2024 Yearly Summary Report - CCDS HCI Wing

HCI Wing
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1 Publication Summary

1.1 Recent Advancements of Computer Vision in Healthcare: A Systematic Review

In [2]: The advancements in Computer Vision (CV) techniques have demonstrated significant promise in healthcare applications. The adoption of CV within the healthcare sector has drawn considerable attention. The aim of this study is to systematically review and synthesize the recent advancements and applications of CV techniques in various domains of healthcare. 125 papers were selected initially, and after gradual filtering, 20 papers were selected for the final study. In this study, we have identified five medical domains such as disease detection, drug discovery, surgical procedures, human identity decoding, and remote patient monitoring where CV applications are being successfully implemented. Among these domains, the use of CV in surgical assistance is notable. It capitalizes on the precision and efficiency offered by CV. Deep Learning (DL) models show adaptability and accuracy in medical imaging. The combination of computer vision and sensors enhances real-time surgical skills assessment. This study revealed that CV applications can be utilized for predictive analytics and personalized patient treatments. Standardized performance metrics, ethics, and data governance are crucial for responsible computer vision deployment in healthcare.

1.2 MatrikalinDiabetes: User-Centered Design of a mHealth App for Gestational Diabetes Mellitus Management and Education Among Bangladeshi Women

In [4]: This study employs the User-Centered Design (UCD) methodology to develop a mobile health (mHealth) application (app) specifically tailored for Bangladeshi women with Gestational Diabetes Mellitus (GDM). GDM affects approximately 10% of pregnant women globally and around 35% within Bangladesh, as reported by the World Health Organization (WHO). Despite its high prevalence, there is a significant lack of awareness and education about GDM in Bangladesh, compounded by language barriers that make existing digital solutions less accessible. The MatrikalinDiabetes mHealth app aims to overcome these barriers by providing comprehensive management and educational resources for GDM in the Bangla language, addressing both pre-pregnancy and post-pregnancy needs. To ensure the app meets the actual needs of potential users, personas were created based on a literature review, and a survey was conducted. This process informed the development of both a low-fidelity, paper-based prototype and a high-fidelity digital prototype. Key features of the MatrikalinDiabetes app include tracking of food and water intake, physical activity monitoring, reminders, GDM education, chat forums for community support, blood glucose level (BGL) monitoring, an SOS button for emergency contacts, and quizzes for user engagement. Preliminary feedback indicated that

53.8% of participants favored the integrated features and expressed willingness to use and recommend the app. The survey of the high-fidelity prototype yielded positive responses, with 57.9% of participants strongly agreeing and 42.1% agreeing that the features were beneficial. The user-friendly design of the high-fidelity prototype ensures intuitive interaction, aiding in health management, enhancing GDM understanding, and promoting a healthier lifestyle among pregnant women in Bangladesh.

1.3 User-Centered Design and Validation of mHealth App for Providing Vital Assistance and Emergency Healthcare Support in Bangladesh

In [5]: Bangladesh is experiencing an increase in demand for easy-to-use digital healthcare solutions. In response to this demand, "SushthoJibon" was introduced as a prototype of a mobile health (mHealth) application which is a comprehensive solution and designed to provide vital aid during emergencies as well. Based on the principles of user-centered design, this app has many other features such as Knowledge Hub, Report Station, Medicine Cabinet with Reminders, Poribar Porijon (Family Care), Nearby Healthcare Services and Appointments, Emergency Response, and Exercise Tracking. The app was well received in terms of usability measured using the mHealth App Usability Questionnaire (MAUQ) and the User Experience Questionnaire (UEQ), where ease of use and user experience were emphasized by the users' feedback. Subsequent changes were made based on the findings, which allowed "SushthoJibon" to fully meet the needs of its users.

1.4 Ensemble and Deep Learning Approaches for Automated Screening of Anxiety, Depression, and Burnout in Medical Student Populations

In [3]: Mental health issues are increasingly affecting people worldwide. Efforts are taken to address these issues, however, similar importance is not always taken for all demographics. Medical students are particularly susceptible to being impacted by anxiety, depression, and burnout due to the intense pressures of their educational and practical settings. These mental health problems become worse because of the demanding workload of medical school, the emotional toll of patient care, and the competitive atmosphere. These problems have adverse effects on student's academic performance, personal wellness, and future prospective role as empathetic healthcare providers, which reinforces the need for introduction of special care and interventions in medical education. This study uses a dataset of 886 Swiss medical students to automate the screening procedure for anxiety, depression, and burnout using Machine Learning (ML) and Deep Learning (DL) approaches. The analysis juxtaposes the performance of two advanced computational models: an Ensemble classifier, integrating Random Forest (RF), Naive Bayes (NB), and Light Gradient-Boosting Machine (LightGBM), and a Deep Neural Network (DNN). The study's cornerstone lies in its evaluation of these models' predictive prowess, underpinned by meticulous feature selection via Information Gain and an ablation study. The DNN model emerges as a frontrunner demonstrating accuracy rates of 81.4% for depression, 76.65% for anxiety, and 73.59% for burnout. Comparative analyses further validate the DNN's efficacy against the Ensemble classifier, thereby providing a promising method for automated clinical diagnosis for mental health professionals. Thus, the ultimate objective is to bridge the gap between undetected mental health issues and accessible, effective care highlighting the

indispensable role of Artificial Intelligence (AI) in shaping the future of mental health services.

1.4.1 Smartwatch-Based Human Stress Diagnosis Utilizing Physiological Signals and LSTM-Driven Machine Intelligence

In [1]: Stress responses, primarily the 'fight-or-flight' reactions, are fundamental to human survival but can become harmful when they persist for extended periods. Prolonged stress exposure has been linked to various health issues and accelerated aging. But this can be addressed or controlled if a person becomes aware of their stress condition early. Traditional methods of identifying human stress relied heavily on self-reported questionnaires, but with the advancements in machine intelligence utilizing Machine Learning (ML) and Deep Learning (DL) techniques, the use of smart wearables like smartwatches for diagnosing stress has gained prominence. These devices can collect real-time physiological data, e.g., heart rate, skin conductance, and movement patterns, which are crucial for detecting stress. In this study, we utilized the 'Stress-Predict Dataset' built from the Empatica E4 wearable smartwatch device. After processing raw signals collected from 35 participants and aligning them to a uniform frequency of 32 Hz, we developed a Long Short-Term Memory (LSTM) model for stress classification. Training and validation sets achieved accuracies of 93.67% and 91.13%, respectively. The test set achieved an accuracy of 91.78%, indicating a strong ability to identify stress events. This includes correctly classifying 30.31% of True Positive (TP) stress occurrences with a low rate of False Negatives (FN) (missed stress events) at 4.56%. There were also 61.47% of True Negative (TN) classifications, demonstrating the model's ability to correctly identify non-stressful states with a low rate of False Positives (FN) (incorrectly classified non-stress events) at 3.66%. This research contributes to the ongoing exploration of stress diagnosis using wearable smartwatch device data, underlining the potential for further advancements in physiological stress monitoring.

References

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