LELEC2811 - Heartbeat monitoring
Context and conditioning chain specifications

Context

In this mini-project, your customer is a manufacturer of medical devices whose goal is to develop a prototype to monitor the heartbeat of a patient. The technique chosen to do so is photoplethysmography, a technique that is used in most of the equipments present in hospitals. The basic idea of photoplethysmography is to expose a fingertip to light and to receive either the reflected or the transmitted light with a light-sensitive device, generally a photodiode or a phototransistor. Blood volume changes linked to the heartbeat result in a pulsatile component of the artery blood, that then translates into a small variation of the light intensity received by the sensing device, as illustrated in Fig. 1.

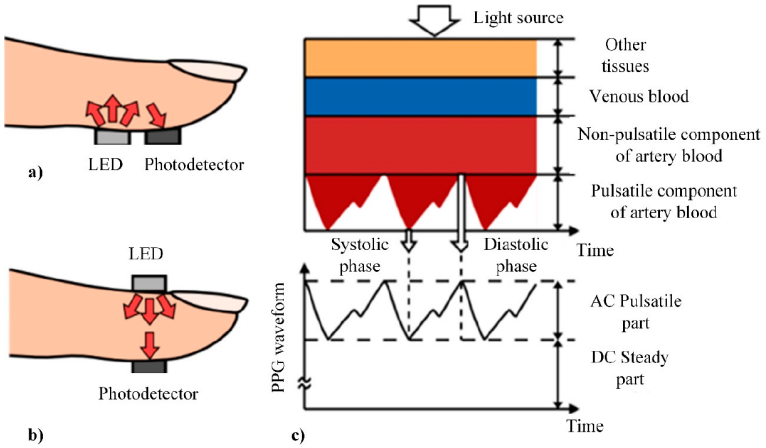

Figure 1: Photoplethysmography can be performed either by reflection (a) or by transmission (b) of the emitted light. (c) The pulsatile component of the artery blood results in a small variation of the light intensity received by the sensing device. Used with the courtesy of [1].

Specifications

The conditioning chain that you are asked to design must operate continuously and needs to convert the measured light intensity into an analog voltage. This voltage will then be digitized by an ADC at a sampling rate of 100 samples per second. In addition, the sensor chain must respect the following specifications:

- Bandwidth: 40 to 200 beats per minute (bpm);
- Power consumption: No restrictions;
- Light wavelength: To be chosen by the design team;
- Radiant intensity of emitted light: As high as possible;
- Sensitivity of the photodiode/phototransistor: As high as possible.

Available raw sensors

Three different raw sensors can be used to develop the prototype:

1. Two discrete components, i.e. the MCL034GD light-emitting diode and the TEPT4400 phototransistor;
2. The SFH7050 photoplethysmograph sensor;
3. The MAX86150 integrated photoplethysmograph and electrocardiogram bio-sensor.

References

[1] A. Dzedzickis, A. Kaklauskas and V. Bucinskas, "Human Emotion Recognition: Review of Sensors and Methods", *Sensors*, vol. 20, no.3, p. 592, Jan. 2020.