Dr. D. Y. Patil Institute of Engineering, Management and Research, Akurdi, Pune – 44
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T.E. Sem II
Department of Electronics and Telecommunication Engineering

A Seminar
On

Cuff-Less Blood Pressure Monitoring

Blood pressure monitoring made easy

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Index

Abstract

Recently, wearable and smartphone health became promising due to their convenience, ubiquity for patients, and the ability to gather data in real time.

- In this project we going to build a device/method for monitoring BP, which will be non-invasive, portable, and cuff-less.
- Our system will estimate BP using pulse transit time (PTT) by measuring two separate photoplethysmogram (PPG) signals.
- we will estimate the parameter which are different for each individual by collecting number of samples and comparing them to actual readings.

Keywords

Hypertension, blood pressure, cuff-less, photoplethysmogram (PPG), pulse transit time (PTT).

Introduction

- Hypertension (or high blood pressure [BP]) is a significant health issue for adults that can result in serious complications, such as stroke and heart diseases.

- There are huge number of people suffering from hypertension in India and globally also.

- Also the patients of hypertension and dubieties are considered more vulnerable to Covid-19.

- Hence, continuous BP monitoring of patients suffering from hypertension can prevent the progression of the hypertension and reduce medical costs.

- And our solution brings a portable and convenient way to do the same.

Comparison between available methods

Method	Principle of working	Accuracy	Invasive	Portability
Catheterization	It involves placing a strain gauge in fluid contact with a patient's blood	Most exact	invasive	Very Low
sphygmomanometer	Uses an inflatable cuff	Very Accurate	non-invasive	Low
Oscillometry	Requires a cuff	Accurate	non-invasive	High
Tonometry	Obtains the arterial waveform using sensors located on the artery sites	acceptable	non-invasive	Very Low
Using PTT	Cuff less Works using PTT	Low	non-invasive	Very high

Comparison between available Cuffless methods

| Sr. No.	Principle	Description	Invasive/ Non-invasive
1	PTT-based estimation	In this method, BP is estimated using pulse transit time (PTT). PTT refers to the time a pulse wave needs to travel between 2 arterial sites.	Non-Invasive
2	Pulse contour method	It uses ballistocardiography and invasive central artery manometers to track mechanical events,	Invasive
3	Acceleration PPG: second derivative analysis	The second derivative of the PPG (SDPPG) signal was analysed based on the amplitudes of waves a–e	Non-invasive
4	Tonometry	In applanation tonometry of the radial artery, when a radial artery is partially compressed or splinted against a bone	Non-invasive

Table for principles discussed [3]

Principals

Pulse Wave Velocity (PWV) and Pulse Transit Time (PTT)

