Synopsis Seminar

Seminar Title	: Attention Learning and Generative AI for Closed Loop Diabetes Management
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Abstract : Diabetes is a chronic condition that requires accurate insulin treatment through many daily injections and frequent glucose testing. Both internationally and in India, its prevalence is increasing. An artificial pancreas (AP) has been designed to mimic the physiological ability to maintain blood glucose homeostasis, enabling continuous monitoring and controlled dosing. However, AP technologies' shortcomings, include inaccurate insulin dosages brought on by a lack of multimodal data, human reporting of meal times, meal amounts, and physical activity, high device costs, a lack of operational awareness, and loss of connectivity, have prevented their widespread adoption. The major goal of the project is to develop accurate glucose forecasting methods for artificial pancreas while smoothly integrating physical activity, abiotic variables, including nutrition, and CGM. This thesis explores advanced methodologies for improving diabetes management systems, focusing on glucose forecasting and insulin dose optimization through deep learning, generative AI, and real-time implementation on hardware platforms.

The research commences with the creation of a novel hybrid deep learning model, the 'Wide Deep LSTM-GRU,' which incorporates content-based attention mechanisms to improve the accuracy of glucose prediction. This model exhibits superior performance in comparison to baseline methods across key metrics by utilizing both clinical and in-silico datasets. Additionally, a specialized architecture, InsNET, was developed to forecast insulin dosages for closed-loop diabetes management. The significance of personalization in glycemic control was underscored by the significant improvement in prediction accuracy that resulted from the integration of unannounced physical activity data through Bahdanau attention learning.

To address challenges in model interpretability and dependability, innovative network topologies were created, including neural basis expansion networks with multihead attention and neural hierarchical interpolation networks employing self-attention processes. The proposed methods improve accuracy and clarity, progressing towards dependable and user-focused solutions for diabetes management.

Furthermore, generative AI was employed to mitigate data loss in continuous glucose monitoring sensor systems. A distinctive GAN-based architecture was created for the synthesis of synthetic data, encompassing glucose levels, physical activity, and meal information. This data augmentation technique, validated across multiple datasets, enhanced the efficacy of glucose prediction models when actual and synthetic data were combined.

The thesis also presents the backend integration and deployment of the proposed models via a cloudbased platform and a dedicated mobile application. A localized dataset, collected from patients with Type 1 and Type 2 diabetes using a custom mobile app linked to Google Cloud Platform (GCP), was used for model validation. Secure data storage, encryption, and access control measures ensured compliance with international data protection standards. Extensive testing and validation confirmed the robustness, generalizability, and adaptability of the proposed methodologies to diverse clinical scenarios.

This thesis integrates advanced deep learning, generative AI, and edge computing technologies to tackle fundamental issues in diabetes treatment, providing notable enhancements in accuracy, personalization, and practicality. The results highlight the capacity of these integrated solutions to transform closed-loop diabetes systems, enhancing their accessibility and reliability for patients globally.