**Reflection/Discussion:**

PPG:

The primary aim of this project is to demonstrate a working prototype system of wireless patient monitoring system. Since Raspberry Pi 3 Model B is chosen to be the Terminal of whole system and Arduino is used as an ADC for collecting analog signal, the remaining problem is how to connect a Pulse Oximeter to the Arduino and capture the desired signal.

We started with the medical standard Pulse Oximeter (BioNomadix Wireless Wearable sensor) from Biopac Systems. The Pulse Oximeter is attached to a wireless transmitter module. Raw data are transferred via wireless communication to a receiver module and then to a wire connected PC. The signal processing and visualization is then performed on the PC. However, the BioNomadix Wireless system is fully developed commercial product such that we cannot get any access to either hardware or software. In another word, it is impossible to collect the PPG signal by connecting their Pulse Oximeter to our Raspberry Pi 3 model B. Hence, we decide to design our own Pulse Oximeter for proof of concept. We also believe that developing your own hardware is also a good practical experience.

Result compared with the commercial Fingertip Pulse Oximeter:

Heart rate (BPM):

|  |  |  |
| --- | --- | --- |
|  | Commercial PPG (BPM) | Our PPG (BPM) |
| Measurement 1 | 91 | 90 |
| Measurement 2 | 88 | 87 |
| Measurement 3 | 97 | 97 |
| Measurement 4 | 90 | 92 |
| Measurement 5 | 90 | 90 |
| Measurement 6 | 86 | 87 |

The average deviation is 0.8333.

Limitation:

Unfortunately, at this stage, the PPG we have designed is not able to detect the Oxygen Saturation level. However, a clean waveform and heart rate can be obtained from the sensor we designed. Oxygen Saturation level calculation is way more complicated than expected. As we stated in previous section, with the waveforms from

Further development:

Since this is a prototype designed mainly for collecting data for the wireless monitoring display, current state of the waveform is sufficient for such purpose. Calibration and noise cancellation can be implemented in the future to counter the issue such as signal variation due to the motion artifacts and noise from the power supply.

For this project, a PCB has been designed for the pulse oximeter. A simpler combination of integrated PCB with ADC and Pulse Oximeter can be used to replace the current design of connecting two separate pieces.

**Conclusion (for the whole project):**

Based on thorough research on the existing systems and the demands from actual doctors, a new wireless patient monitoring system requires features such as single screen for display of vital parameters, a design that can be easily affixed to and removed from the bed, no gaps in monitoring while patients are in transit or remote hospital locations, reduced/no tripping hazard and false alarms due to wires being pulled out and lowering infection risks. Those vital parameters include: ECG, EEG, PPG, Blood pressure and Blood temperature.

The system we have developed is able to provide such mobility and centralized visualization.

Future development:

Control Interface/Application on display devices: easy to use is one of the most demanded requirements for such system. A fully developed interface/application can help doctors to set up the whole system within seconds. During the monitoring stage, doctors will also be able to control sensors to adjust the refresh rate or amplitude via such interface. Features such as sweeping between different readings will also provide convenience. Such control interface offers doctors/anesthetists easier access to all the vital parameters and reduce their stress in some sense.

Centralised database/cloud server: all the data collected should be transferred to a central database. For privacy reason, only authorized doctors are afforded access to those data with the permission from patients.

Improve the reliability and stability of sensors to a medical level: as this stage, the system is still a prototype for proof of concept. The sensors we used have certain level of precision and reliability. However, for real operation environment, only those sensors meet the medical standard can be used.