University of Essex

A Non-Invasive Glucose Monitoring (NIGM) System: Machine Learning-Based Calibration and Predictive Models Based on Multi-Sensor Data

Research Proposal

by Andrius Busilas, 7th April 2025

Disclaimer: This research proposal is independent of and not associated with the capstone project.

Link to video record

https://youtu.be/p2hLUDzFzCs

What is a problem?

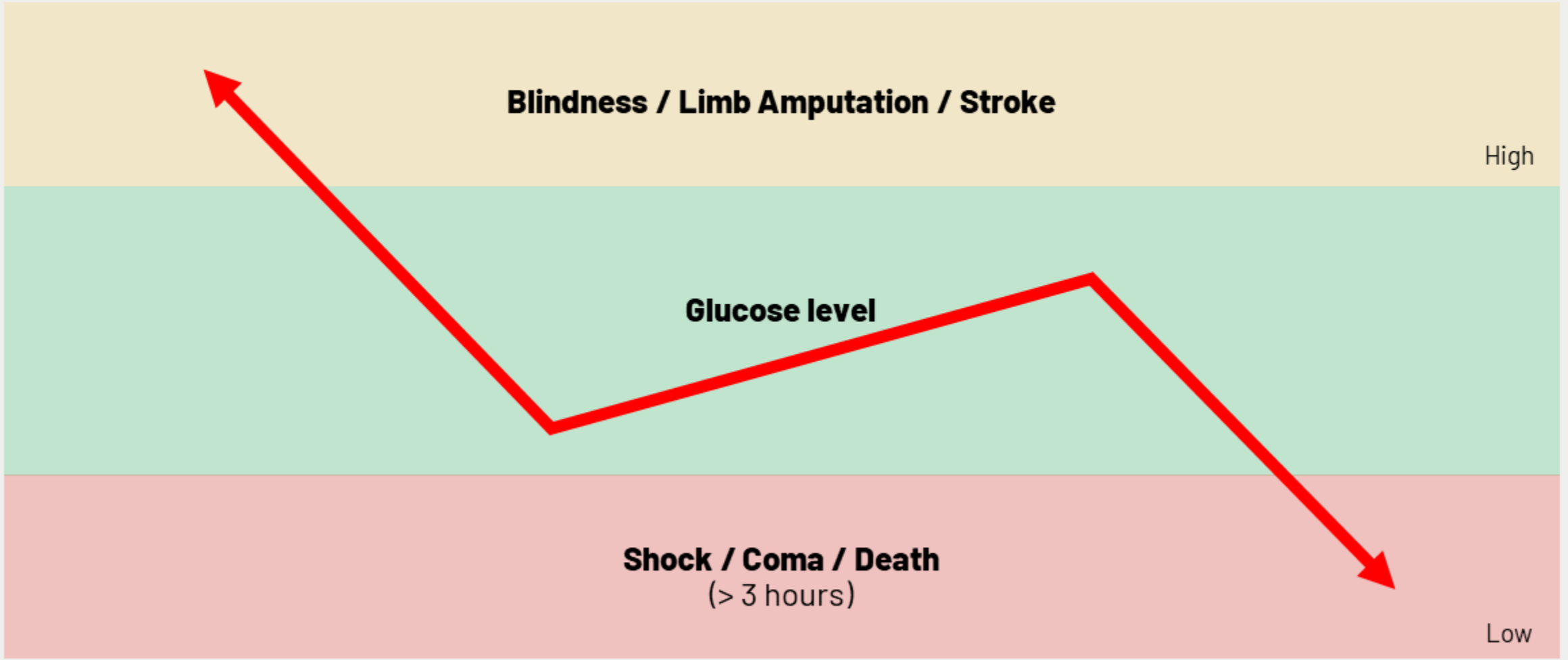
Invasive glucose monitoring is **painful and inconvenient**. The blood glucose monitoring requires a blood sample to be obtained, which is associated with self-harm:

- **4** to **6** times a day
- **1.825** per year
- **18.000** in 10 years

and it has a detrimental influence on the desire of patients to self-measure BG levels.

(ElSayed et al., 2024), (Uhl et al., 2023), (Roglic, 2016).

What is a problem?



(Alghamdi et al., 2021), (Ceriello et al., 2022), (Seaquist et al., 2013), (ElSayed et al., 2023).

Background

200 mil.
1990

830 mil.
2020
8.5% of global population

1.3 bn.
2050

5-10%
Type 1 diabetes

90%
Type 2 diabetes

(WHO, 2024), (Klein, 2023).

Significance of study

1

Medical Impact

Affordable, pain-free monitoring.

2

Tech Innovation

Multi-modal data fusion.

3

Scientific Contribution

Bridging ML and wearable tech.

(Patel & Shah, 2021).

Research questions

Primary research question:

How can machine learning-based calibration and prediction models improve the accuracy and reliability of non-invasive glucose monitoring systems using multi-sensor data?