PWV
The velocity at which heart pulse travels is known as Pulse Wave Velocity
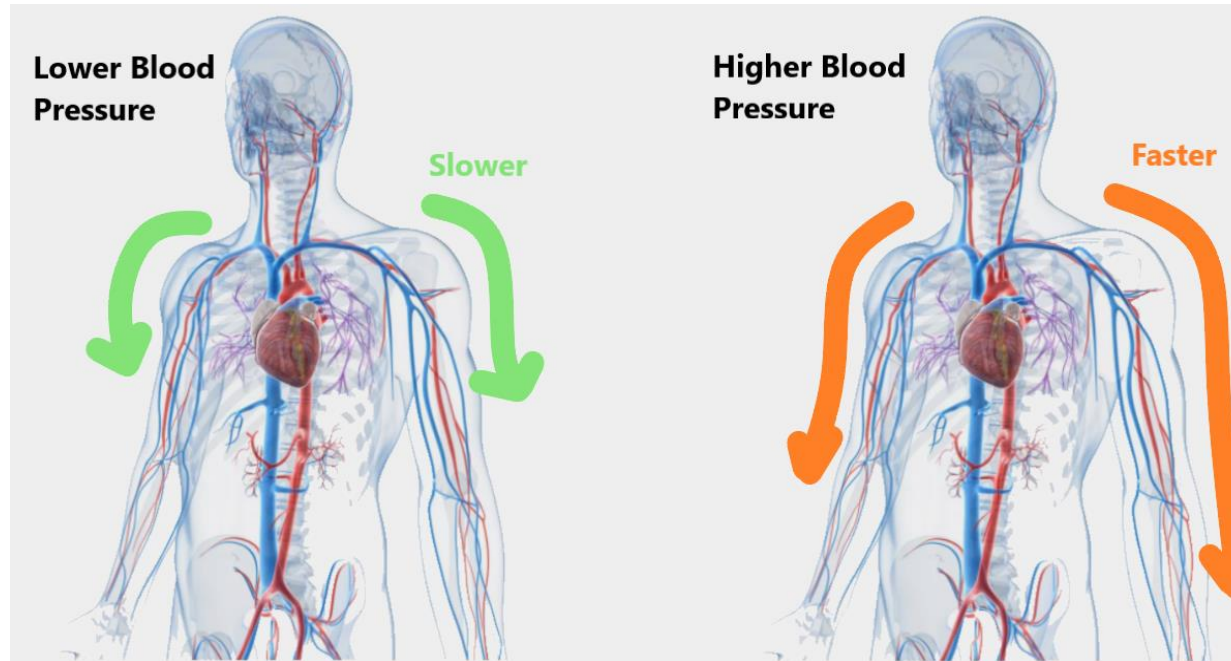
PTT
Time required to travel a pulse wave from one arterial site to another is referred as Pulse Transit Time

Pulse wave velocity is directly proportional to the Blood pressure

Proposed System and working

- Our used 2 identical PPG sensor
- A PPG sensor works by illuminating a arterial area with LED and reflected light is captured by Photo diode.
- The amount light going to absorb depends on the density of blood and density change due to heart beats. This way a heart beat is recorded as shown in fig a.

- PPG sensors will collect data form 2 different arterial areas i.e. form finger tip of index finger from both left and right hand
- Pulse Transit time (PTT) will be estimated form the data we got from PPG sensor which will further get used for BP estimation
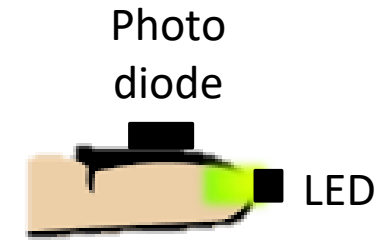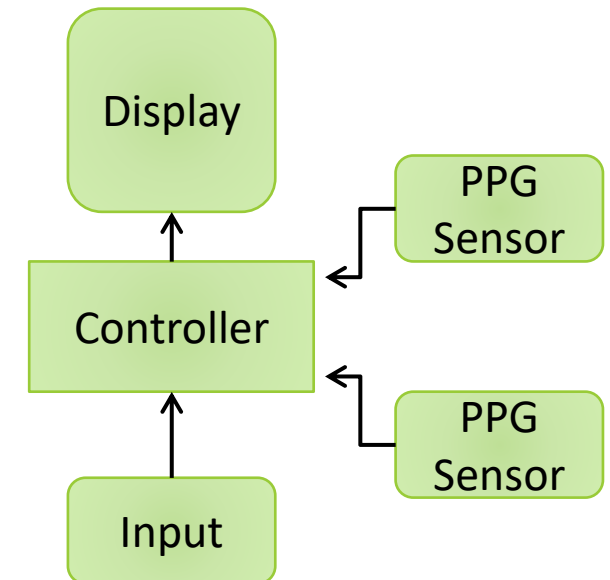
Photo diode

