress Detection on it employees using YOLO deep learning (STEP-YOLO) has been proposed for detecting the Stress on IT Employees. Initially, the input images are pre-processed in this pre-processing image acquisition and image processing are done to enhance the image. The features are extracted from the pre-processed image it extracts the feature whether they are happy, sad or neutral. Finally, the objects are detected using the YOLOv5 technique to detect the stress on IT employees. The proposed STEP-YOLO achieves an accuracy rate of 99.35% and an overall accuracy rate of 0.94%, 1.61% and 0.7% which is comparatively higher than the existing methods such as UBFC-Phys, PSS and SAD. The proposed method takes 0.18 milliseconds to detect the stress on IT employees which is comparatively less than the existing methods. The main added value of this article is that it helps the user to precisely recognize ongoing stress in order to decrease future health risk factors. The results are preliminary due to the small number of participants or technical details. Our plan to conduct more extensive demographic study in the future.

CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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