RESEARCH OF A CAMERA-BASED BLOOD PRESSURE MONITORING SYSTEM

STUDENT NAME: N. V. A

STUDENT NUMBER: MSExxx

Advisory Panel:

DATE OF SUBMISSION: **xxx**

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INTRODUCTION TO THE RESEARCH PROPOSAL

INTRODUCTION

Blood pressure is one of the key indicators of a person health condition. The convention approach is to use a non-invasive auscultation-based blood pressure monitoring device, which is relatively cheap and can be used at home. However, users still have to learn to use these devices to get the correct measurement. Moreover, most of the devices on the market at the time of the research is not IoT-enabled and not internet-connected i.e., users have to find a way to send the readings to their doctors.

PROBLEM STATEMENT

This research aims to find a novel approach to blood pressure measurement using the readily available phone's camera.

SIGNIFICANCE OF THE STUDY

If a vision-based system can be used to monitor user's blood pressure, not only it will save the cost of a dedicated monitoring system, but it will also make it easier to measure often and transfer the readings electronically over the internet.

BACKGROUND AND LITERATURE REVIEW

Background

Throughout the Covid-19 pandemic, doctors and patients have widely accepted the concept of tele-health and tele-medicine. Patients can sit comfortably at their homes and consults their doctors through the readily available video communication systems. They only need to go to the hospital for further medical-assisted requirements.

This trend, however, increase the demand of home medical devices such as blood pressure monitoring systems and blood glucose meters. While these devices can give accurate result if used correctly, they are not easy to use, especially for older peoples. The proposed research aims to find a novel approach, which uses the phone's camera to measure user's blood pressure and send the result to their doctors. By this way, it would save a lot of hassle for their users, who are already using their phones to communicate with the doctors on the tele-health system. It would also avoid the misreading which happen frequently with older patients.

Literature Review

Blood volume changes measurement using photoplethysmography (PPG) has been researched and applied in a few applications. However, most of the research were only conduct on a very limited number of patients or on a group of a specific demography. The ground truths used in many experiments also based on one auscultation measurement, which is while reasonably accurate, is also contain a margin of errors.

Manish Hosanee et al [1] have reviews more than 30 recent research regarding the use of a single-site PPG on mobile camera and finger-clipping devices for blood pressure monitoring system. They found the errors of the measurement is between 5 and 7 mmHg compared with the diastolic blood pressure (DBP) and systolic blood pressure (SBP) measured using invasive methods. The research also pointed out the lack of data for pregnant women and hypertensive patients.

In a recent search by Steinman et al [2], they applied optical model and machine learning to extract and analyzed 17 regions in the face of the test subjects. The result was impressive with 95% accuracy and maximum error is under 7.3 mmHg. The experiment, however, was conducted in a very controlled environment with stable light condition and the subjects were requested to stay still for 2 minutes. These conditions are very unlikely to be applicable in actual usage scenario.

Omkar et al [3] and Verkruysse et al [4] has pointed out that remote blood pressure monitoring might be possible using PPG under normal ambient light. Omkar used neural network (NN) and an inexpensive webcam to estimate the blood pressure of 20 people and achieved an accuracy of 85% under ambient light condition. While the result turned out not very accurate, it did show a good correlation between vision data recorded and systolic-diastolic blood pressure. The result was also compared to a standard wrist BP monitor, which might also contain a margin of error so the actual accuracy might be different.

Luo et al [5][6] proposed a machine learning (ML) and signal processing (SP) based approach to estimate the blood pressure level. The experimented on more than 2000 subjects at University of Toronto and Hangzhou Normal University. The model predicted the subject's blood pressure with an average accuracy of 94.81% for systolic and 95.71% for diastolic blood pressure. The research was, however, conducted on a group of very similar demography i.e., students with normal blood pressure level and light skin color.

On another experiment, Sagirova et al [7] use a special phone-case with electrocardiogram (ECG) sensor combine with PPG data from the phone camera to estimate blood pressure on a number of prehypertensive and hypertensive patients. The experiment yields impressive result with up to 98% accuracy. The research, however, was not conducted on patient with very high or very low blood pressure, and thus more research need to be done before it can be applied to general population. Another drawback is that, requiring a special phone case with ECG sensor is as much of as hassle as bring a standard blood pressure monitor device, so user experience is not much improved.

While PPG and in general vision-based data have been research thoroughly and show a high correlation with blood pressure level, further research is needed to verify the accuracy the approach under normal light condition. There is also not enough research data for patient with high blood pressure disease (hypertensive), darker skin color or with pregnant women.

RESEARCH OBJECTIVES, METHODOLOGY & RESOURCES

Research Objectives

The research aims to find the most suitable smartphone camera-based solution to measure blood pressure, which can be applied to telehealth customers.

A suitable solution should be able to:

- Measure blood pressure accurately
- Are not camera spec dependent
- Can measure blood pressure of patient with hypertensive

Preferably, the solution should also:

- Be able to run directly on user smartphone
- Estimate blood pressure within 1 minute of measurement

Research Methodology

A group of random selected users will have their blood pressure recorded using a standard blood pressure monitoring system. At the same time, their face will be recorded using different mobile phones. Each user will have their blood pressure recorded 3 times to make sure the result is correctly measured. Another group of users with hypertensive will also be recorded the same way as the above group.

The dataset will be divided into 3 set (70% training, 15% validation and 15% test). The research will try various techniques and their combinations, apply them to the recorded dataset, and compare the results.

The research will conclude whether a suitable technique can be selected, or further investigation is needed before it can be applied for practical usage.

Resources

The research will be conducted internally by scientists and engineers from FPT Healthcare division. Data will be collected from volunteers and existing patient who agree to take part in the program.

TIMESCALE

Data collection phases

Data will be collected starting from the first quarter of 2023.

Data will continuously be recorded using the existing healthcare system, with user agreement.

Number of data record expected to be collected each quarter is: 10,000 records.

Research duration

Research will be conducted from the second quarter of 2023.

Expected time of finish: December 31, 2023.

The research could be concluded earlier if a suitable solution is found and ready to be applied in practice.

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