Secondary research questions

- RQ1: What are the most effective machine learning algorithms for processing and fusing multi-sensor data in NIGM systems?
- RQ2: How can calibration models be optimized to account for individual variability and environmental factors?
- RQ3: What are the key challenges in deploying ML-based NIGM systems in real-world scenarios?

(Bhajane et al., 2024), (Sun et al., 2024), (Nyiramana, 2024), (Singh & Berretti, 2024).

Aims and Objectives

Design ML framework for accurate NIGM

1. Analyse existing NIGM technologies
2. Collect multi-sensor data
3. Develop ML models
4. Validate models
5. Design a prototype NIGM system

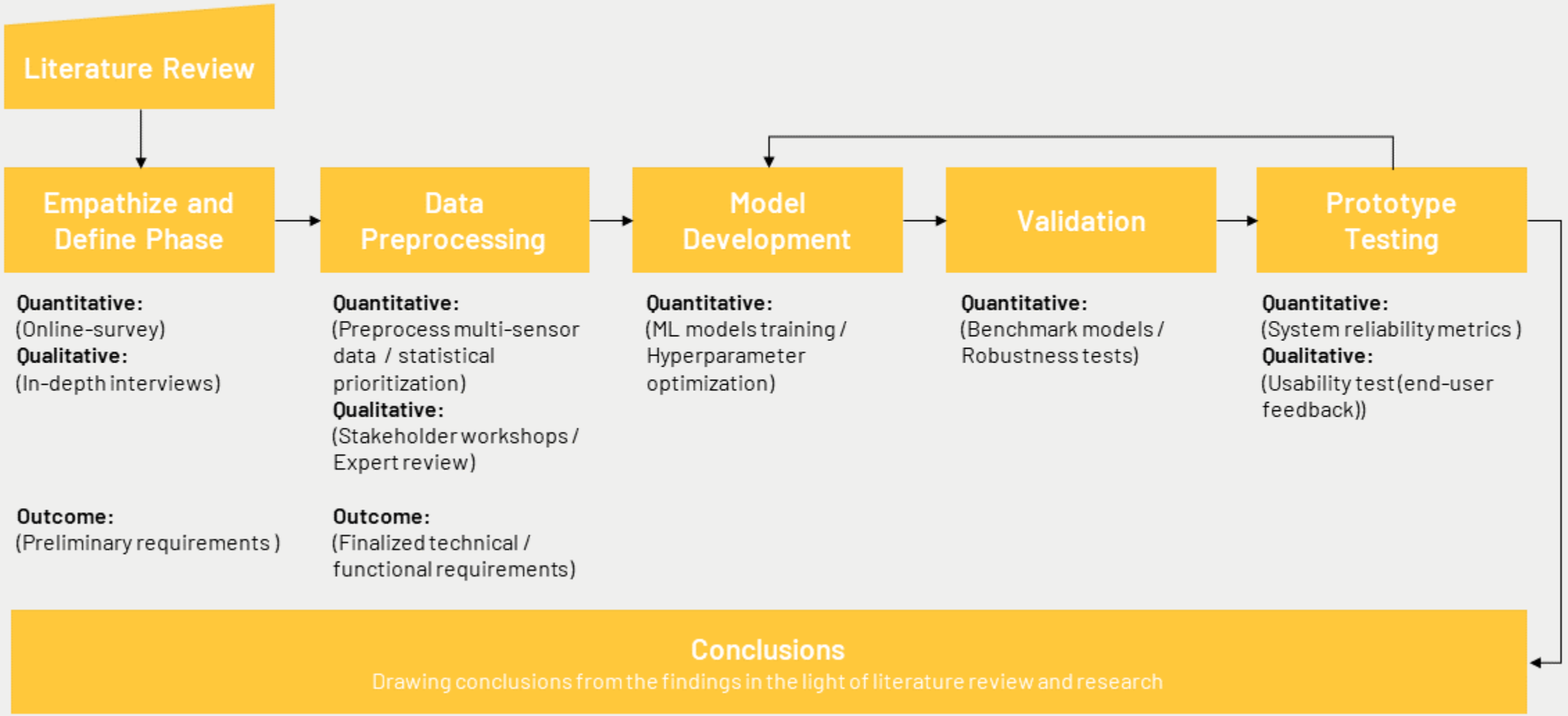
(Rahman et al., 2024).

Key literature

1. Non-Invasive Glucose Monitoring Technologies
2. Machine Learning in Healthcare
3. Multi-Sensor Data Fusion
4. Calibration Models for NIGM systems
5. Diabetes Management

(Bhajane et al., 2024; An et al., 2023), (Rangayyan & Krishnan, 2024), (Zamani et al., 2024), (Patel & Shah, 2021), (Rajesh Hanni et al., 2024), (Hussain et al., 2024), (Jiang & Ke, 2024), (Zanon et al., 2013; Moses et al., 2024), (Villena Gonzales et al., 2019), (Nomura et al., 2021), (Joshi & Kor, 2024).

