CUFFLESS BLOOD PRESSURE MEASUREMENT USING ECG AND PPG

INTRODUCTION:

Measuring blood pressure traditionally involves a nurse or the doctor placing an inflatable handcuff somewhere above your elbow, asking you to breathe in and out. They then use a stethoscope to understand the timing of the measure. If you happen to have one of those digital Blood pressure meters at your home, you already know the poor accuracy. This is by no means a continuous or consistent measure of blood pressure!

Cuff-less BP measurement has always been a challenge. There are a wide variety of studies where several methods were developed for cuff-free BP measurement and one among them which showed great potential is PTT or Pulse Transit Time, which acts as an indicator of Blood Pressure. Pulse Transit Time in simple words is the time taken by a pulse wave to propagate from heart to the point where reading is taken, in our case the finger tip.

Components used:

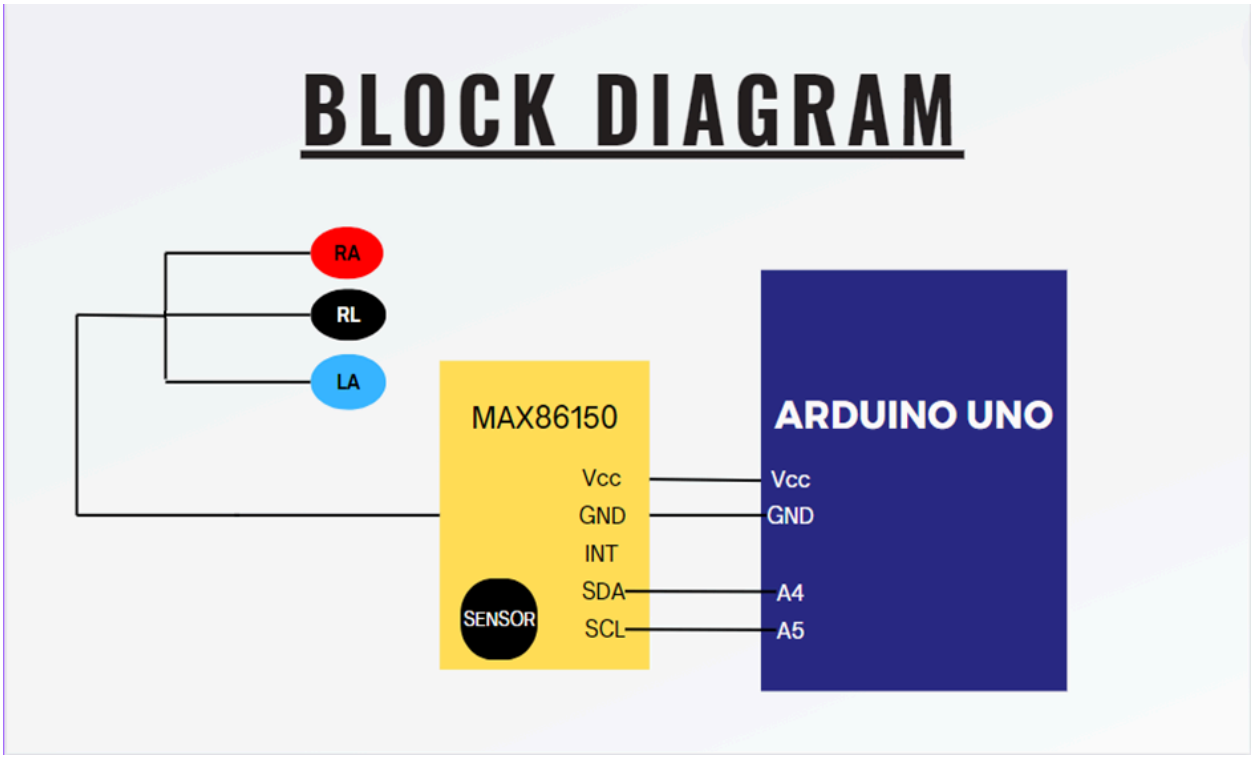
1. **MAX86150.**
2. **ECG Electrode Patches and chest lead.**
3. **Jumper wires.**
4. **Arduino uno.**
5. **USB cable.**

Experimental Setup and Connections:

1. Connect ground pin of MAX86150 to Ground pin Arduino.
2. Connect VCC pin of MAX86150 to 5V pin of Arduino.
3. Connect SDA to A4 pin of Arduino.
4. Connect SCL to A5 pin of Arduino.