LED

Fig a

Display

Controller

Input

PPG Sensor

PPG Sensor

Block diagram

Calculating PTT

1. Collecting User inputs like data and when to start estimation
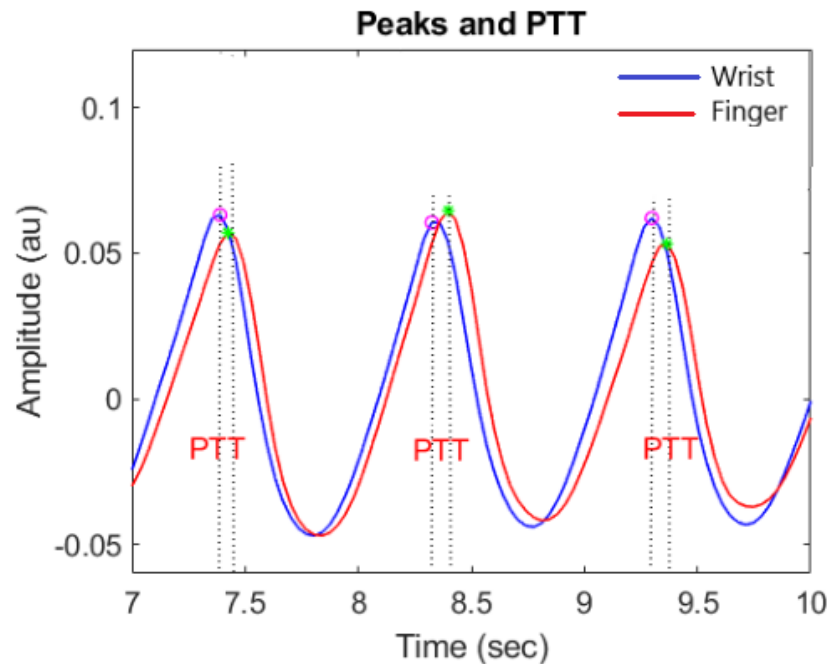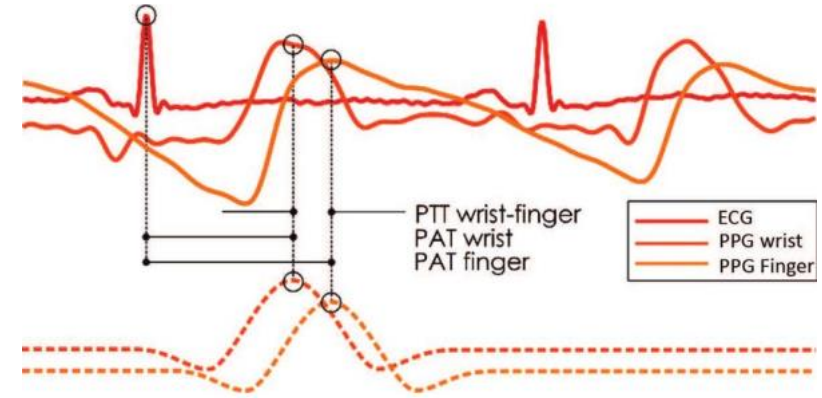2. Collecting input from the PPGs located at wrist and finger at synchronous time

Fig PTT calculation based on the PPG waveform and ECG R wave [3]

Fig PPT using PPG only [1]

3. Converting PPG signal in to digital by using onboard ADCs of Arduino, as shown in fig 4.1.1Calculation of PTT

4. BP estimation

5. Display and storing results

Relation Between PTT and BP

$$BP = K1 * PTT^{-1} + K2$$

Blood Pressure is inversely proportional PTT where,
K1 and K2 are the unknown individual-specific parameters.

- Ki values can be derived using **linear regression model**

- MAE ± SD is 2.07 ± 2.06 mm Hg for SBP estimation, and 2.12 ± 1.85 mm Hg for DBP estimation has been achieved.

- These estimates are lower than accurate BP estimation standard (5 ± 8 mmHg).

