The Influence of Illumination on Measurement of Springs with Computer Vision

Degree programme: BSc in Industrial Engineering and Management Science | Specialisation: Business Engineering
Thesis advisor: Patrik Marti
Expert: Prof. Dr.Cédric Bessire
Industrial partner: H. Häberli AG, Grenchen

Existing solutions for visual measurements of springs are extremely expensive. This thesis shows the design and construction of an alternative, low-cost solution for visual measurement of springs. The prototype is based on open-source software and consumer hardware. Furthermore, the influence of tactile brightness, exposure time, light color, and contrast on the accuracy of the measurements was investigated.

Introduction and Objective

For each order, 20 springs must be measured for their free length at Häberli AG. There are various possibilities such as calipers, micrometers, or profile projectors. However, these measurement systems all have their disadvantages. They are slow because the springs must be aligned correctly. In addition, there is a high risk of human error. The main problem with tactile measurement methods is the compressibility of the spring. The existing solutions on the market are effective but are extremely expensive. There is a lack of an inexpensive, fast, and sufficiently precise measuring device for measuring springs.
This thesis develops a low-cost prototype of a visual measurement device. The measurement equipment is to optically detect and measure randomly placed springs in real time. This optical spring length measuring system should be current included in the production process of Häberli AG.

Research Approach

The goal is to do the image processing as well as the object recognition with the open-source library OpenCV. An experimental approach was chosen for the development of the prototype. To achieve maximum results with the inexpensive hardware and software used, an experimental series of measurements was performed. The parameters brightness, exposure time, light color and contrast resulted in 445 measurement combinations. A total of 12500 measured values were recorded and quantitatively evaluated.

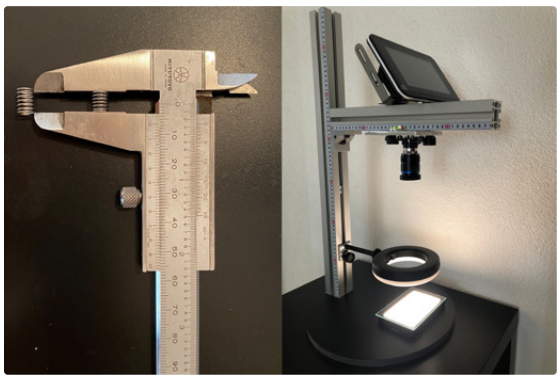

Figure 1 Problem illustration and developed solution approach

Developed Solution

For cost reasons the prototype is based on a Raspberrypi 4B with a Raspberrypi HD camera and a 35mm telephoto lens. With CHF 700.- the developed prototype is far less expensive than existing solutions which cost CHF 20000.- or more.
The results showed that, depending on the chosen parameters, the light intensity had the greatest influence on the error. The measuring equipment is capable of measuring aligned springs with a maximum deviation of 0.03 mm over 49 measurements. For non-aligned springs, outliers outside the tolerance were detected.

Implications and Recommendations

The alignment problem can be solved mechanically or with an additional query in the script. It is recommended to conduct more experiments to validate the reliability of the prototype.

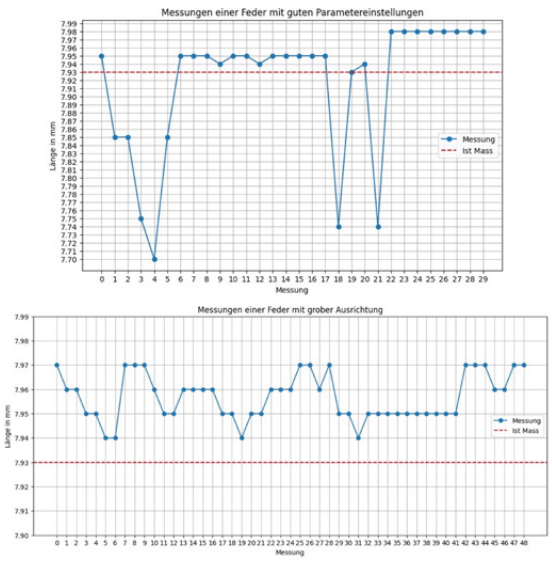

Figure 2 Spring measurement unaligned (top) vs aligned (bottom)

Aaron Sperisen
aaronsperisen@gmail.com