EARLY DETECTION OF PREECLAMPSIA USING AMBULATORY BLOOD PRESSURE MONITORING USING WEARABLE DEVICES AND LONG SHORT TERM MEMORY NETWORKS (LSTM-NN) ON THE EDGE - 1ST AFRICANLP WORKSHOP, INTERNATIONAL CONFERENCE ON LEARNING REPRESENTATIONS (ICLR 2020)

Moses Thiga;Pamela Kimeto;

;

Early detection of preeclampsia using ambulatory blood pressure monitoring using wearable devices and Long Short Term Memory Networks (LSTM-NN) on the edge.

Moses M Thiga, Pamela Kimeto
Kabarak University

Introduction

The Sustainable Development Goal (SDG) 3 aims to reduce the global maternal mortality ratio to less than 70 per 100,000 live births.

These deaths are caused by among other things the emergence of conditions such as pre-eclampsia during pregnancy.

If undetected the condition can lead to the loss of both the mother and child, and often times persists even beyond the delivery of the baby.

Introduction

This study is seeking to explore the use of wearable devices for ambulatory blood pressure data collection for use in blood pressure prediction using Long Short Term Memory (LSTM) recurrent neural networks on mobile devices.

Objectives of the study.

To explore ways in which an LSTM solution for preeclampsia monitoring and prediction can be accessed from a mobile device.

To develop an open access database of ambulatory blood pressure readings that includes demographic information and related activities when the readings are taken for use in future machine learning activities.

Introduction

It is expected that such a solution will be of great benefit in the detection and management of general blood pressure conditions and not just preeclampsia.

Additionally the data collected will be valuable for future studies in the area of hypertension prediction and management using machine learning and other techniques.

The Complete Study Idea

IJCAI workshop on AI and the United Nations SDGs

August 10-16, 2019 Macao, P.R. China

IJCAI International Joint Conferences on Artificial Intelligence

https://www.k4all.org/wp-content/uploads/2019/07/Early-detection-of-preeclampsia-using-ambulatory-blood-pressure-monitoring-using-wearable-devices-and-Long-Short-Term-Memory-Networks-LSTM-NN-on-the-edge.pdf

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Key requirements for this study are;

1) The ability to get the BP data from an individual.

2) The ability to get a corresponding record of their activities for the BP readings.

3) The identification of a suitable Machine Learning (ML) Algorithm for predicting future BP.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Pre-test the idea - Pre testing the idea was a critical first step in our process before we could proceed to collect the actual data.

The data collection process would require the procurement of suitable smart watches and the development of a mobile application, both of which are time consuming and costly activities.

At this point we learnt **our first lessons**; (i) there was no precedence to what we were attempting and subsequently (ii) there were no publicly available BP data sets available for use in pre-testing our ideas.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Simulate the test data - The implication therefore was that we had to simulate data based on the variables identified for our study.

The variables utilized were the Systolic and Diastolic BP Reading, Activity and a timestamp.

This was done using a spreadsheet and the data saved as a comma separated values (csv) file. The csv is a common file format for storing data in ML.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Identify a suitable ML model - The data simulated and that in the final study was going to be time series data.

The need to predict both the Systolic and Diastolic BP using previous readings, activity and timestamps meant that we were was handling a multivariate time series data.

Model identified - **LSTM model for multivariate time series forecasting** based on a guide by Dr Jason Browniee (https://machinelearningmastery.com/how-to-develop-lstm-models-for-time-series-forecasting/)

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Develop the data collection infrastructure – There being no pre-existing data for the development implied that we had to collect our data.

The unique nature of our study, collecting BP and activity data from individuals called for an innovative approach to the process.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

BP data collection – for this aspect of the study we established that the best way to achieve this would be the use of smart watches with BP data collection and transmission capabilities.

A key consideration for the device selection was affordability.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

The watch identified was the F1 Wristband Heart and Heart Rate Monitor.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Activity data collection – for this aspect of the study a mobile application was identified as the method of choice.

