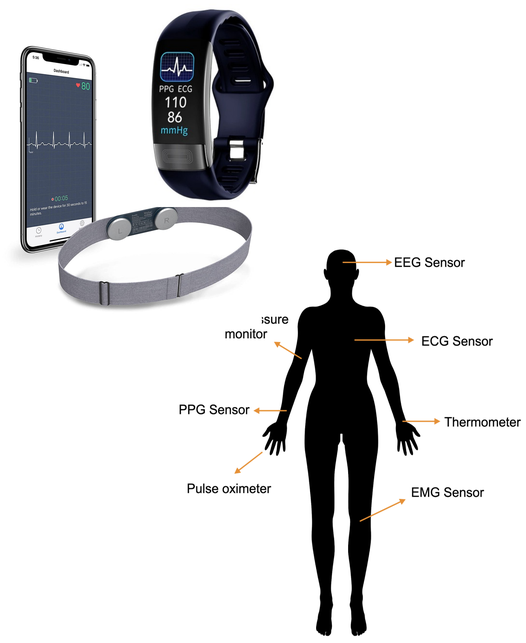
An Agent-Based Framework for Precision Health

Data fusion, situation analysis and decision support using sensor data

Mbithe Nzomo

THE PROBLEM

- Many health monitoring systems based on sensors have been proposed to monitor patients with existing diseases or in clinical settings.
- However, the essence of precision health is to predict and prevent disease before its onset.
- This requires systems that can fuse heterogeneous data from multiple sensors (*data fusion*), determine an individual's health state (*situation analysis*), and provide appropriate *decision support* for risk mitigation as well as health and wellness promotion.
- Developing systems that meet these requirements is a challenge. This can be alleviated by a framework that integrates various techniques for these tasks.



USEFUL AI TECHNIQUES

- Ontologies are a powerful tool for reasoning and representation, and have been widely used for situation detection in sensor-based systems.
- Sensor networks and machine learning are complimentary technologies; sensors can provide ML algorithms with the necessary large volumes of data, while ML algorithms facilitate smart sensor-based applications
- Bayesian networks provide a means for reasoning under uncertainty, and have been widely used for decision support in the health domain. Dynamic Bayesian decision networks can model change over time by incorporating time-slices while also modelling general sequential decision making.
- Intelligent agents demonstrate cognitive abilities such as learning, adaptive planning, and decision making and therefore present a promising paradigm for integrating different AI techniques.

AIM & OBJECTIVES

The aim of this research is to design and evaluate an agent-based framework for data fusion, situation analysis, and decision support for personal health monitoring using sensors.

1. Develop and evaluate an ontology to capture and represent sensor data and expert knowledge. Develop and evaluate ML models for pattern recognition, anomaly detection, and health state prediction.
2. Develop and evaluate a dynamic Bayesian decision network to capture the decision process for health promotion and mitigation of health risks over time.
3. Design and evaluate an agent architecture to integrate the above components and facilitate the development of personal health monitoring systems

METHODOLOGY

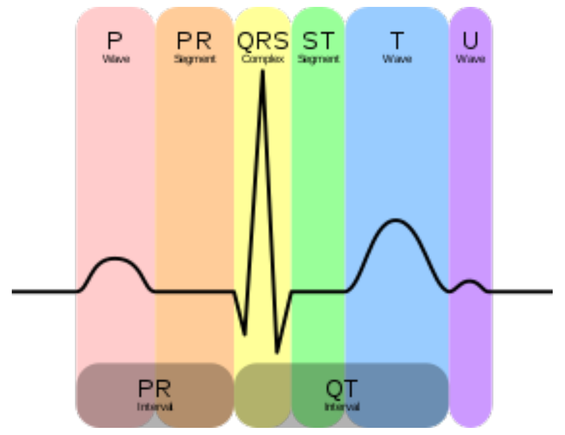
Three-phase, use case-based approach:

- Phase 1: health risk detection and prediction
- Phase 2: wellness monitoring
- Phase 3: integration with live body sensor network

The framework will be developed and evaluated iteratively. The basic components of the framework will be developed in the first phase, resulting in the first prototype of a personal health monitoring agent. The prototype agent will be further refined, extended, and evaluated in the subsequent phases.

PHASE 1 (in progress)

Use case: Arrhythmia Detection and Prediction using ECG data



PUBLICATIONS

Wanyana, T.; Nzomo, M.; Price, C. S. and Moodley, D. 2022. *Combining Machine Learning and Bayesian Networks for ECG Interpretation and Explanation.* In Proceedings of the 8th International Conference on Information and Communication Technologies for Ageing Well and e-Health (ICT4AWE 2022), pages 81-92. (Nominated for best student paper award.)

Mbithe Nzomo
Supervisor: Prof. Deshen Moodley

E-Mail: mnzomo@cs.uct.ac.za
Web: http://mbithenzomo.github.io

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