Topic: Detecting Depression using Machine Learning Approaches through Digital Biomarkers

Depression is one of the most common mental illnesses, significantly impacting a person's quality of life [1]. The World Health Organization (WHO) reports that approximately 280 million people in the world suffer from depression [2]. It is characterized by prolonged periods of sadness, loss of interest in activities, and can affect an individual's thoughts, behaviour, and overall well-being [3]. The traditional clinical diagnosis of depression depends heavily on subjective assessment, underscoring the necessity for more objective, accurate, and cost-effective methods [4]. Advances in machine learning are facilitating the development of diagnostic techniques for depression by examining digital biomarkers.

Many machine learning techniques have been used to identify depression by analyzing various digital biomarkers such as facial emotions, facial landmarks, Action Units (AUs), and head pose [5, 6, 7, 8]. There are different methods for extracting these facial features. One widely recognized method is the Facial Action Coding System (FACS), developed by Ekman et al. [9, 10], which codes emotions based on distinct patterns of facial muscle activations and uses 44 AUs to represent all facial expressions [11,12]. Another tool is OpenFace [13], an open-source software that provides automated extraction of facial features, including facial landmarks, eye gaze, head pose, and AUs [14,15]. FaceReader [16], a commercially available tool, excels in facial analysis with its advanced feature extraction and analysis capabilities [17,18]. It analyzes facial behaviors by providing comprehensive features, such as facial emotions, valence, arousal, head orientation, eye gaze, AUs from both the left and right sides of the face, and 2D and 3D facial landmarks. Compared to OpenFace, FaceReader extracts a greater number of AUs and provides a more detailed analysis by capturing these metrics from both the left and right sides of the face. Additionally, Convolutional Neural Networks (CNNs) have also been employed to automatically extract and analyze facial features [7,12,15].

While significant progress has been made in detecting depression using digital biomarkers, current methods face several limitations. Existing approaches often focus on isolated features rather than integrating multiple types of digital biomarkers like AUs, head pose, and emotional cues for a comprehensive analysis. Moreover, there is a pressing need for scalable and automated tools that can efficiently process and analyze large datasets without requiring manual intervention, thereby enhancing the practicality of depression detection models.

This thesis aims to contribute to the field of mental health diagnosis by developing machine learning models capable of detecting depression and predicting the severity of symptoms as measured by the Patient Health Questionnaire (PHQ-8) [19] scoring system. To achieve this goal, the model will integrate a range of features extracted from video data using FaceReader software, including emotional cues, AUs, head orientation, and facial landmarks. These features will be used to distinguish between healthy individuals and those suffering from depression based on the EmpkinS D02 dataset [20].

The proposed work consists of the following parts:

- Conducting a comprehensive literature review on depression detection through facial expressions, focusing on relevant studies.
- Collecting the EmpkinS D02 dataset including video recordings from healthy individuals and those diagnosed with depression.
- Preprocessing data by utilizing FaceReader version 9 software to extract facial features.
- Implementing and evaluating different classification algorithms for distinguishing between individuals with depression and healthy individuals.
- Implementing and evaluating different regression algorithms to predict PHQ-8 scores.
- Evaluating the effectiveness of the classification and regression models to assess the accuracy and reliability of the developed models.

The thesis must contain a detailed description of all developed and used algorithms as well as a profound result evaluation and discussion. The implemented code has to be documented and provided. Extended research on literature, existing patents and related work in the corresponding areas must be performed.

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