What our model proposes

As It is shown that these parameters are related
to the individual's age, height, and other physiological parameters variation

We'll collect several different readings from different age group and will find the general values of Ki parameter based on individuals physical parameter.
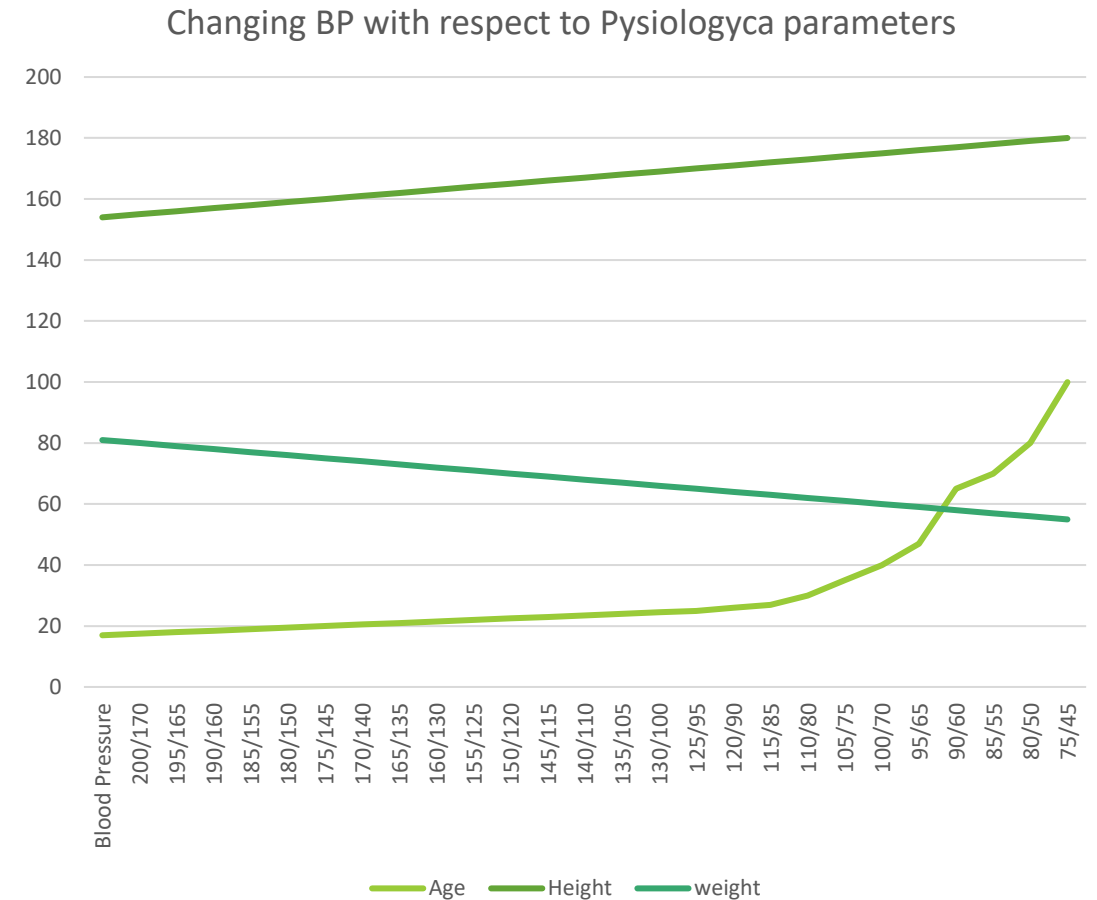
Changing BP with respect to Pysiologyca parameters

Chart: Changing blood pressure with changing height, weight and age

Expenditure incurred

COMPONENTS	COST (IN RS)
Arduino UNO board	530
PPG sensor X 2	270
LCD module	120
Push button X 4	40
Copper Wires	50
Bread board	70
Battery	15
TOTAL	1095 Rs

Disadvantages

- Less accurate

Advantages and Application

- Extremely Portable
  AS portable it can be included into wearables using advance fabrication techniques.

- Easy to use
  So easy that individual can monitor their own blood pressure.

- Though it is not very accurate but accurate enough to give a big idea before stroke or can prevent the progression of the hypertension and reduce medical costs

References

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December 2020

Thank you

Question ?