Miniaturization of a low-cost LED sensor for vein detection

Studienarbeit 0074
15.10.2020

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Introduction

- Venipuncture is one of the most common invasive procedures in medical healthcare[1]
- Existing sensor for vein detection is to be miniaturized[2]
- Improving the resolution and enabling a matrix of separate sensors

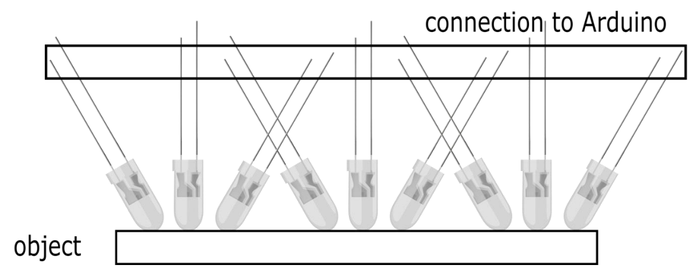
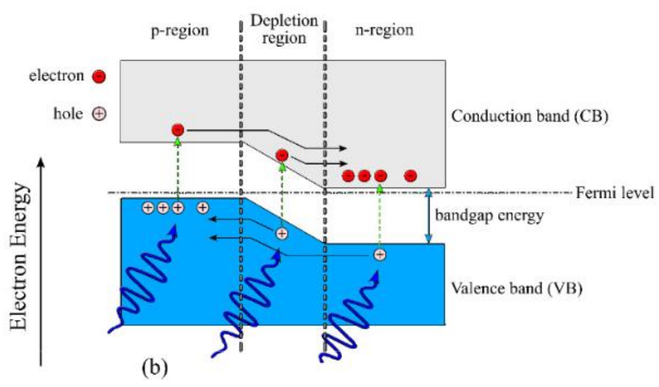


Figure 1: Working principle of the sensor

LED as sensor

- LED in reverse bias
- LED can be modelled as parallel connection of current source and capacity
- Charging LED capacity
- Measured discharging time dependent of amount of incoming light



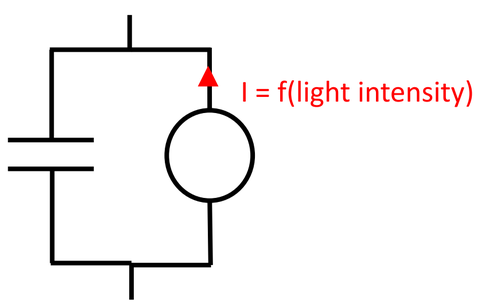


Figure 2: Model of LED as a sensor

Final LED vein detection sensor

- LED row constellation (two emitting and one sensing LED)
- Emitter LEDs: SMD 0603
- Detector LED: 3 mm LED

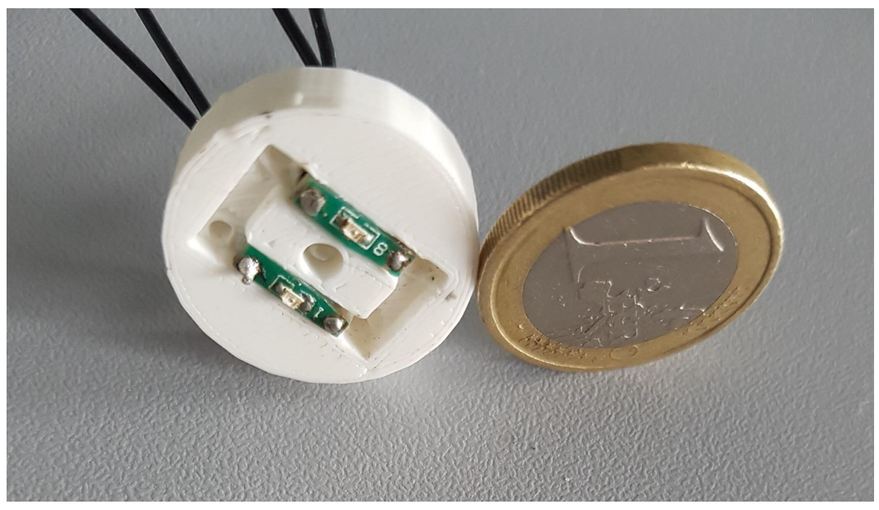


Figure 3: Vein detection sensor

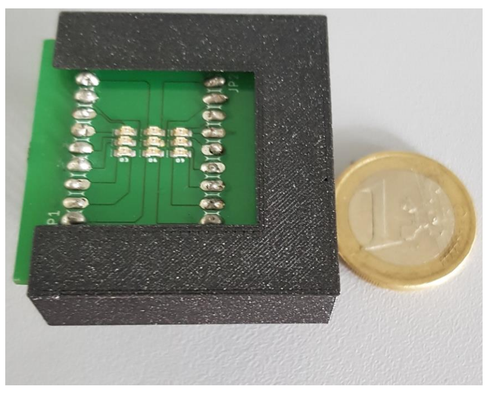
Future work

- Further miniaturization of the sensor with alternative concepts
- Construction of a matrix of SMD LED emitters and 3 mm LEDs for detection
- Automated evaluation of the results
- Extension for measuring the vein depth

