Chapter 6

Deep Learning Diabetes Monitoring and Prevention:
Personalized Health Assistant Contribution

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ABSTRACT

This chapter introduces the Personalized Health Assistant, an integrated system that combines Internet of Things devices, machine learning, and natural language processing to monitor diabetes and promote proactive, personalized healthcare. For diabetic patients, the system leverages wearable sensors data. For non-diabetic users, physiological parameters are inferred through lifestyle and stress indicators. To support predictive health monitoring, the system incorporates advanced machine learning models: Long Short-Term Memory, Multiple Back-Propagation, and a Convolutional Neural Network. Another component of the system is a clinically aware chatbot, built upon the Falcon-7B large language model and semantically validated using Bio_ClinicalBERT. The chatbot pipeline integrates FAISS-based context

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retrieval, clinical term detection, and semantic similarity scoring. The validation results underscore the system's reliability for predictive analytics, intelligent interaction, and real-time clinical support, making it a viable solution for scalable and secure chronic disease management.

INTRODUCTION

Diabetes mellitus is one of the most prevalent chronic diseases globally, leading to severe complications that significantly impact patients' quality of life and generate substantial pressure on healthcare systems (Naveed, Kaleem, Keshavjee, & Guergachi, 2023). Recent advances in digital health - namely, the Internet of Things (IoT) (Rodríguez-Rodríguez, Campo-Valera, Rodríguez, & Frisa-Rubio, 2023), machine learning (ML), and conversational agents - have enabled the development of innovative, patient-centered approaches for chronic disease monitoring and management (Fagherazzi & Ravaud, 2019). These technologies offer the potential to personalize care, improve disease control, and empower patients through real-time feedback and data-driven decision support.

The Personalized Health Assistant (PHA) system (Ribeiro, Gonçalves, & Silveira, 2025) was designed to address this challenge by integrating a modular and scalable architecture that continuously monitors health parameters using IoT devices such as the Fitbit Charge 4 and Dexcom G6. These devices can collect vital metrics including heart rate, physical activity, sleep quality, glucose levels, and calorie expenditure. Data is transmitted securely using OAuth 2.0 and stored in Firebase Firestore, forming the system's Online Transaction Processing (OLTP) layer. A Python-based ETL (Extract, Transform, Load) pipeline transforms the data into structured analytical tables and loads it into Google BigQuery, enabling advanced Online Analytical Processing (OLAP) and visual exploration through interactive dashboards in Power BI.

To ensure regulatory compliance and user trust, the system adopts a privacy-by-design strategy, aligned with the General Data Protection Regulation (GDPR) and ISO/IEC 27001:2022. Measures such as pseudonymization, encryption, role-based access control, incident logging, and risk assessments are implemented across all stages of data collection and processing.

From an analytical standpoint, the system integrates multiple artificial intelligence models tailored to different user profiles. In the hospital triage phase, initial clinical parameters - such as blood glucose, blood pressure, and other vital signs - are collected and entered via a chatbot interface. The data is analyzed using the K-Means algorithm (Hartigan & Wong, 1979) to segment patients into risk clusters, with dimensionality reduction applied to improve clustering quality. For diabetic patients, a Long Short-Term Memory (LSTM) model (Hochreiter & Schmidhuber, 1997) predicts critical fluctuations in glucose levels with high temporal resolution. For non-diabetic patients, a neural network with Multiple Back-Propagation (MBP) algorithm (Lopes & Ribeiro, 2009) and the LightGBM model (Ke, et al., 2017) are used to predict glucose and blood pressure values based on indirect variables, leveraging parallel computing to improve performance. Additionally, dietary habits are assessed using a Convolutional Neural Network (CNN) (LeCun, Bottou, Bengio, & Haffner, 2002) trained to classify food images and estimate nutritional balance.

An intelligent and clinically aware chatbot was also developed to improve patient engagement and automate the collection of lifestyle and clinical data. The chatbot leverages a pipeline of FAISS-based (Douze, et al., 2025) context retrieval, Falcon-7B (Almazrouei, et al., 2023) for response generation, and

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