Digital Companion for Obesity

ELECOMP Capstone Design Project 2023-2024

Sponsoring Company:

Novo Nordisk

800 Scudders Mill Road, Plainsboro, NJ 08536
http://www.novonordisk.com

Company Overview:

NovoNordisk A/S is a Danish multinational pharmaceutical company, headquartered in Bagsværd Denmark, with production facilities in nine countries and affiliates or offices in five countries. Novo Nordisk is controlled by majority shareholder Novo Holdings A/S which holds approximately 25% of its shares and a relative majority (45%) of its voting shares.

Novo Nordisk manufactures and markets pharmaceutical products and services, specifically diabetes care medications and devices. Novo Nordisk is also involved with hemostasis management, growth hormone therapy, and hormone replacement therapy. The company makes several drugs under various brand names, including Ozempic, Wegovy, Levemir, Tresiba, NovoLog, Novolin R, NovoSeven, NovoEight, and Victoza.

Novo Nordisk employs more than 48,000 people globally, and markets its products in 168 countries. The corporation was created in 1989, through a merger of two Danish companies which date back to the 1920s. The Novo Nordisk logo is the Apis bull, one of the sacred animals of ancient Egypt.

Novo Nordisk is a full member of the European Federation of Pharmaceutical Industries and Associations (EFPIA).

The company was ranked 25th among the 100 Best Companies to Work For in 2010 and 72nd in 2014 by Fortune. In January 2012, Novo Nordisk was named the most sustainable company in the world by the business magazine Corporate Knights, while spin-off company Novozymes was named fourth.

Novo Nordisk is the largest pharmaceutical company in Denmark.

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Project Motivation:

It is estimated that 1/3 of people diagnosed with a serious, life-changing chronic illness or disease will experience symptoms of depression such as loneliness, sadness, isolation, and despair. As chronic conditions such as obesity increase, the condition of depression rises with this increase, or is greatly associated and therefore exacerbating the condition. It has been demonstrated that patients living with obesity experience a high incidence of depression and associated symptoms. Compounding this circumstance, many people who suffer from chronic illness and depression remain isolated or avoid communal settings. Finding a solution in-home to alleviate the depressive aspects of this condition can help these people achieve more positive health outcomes.

Anticipated Best Outcome:

Personalized disease-state related outputs from the digital companion for the obesity patient to manage their condition.

The creation of the digital companion as a smartphone application with the integration of a wearable (smartwatch) device as well as sensor integration.

Machine learning algorithm(s) with multiple data inputs providing the ability of the companion to train against the patient's inputs and biomarkers for advanced customization/personalization to help manage their condition.

Project Details:

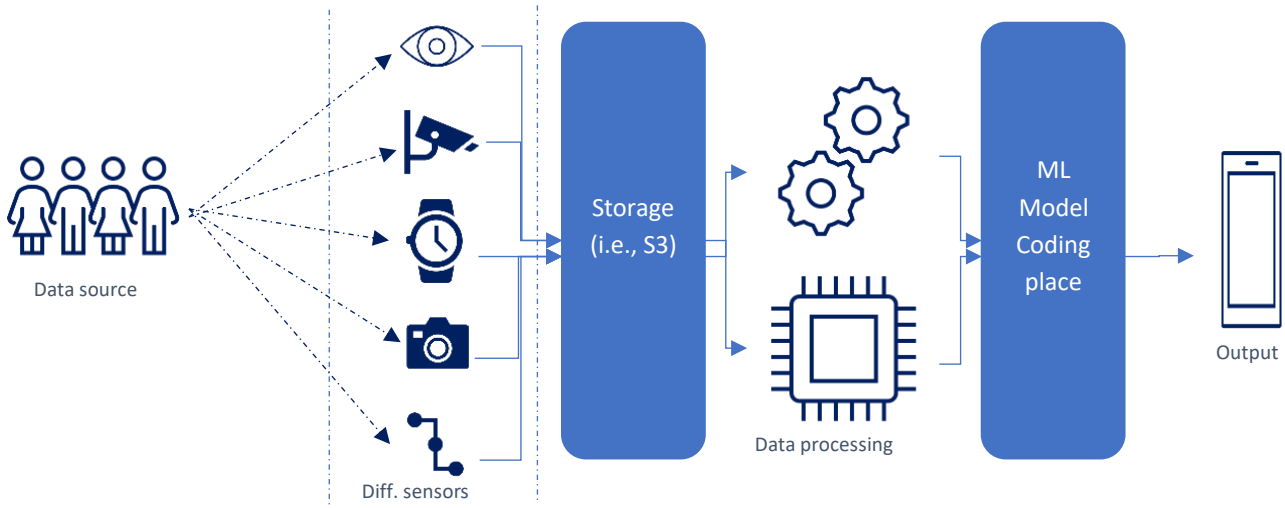
This project is focused on the development of a digital companion device (a smartphone application and integrated smartwatch) which will provide information on the patient's locomotion, heart rate (HR) and heartrate variability (HRV). This device would also optimally be integrated with a portable, non-invasive VOC/sweat/saliva sensor (*an off-the-shelf option should be assumed with the measurement of any of these listed biomarkers – as many measured and integrated as possible considering project breadth and timeline*) which can capture cortisol levels as well as (*again, potentially*) levels of the "hunger hormone" ghrelin. These measurements could provide an involuntary assessment of the patient's overall emotional state (mood) on any given day, as well as a means to track and assess the patient's emotional state over time, therefore helping this patient manage their condition and ultimately alleviate or eliminate depressive symptoms.

As an additional application feature set (*these features could possibly represent a set of stretch goals*), the tool could provide information to address aspects of their daily activities such as dietary (nutritional) needs and management, physical activity and exercise, medication management, and emotional and social support functionality. With the integration of these inputs/outputs, this device will provide the patient personified feedback that is customized to their unique needs employing machine learning in order to customize the tool functionality towards the specific patient need state. As the machine trains (locomotion, HRV, HR, neuroendocrine variables), it will become more precise with customized recommendations specifically for the patient in the specified areas of need.

The companion's functions will be in the form of command-based and proactive interaction. The companion could employ output functions from a selection of modalities such as voice (NLP), on-screen text and visuals, LED's, gestures, and sound effects.

The development of this device should also include optimized front-end design employing UX design principals as well as standardized accessibility design principals.

Block Diagram



Hardware/Electrical Tasks

- Trade study and selection of motion and heart rate sensors and/or evaluation platforms
- Embedded processor for sampling above sensors
- Transmission mechanism to/from the smartphone
- Feedback provisions to get the user's attention (vibration/beep/lights)
- Potentially develop custom hardware based on the success of the evaluation hardware

Firmware/Software/Computer Tasks

- Code for embedded processor, which should be fairly minimal
- Smartphone ML model development and training based on motion, HRV, HR, and other biomarkers
- Smartphone interaction with sensor platform (likely via bluetooth or similar) to retrieve data and send alerts
- Smartphone based output functions

Composition of Team:

2 electrical and 2 computer engineers

Skills Required:

Electrical Engineering Skills Required:

- Familiarity with sensor design and integration

Computer Engineering Skills Required:

- Software/Application design
- ML Development
- User Experience and Accessibility Design

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact:

With the development of this device, which may be utilized for commercial purposes for a future commercial team, the company could derive benefit through a future revenue stream. This will also provide a key patient benefit helping to promote the company's objective of providing solutions to patients and improving their health outcomes.

Broader Implications of the Best Outcome on the Company's Industry:

With the advent of machine learning and artificial intelligence, the ability to more closely align the company's objectives to the patient's specific needs (customization = patient adoption = improved outcomes) will create a deeper and more enriching patient experience and connection, and ultimately improving the health of our patients and all patients who suffer from depressive symptoms due to their condition.