Experiments & Results

Using back of the hand as measuring object

Variant 1: Emission and detection with SMD-LEDs



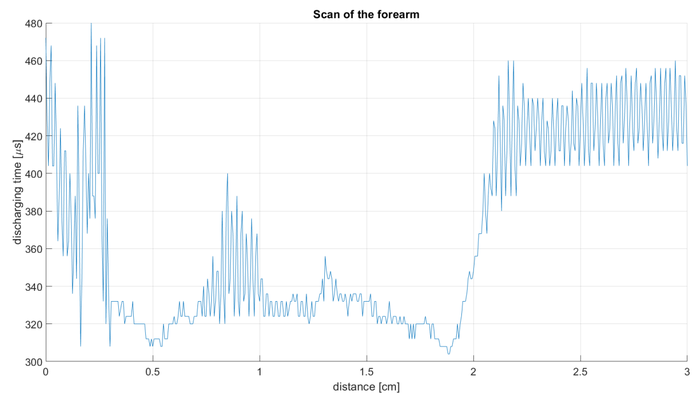


Figure 4: Setup and result of variant 1: Vein at 0.8 cm could be detected

Variant 2: SMD emitter and 3 mm detector (see final LED vein detection sensor)

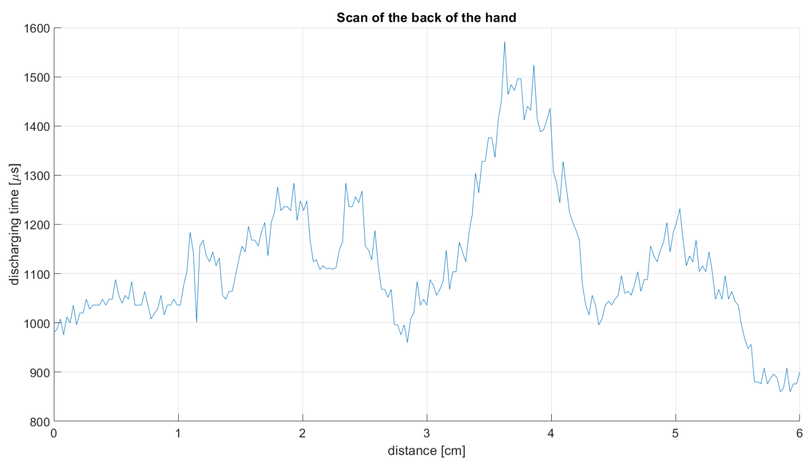
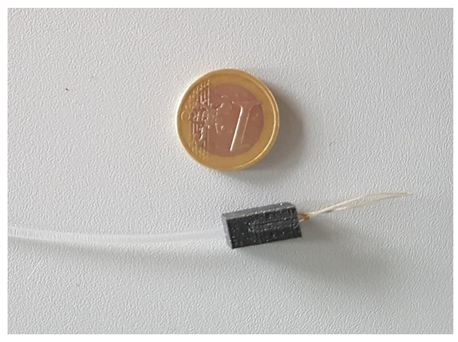


Figure 5: Result of variant 2: Detected all present veins at 1.9, 2.3, 3.8 and 5.1 cm

Variants 3 and 4: Using optical fibers which are combined with 5 mm LEDs



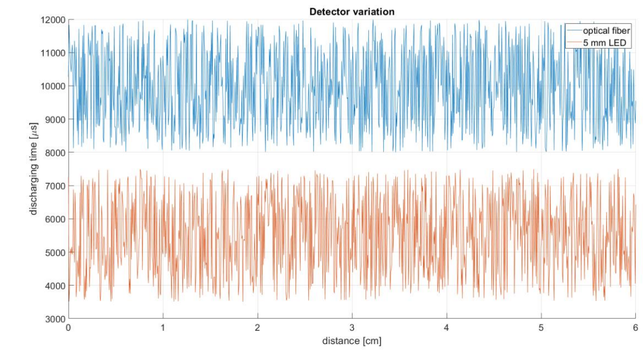


Figure 6: Fiber setup and results: No veins could be detected

Analysis of Noise:

- All LEDs show a strong noise, which was examined with a FFT
- Noise does not depend on environment, probably due to component

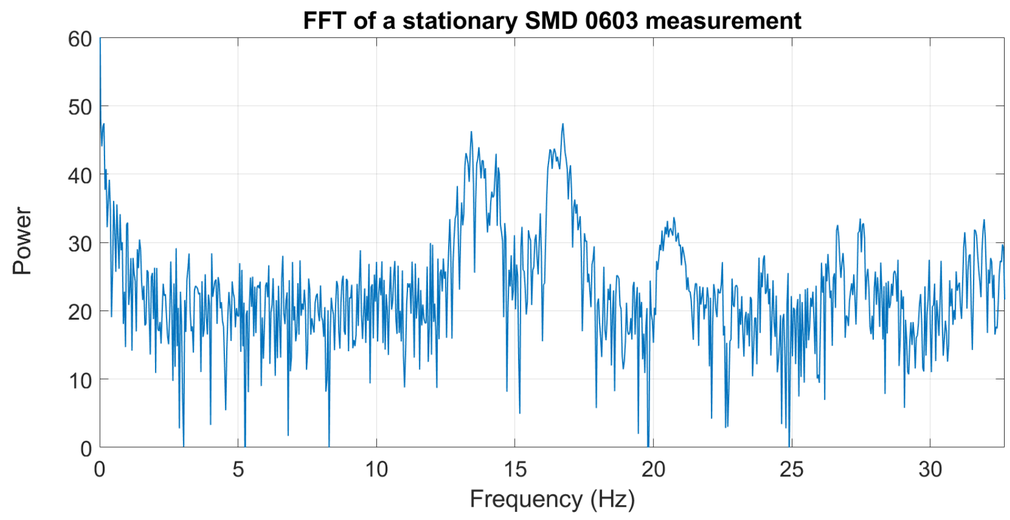


Figure 7: FFT of a stationary measurement of a SMD 0603 LED

Literature

1. G. Walsh, "Difficult peripheral venous access: Recognizing and managing the patient at risk", Journal of the Association for Vascular Access, vol. 13, no. 4, pp. 198–203, 2008
2. Pia Willmann, "Development of a low-cost led vein detection sensor", Bachelorarbeit, Universität Stuttgart, 2019.