Analysis and Applications of Human Emotion Dynamics

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***Abstract*—This paper summarizes the three presentations in the track, "Analysis and Applications of Human Emotion Dynamics". These research works cover the dynamics of human emotion in response to music and visual arts using Convolutional Neural Networks (CNN), and the change and evolution of emotion over time. In music, attention is focused on piano music, particularly the performance techniques of piano playing. Several techniques are considered, such as glissando, arpeggio, octave, and trill, and the human emotion response to these are analyzed. In the visual arts, the focus is placed on the classification of emotions arising from the viewing of paintings; in studying the resultant response, it generalizes the approach to the possibility of using deep learning models for art therapy. In the research into emotion evolution, the importance of having a healthy emotion state for safety-critical tasks is highlighted, and CNN are used to first recognize emotions; subsequent to these, Markov chains are introduced to model the change in emotional states over time.**

Keywords: Art Therapy, Convolutional Neural Networks (CNN), Emotional States, Large Language Models, Markov Processes, Music Emotion Recognition (MER).

I. INTRODUCTION

In contemporary society, individuals increasingly face significant pressures that can stem from various sources. The intricate nature of human interaction and brain processes underscore the critical importance of accurately perceiving and articulating emotions. Emotions profoundly shape individual experiences, influencing every facet of life including our inter-personal interactions, decision making processes, and overall well-being.

Human emotion dynamics includes identifying and interpreting human emotions. People vary significantly in their ability to accurately recognize or differentiate [4] the emotions of others, which has led to the emergence of a specialized field that leverages technological advancements to aid in this task.

This Special Track brings together the latest research findings on the theory and applications of Emotion Detection, Recognition, Classification and Prediction, covering the prediction of emotion evolution over time for those performing safety-critical duties, and the emotional states in response to art and music. Another common theme in these studies is the use of deep learning methodology, which has shown to be particularly appropriate and effective.

II. SUBMISSIONS

The paper "Dynamic Emotion Analysis in Piano Music Based on Performance Techniques" [1] considers the emotion invoked by the different piano playing techniques. Considering that music is the language of emotions, the study focuses on the impact of playing styles on the listeners including the dynamics and volume of the music. The study can be divided into two aspects: the first makes use of deep learning to automatically identify piano performance techniques; while the second analyzes how these techniques influence dynamic emotional expression. The raw audio music is firstly processed to extract the relevant features, which include format conversion, segmentation, and augmentation. The paper focuses on four main features, which are glissando, arpeggio, octave, and trill. Deep learning is used in the recognition of these playing techniques. The study then uses GEMS (Geneva Emotional Music Scales) with 45 emotion tags across 9 categories (amazement, solemnity, tenderness, nostalgia, calmness, power, joyful activation, tension, and sadness) for emotion classification. The study has found that glissando has a strong positive correlation with pleasure activation, surprise and power, while trills are highly associated with nostalgia and tenderness, and are positively associated with sadness. Arpeggios were found to be positively correlated with nostalgia and tenderness, but negatively correlated with tension and sadness, and the octave shows a strong sense of power and pleasure activation, and is negatively associated with tenderness and sadness. The paper concludes that the CNN-based approach effectively identifies various performance techniques and achieves high classification accuracy, and may be usefully deployed in various applications, such as music recommendation systems and music education.

The paper "CNN-Based Emotion Classification in Visual Art for Therapeutic and Creative Applications" [2] focuses on the classification of emotion arising in the context of visual

arts. Since emotion reaction and subsequently its detection in paintings has the potential to enhance the user experience in art exhibitions, where the emotions conveyed by artworks can improve the viewer's experience with synchronized lighting, music, and multimedia elements, it can be further applied to help with art therapy. The study presents a system that uses Convolutional Neural Networks and Transfer Learning to detect emotions in paintings, comparing VGG16, InceptionV3, and MobileNetV2, three state-of-the-art models with different characteristics. In addition, the authors have also built a prototype that is able to show the classification capability of the best-performing model. It makes use of the 6-class emotional states (anger, disgust, fear, happiness, sadness, surprise) as well as binary classification of emotion states (pleasant and unpleasant). It is able to show that the InceptionV3 model attains the highest accuracy for binary classification with an accuracy of 71%. The paper concludes that there is great potential of using deep learning models for applications in art therapy and immersive art experiences, particularly when it is augmented by textual description and user annotations.

The paper "Predicting Emotion States Using Markov Chains" [3] turns attention from the art and music to situations that are more practical. It recognizes that in a wide variety of jobs, particularly those involving safety-critical elements, it is crucial that human participants maintain appropriate emotional states, and the accurate recognition of these emotional states has the potential to save lives or minimize injuries. The study firstly focuses on classifying and predicting binary emotional states, specifically distinguishing between positive and negative emotions. It makes use of CNN to classify emotion states and then develop a Markov Chain model to represent the evolution of non-binary emotions over time. Since in an industrial setting, the scheduling of duties, such as the emotion state of the physician on duty on a particular night in a hospital department, is correlated with her performance, the accurate prediction of employee emotion evolution is vital. The Markov model is used to advance the timeframe of the classification of emotions to facilitate emotion prediction. It makes use of Plutchik arrangement of eight primary emotions—joy, trust, fear, surprise, sadness, disgust, anger, and anticipation, and build an 8×8 transition matrix for the Markov Chain. In addition, the paper also deploys ChatGPT4's ability to interpret emotions directly from images. Experiments have been carried out and they show that ChatGPT4 can be surprisingly useful and can effectively predict changes in emotional states over time, surpassing expectations in identifying the progression of positive and negative emotions. The paper suggests that, while CNN and mathematical modelling are useful for predicting emotions, these can be usefully augmented and validated by using various Large Language Models.

III. Conclusion

Human emotions often determine human behavior in daily life and work situations. Human emotion states, however, can often be influenced by art and music, as some of the papers presented have shown. They can be effective in, not only improving the mood, but also can enhance overall well-being through art therapy. On the other hand, unhealthy emotional states in safety-critical situations can have serious or even fatal consequences. In the practical scheduling of duty roster in such work situations, the accurate prediction of emotion states is critical. While this problem is being addressed here, more research needs to be done in this area to ensure that the people affected in those situations are adequately protected.

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References

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