Biometric Systems
Capturing of 2D Hand Geometry With Line Camera

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1 Assignment

The task in hand is to assemble a mechanical device and create software for acquiring 2D hand geometry via a line camera. A solution for mounting the camera and hand placement should be proposed in the following sections for best geometry acquisition and image reconstruction.

The document is structured as follows: in section 2 we describe the hardware part of the project, what hardware was used and we propose a solution for camera mount and hand placement. In section 3 the software needed for camera control and image reconstruction is presented. In section 4 we detail the created hand geometry database and how we acquired it and in last two sections 5 and 6 we sum up the proposed hardware and software solution and what further work can be done.

2 Hardware

In this section we describe the hardware we used in the process of creating the device.

2.1 Hardware Setup

Camera

The selected camera is Basler raL6144-16gm. This camera provides us with the resolution of 6144 × 1 pixels with line rate up to 17 kHz. The captured image is in greyscale colors which for our use case is the desired output. The camera's shutter can be operated either via hardware or software trigger[1].

The camera is equipped with AF Nikkor 50mm f1.8D lens. The lens suits our needs for multiple reason. It is relatively inexpensive, simple to use and has good depth-of-field control with aperture ranging from f/1.8 up to f/22.

Camera Mounting

In order to acquire images with line camera either the object or camera has to move in smooth direct line. We decided to move the camera for various reason. The main reason is the human error. People can easily place a hand on a firm stable surface and keep the hand as it is for a long period of time, in our case no more than 30 seconds.

The camera is mounted on a slide rail with stepper motor with the platform facing down in order to mount the camera and light as seen in figure 2.2. The slide rail itself is mounted on an aluminium scaffolding which raises the rail to the desired height.

Slide Rail & Stepper Motor

We proposed for straight and smooth movement in one axis a slide rail controlled by a stepper motor. The stepper motor itself is controlled by Leadshine EM705 Digital Stepper Drive which is controlled by pulse width modulation generated by Arduino UNO with our custom code generating 976 Hz PWM with 50% duty cycle.

The PWM can be calculated as follows:
$PWM_{Frequency} = 16000000/(Prescale\_Factor * 256)$

[1] The camera also disposes of "free-run mode".

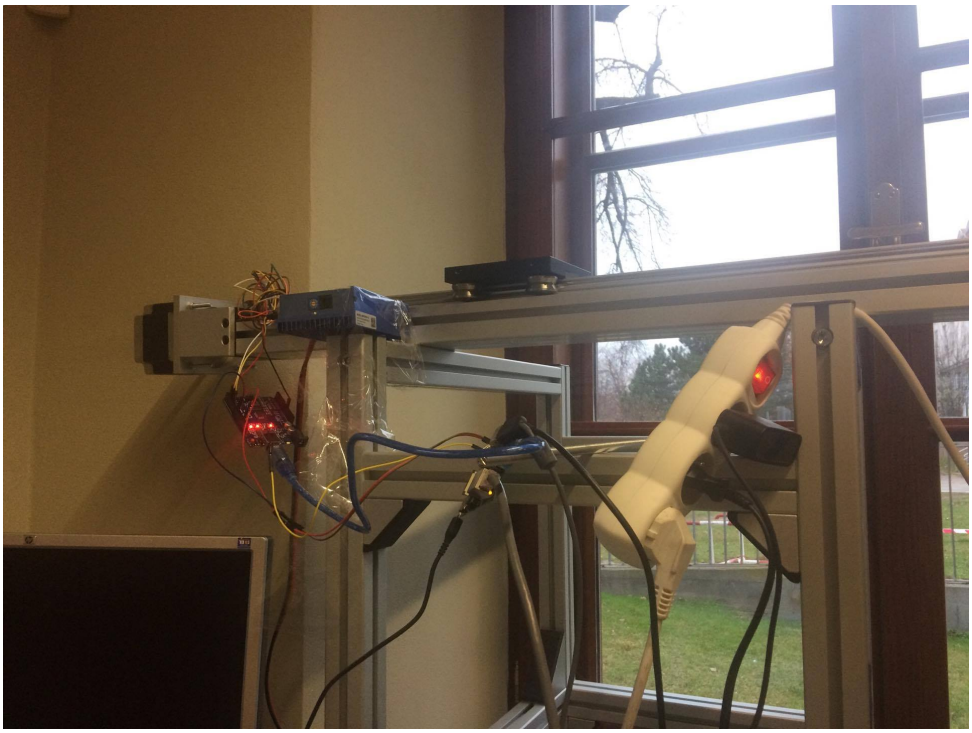

Figure 1: Camera mount setup. ** tohle se jeste jednou vyfoti **

where *Prescale_Factor* can be set to 1, 8, 64, 256 or 1024. The default value is 64 which results in aforementioned 976 Hz PWM.