The application was developed to be able to receive BP readings from the smart watch and to also collect activity data from the user.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application
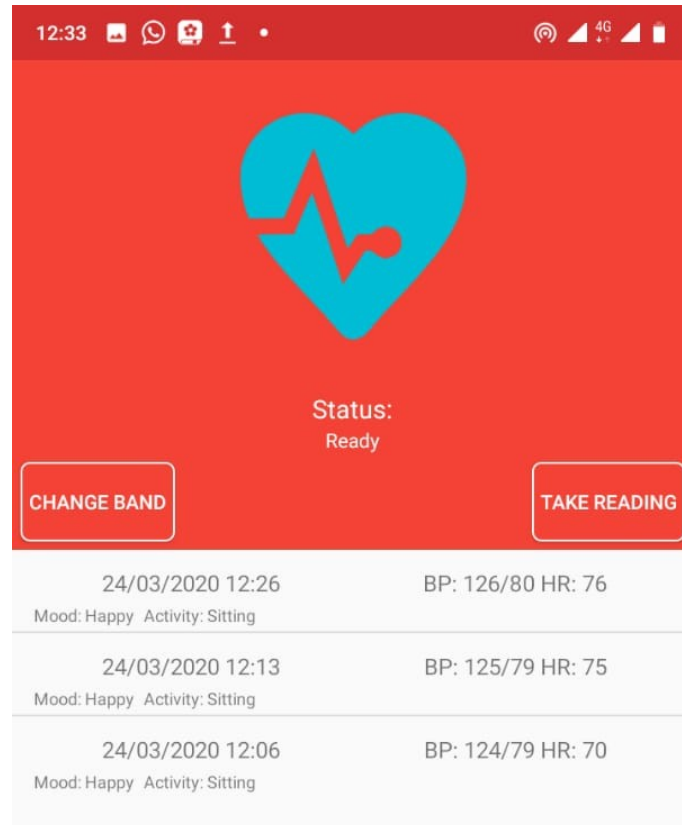
Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Test the data collection – The smart watch – mobile app data collection was tested and a number of key observations were made.

Smart watch challenges – In as much as the watch identified is affordable it does not work well for dark skinned persons.

Mobile app connectivity challenges – The app initially would not connect to the smart watch but this was resolved and the data collection is now possible.

Stage 1: Building a Data Pipeline for a Real World Machine Learning Application

Next Steps in Stage 1

Pilot the data collection - We are now working on piloting the solution with at least 10 people over a period of 2 – 3 weeks. This will give us an idea on how the final study will be carried out with respect to:

1) How the respondents use the solution,
2) The kind of data we will be able to actually get from the respondents
3) The suitability of the data for the machine learning exercise.

Stage 2: Develop and Deploy the LSTM Model

We shall then develop the LSTM model and deploy it on the mobile device to examine the practicality of our proposed approach to BP prediction.

The Full Story

https://ai4d.ai/blog-preclampsia/
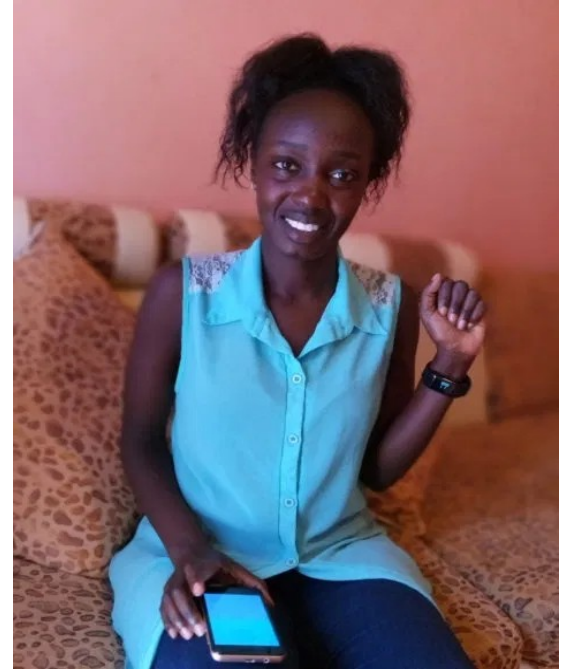
Thanks

The Team

Dr Moses M Thiga, PI

Dr Pamela Kimeto. Co PI

Ms Daisy Kiptoo, Research Assistant