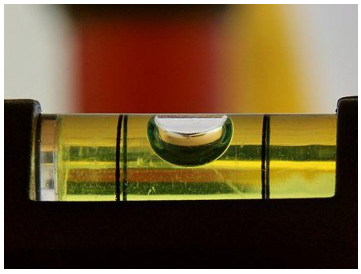
Valentina Scharpf
CS 639 – Introduction to Computer Vision
Project Proposal

Computer Vision Project Proposal
End of Line Inspection of Spirit (bubble) Levels

What is a Spirit Level?



- A spirit level, bubble level, or simply a level is an instrument designed to indicate whether a surface is horizontal (level) or vertical (plumb).
- Different types of spirit levels may be used by carpenters, stonemasons, bricklayers, other building trades workers, surveyors, millwrights and other metalworkers, and in some photographic or video-graphic work.
(Wikipedia)

Importance

- Even though there are alternative modern options (laser level), spirit levels are still widely popular due to their
  - low cost,
  - durability (bubble vs. electronic circuits), and
  - no requirement for recalibration.
- Due to the fact that levels are used in construction, it is critical that all measurements taken are accurate. The repercussions of inaccurate readings can lead to dire consequences involving
  - public safety (ex. uneven buildings or bridges) as well as
  - cost overruns (if a project has to be restarted).

Current state-of-the-art

- During the manufacturing process of spirit levels, an end of line inspection is required to make sure the bubble is accurately placed according to specific requirements.
- Most commonly, this is accomplished by placing the level on a calibrated surface and having an operator (person) visually inspect that the bubble is within the lines.
- This inspection is prone to errors due to human subjective perception.
- The time required for inspection creates a bottle-neck during manufacturing process, which leads to additional production costs.
- Some steps can be taken to improve this process, such as
  - adding a microscope or
  - adding a magnifying glass
- However, there is still a person performing the visual inspection.

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The Need for a Computer Vision Application

- A computer vision solution to this problem would
  - increase throughput (which would lead to increased sales),
  - decrease worker fatigue,
  - increase accuracy of the final product,
  - provide valuable data (inspection results that can be saved to a database for long-term process improvement).

- During my research, I was not able to find any complete automated system commercially available for solving these problems.
- I believe that currently, the correct position of the bubble is determined either by visual inspection performed directly by a person or by using an inspection camera for which custom software is written (in this case, I assume companies tend not to share industry secrets).

Possible Procedures That Could Improve the Testing Process

- Precisely locate position of bubble in relation to the lines
- If bubble is not perfectly centered, provide a numerical value describing amount of error
- Determine if the bubble has the correct width
- Determine is the vial is straight
- Determine if the lines are symmetrical
- Save test results to a database for long term process improvement

Proposal

- My proposal is to automate this process by using an inspection camera at the end of line and write custom software that will locate the level-bubble in relation to the lines and provide a numerical value describing amount of error, if any.
- Due to the fact that an end of line camera is not available to me, I will instead acquire enough high-quality images to simulate various test conditions, such as
  - a bubble in an optimal position,
  - a bubble shifted to one side,
  - a vial installed incorrectly or at an angle,
  - the bubble having the wrong size.
- The project will use Python as a programming language, due to the fact that it offers some libraries that will facilitate some Computer Vision operations.

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Project Outline (Sequence of Operations)

- Acquire Image (import to simulate camera operation)
- Apply filters
- Locate vial using Template Matching
- Locate reference lines
- Calculate angle from horizontal
- Locate bubble and surface by detecting edges
- Calculate distances from reference lines
- Decide if bubble position within allowed error

Proposed Schedule

October 1st	Submit proposal
October 2nd	Build website for the proposal
Oct. 3rd – Oct. 15th	Acquire test images
Oct. 5th – Oct. 10th	Define specifications
Oct. 10th – Nov. 25th	Determine concepts useful for this application
Oct. 10th – Nov. 25th	Develop application
Nov. 25th – Dec. 1st	Test, debug and verify
December 1st	Presentation

Conclusion

- I think a computer vision system similar to the one I am proposing could possibly improve the final inspection process by providing accurate test results in faster times.
- It could also provide data related to quality control.

REFERENCES

- Wikipedia – Spirit Level - https://en.wikipedia.org/wiki/Spirit_level
- Information included in “Current State of the Art” section was provided by Jeff Scharpf – Principal Engineer at Milwaukee Electric Tool