2.2 Hand Placement

The hand is placed in the centre of the scaffolding on a prepared foundation which aligns and spreads the fingers in order to always capture the same hand geometry. The hand stays put during the whole image acquisition procedure which minimizes the human error.

2.3 Slide Rail Control

The stepper motor's speed is controled by the PWM. Next we can control the direction and `ENABLE` state. Both of the leads are connected to the Arduino UNO as seen in figure 2.3

Here should be the calculation of speed

In order to provide remote control the Arduino UNO is connected via GPIO to a Raspberry Pi 3 which controls the `DIRECTION` and `ENABLE` pins on the Arduino UNO board. The Raspberry Pi GPIO pins, using BCM notation, are used as follows:

- PIN 5 - `DIRECTION` control
- PIN 6 - `ENABLE` control

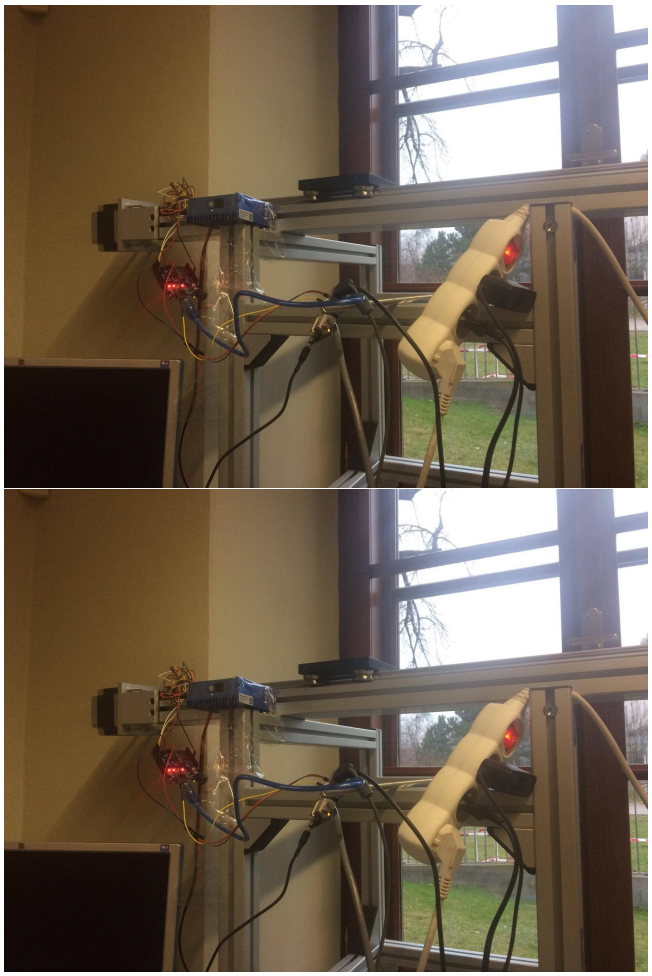

Figure 2: Tu bude neci ruka s deskou ** tohle se jeste jednou vyfoti **

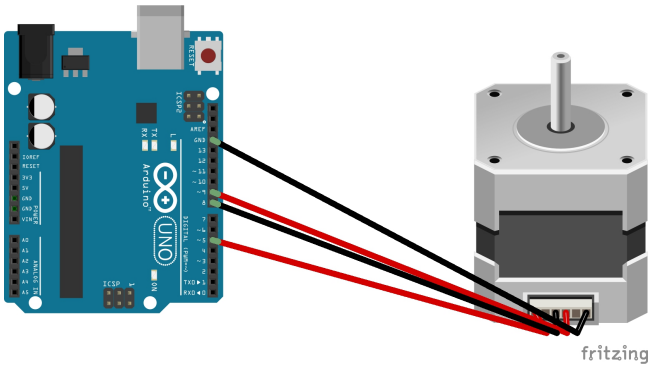

Figure 3: Schematics for Arduino UNO and stepper motor connection ** tohle se jeste dodela **