Methodology



(ElSayed et al., 2023), (Habehh & Gohel, 2021), (Villena Gonzales et al., 2019), (Chen et al., 2022), (Rodriguez-Calero et al., 2020), (Bian et al., 2024), (Pfob et al., 2022), (Clarke, 2005), (Zhang 2024), (Patel et al., 2023), (Rajkomar et al., 2019), (Rodbard, 2017), (Wiklund et al., 2016),

Ethical considerations and risk assessment

Ethical Approval
Approval from ethics committees.

Data Privacy
Compliance with GDPR, HIPAA.

Informed Consent
Consent from participants.

(Min et al., 2025).

Artefacts

ML Models

Calibration and prediction models.

Prototype NIGM System

Functional prototype with user interface.

Dataset

Curated multi-sensor glucose data.

Timeline

Phase 1:
Literature Review and Data Collection

Phase 2:
Data Preprocessing and Feature Engineering

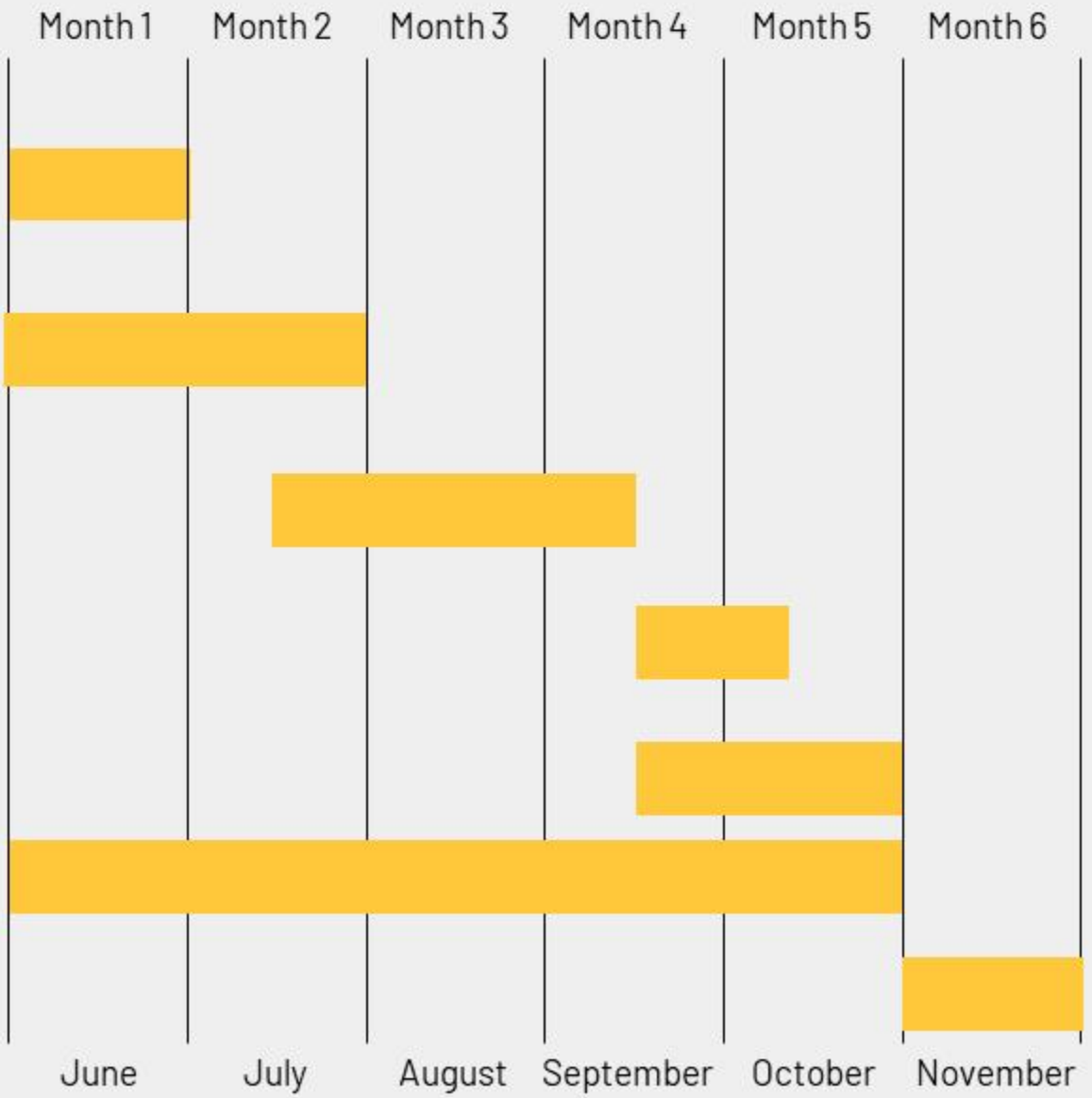
Phase 3:
Model Development

Phase 4:
Model Validation

Phase 5:
Prototype Development

Work on report

Phase 6:
Final Reporting



Thank

You!

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