5. Connect ECG electrode patches and chest lead.

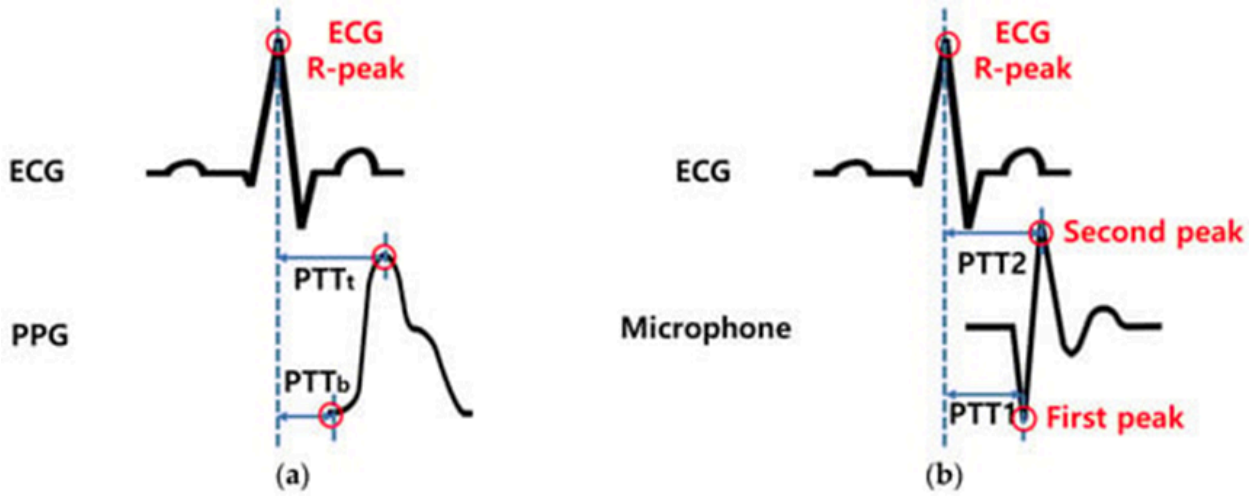
BLOCK DIAGRAM



PTT and BP calculations:

In the existing Pulse Transit Time (PTT) method, the starting points of the pulse wave of the Photoplethysmography (PPG) signal, measured in peripheral blood vessels such as those in the toes and fingers, and the point in time at which the signal reaches its maximum value, are set as feature points. As illustrated in Figure 1a, the time interval between the R-peak of the Electrocardiogram (ECG) and the start of the PPG pulse wave is defined as PTT(b), while the time interval between the R-peak and the maximum point of the PPG pulse wave is defined as PTT(t).

PTT is inversely related to blood pressure, with PTT(b) corresponding to diastolic blood pressure (DBP) and PTT(t) corresponding to systolic blood pressure (SBP). The waveform obtained from a microphone sensor in the radial artery differs from that of the PPG signal. The PPG sensor measures light that is reflected or transmitted by tissue and blood, whereas the microphone sensor detects changes in the membrane within the sensor. The sound generated by blood flow in the radial artery causes the membrane to vibrate, producing a waveform distinct from the PPG pulse wave. As shown in figure 1b



Formula to calculate BP:

BP = ΔBP/0.7 = 1/0.7 * ((1/2)ϱ $d^{2}PTT$^2 + ϱgh) = A/PTT^2 + B

A=(0.48×$height$)^2×(ϱ/1.4)

Where ϱ=1035 kg/m^3

Note: Here, **d** can be approximated as the height of the subject. In practice, it represents the distance between the two measurement points, which is typically the distance from the heart to the finger

THANK YOU