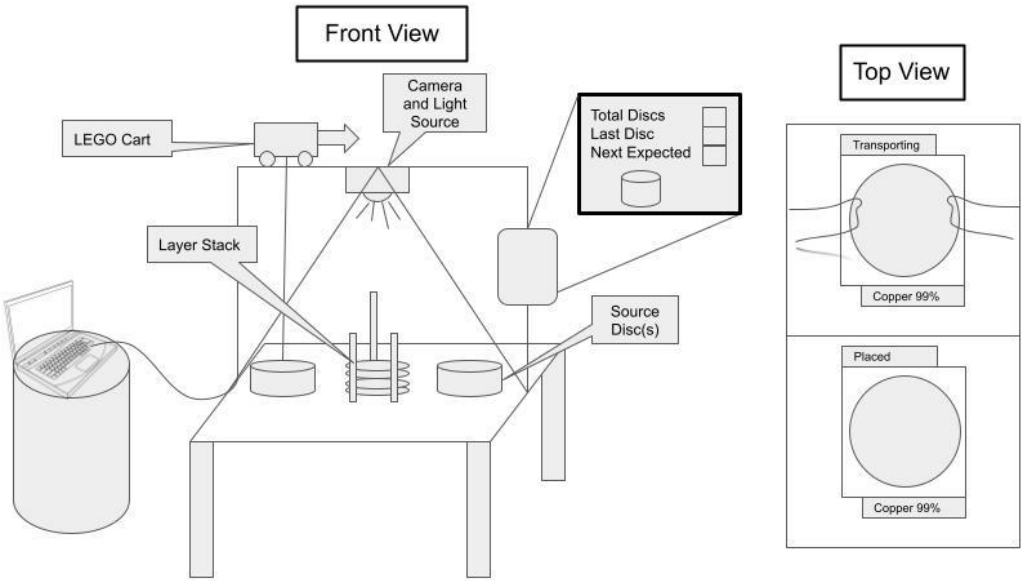
Project Title: Disc Layer Counter



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Education	University of Arizona B.S. Geosciences M.Ed Science Education	University of Dayton Bachelor of Mechanical Engineering Masters of Mechanical Engineering
Related Coursework/Experience	OpenCV I&II OpenCV Pytorch (in Progress) 22 years software development and implementation	25 years Manufacturing Engineering experience.

Problem:

Like a wedding cake or Pringles in a can, assembling a multi-layered cylindrical product requires counting and stacking objects consistently and accurately from the bottom to top of the cylinder. Although it is critical to correctly count and identify the number and material of each sequential layer, it is often difficult to implement an auditable and accurate process when the work is completed manually. This challenge is computed when the layers are the same shape (cylindrical), thinly sliced (1-2mil), and different materials (copper, zinc, lead, etc.). Miscounting or wrongly identifying the material stack can result in a defective product that is inefficient and potentially unsafe due to unintended chemical reactions when certain metals are in contact with each other (or even worse if the wedding cake doesn't taste good)!

Proposed Solutions:

The proposed solution to this challenge is to develop a system that combines Computer Vision (OpenCV) and LEGOs in order to streamline and automate the layer stacking process. A camera and light will be placed above the cylinder in order to record the video and provide a uniform lighting source for material identification. The camera will be used to record a video of the engineer while they are loading each disc onto the cylinder in real time. The video stream will detect the disc and classify as either “Transporting” or “Placed”. Once a video has been classified as “Placed”, the digital counter will add one disc to the total count.

A color analysis will classify the material. RGB and HSV values will be used to differentiate the material composition of each disc. Copper, lead and zinc discs will be used for the test, however the material inputs will be configurable in order to handle other types of materials in the future. The material classification will be displayed on the monitor and recorded in a database with the overall count. If specific material combinations are required, the system will notify the user what the next disc should be based on the overall sequence expected. For example, if there are 2 copper and 2 zinc discs expected in the sequence, and 1 copper disc has been placed, the display will notify the user that a copper disc is expected. The user will be alerted if there are any errors and require manual override to continue.

The video will be available for playback, process auditing, and comparing planned vs. actual time required. A tablet or PC will notify the user with the number of discs loaded, the next expected material, and the total count overall using an easy-to-use dialog. All information will be stored in a relational database, such as SQLite, for creating reports, process auditing, and linking to the video files. Future versions will connect to ERP systems in order to link the source of the material in case metal defects need to be traced to the final product.

A final element to the project is to use a LEGO crane in order to move the discs from the source stack to the destination cylinder. This would enable the engineer to monitor the process without having to do the process manually. A lego crane will move across the top of the device and lift a single disc and transport it to the cylinder. The same computer vision counting and material detection algorithm will be used to validate the workflow using manual and LEGO automated workflows.

The proposed project will be completed in three phases based on complexity.

1. **Object Counting** - Computer vision cameras will be used to automatically count the number of disks placed on the cylinder. This will eliminate the need for manually counting the disks as they are placed on the cylinder “cake”.
2. **Object Material Identification** - Computer vision algorithms will be trained to identify the type of material placed on the cylinder “cake” based on colors detected. A consistent light source will be placed above the cylinder to help correctly identify the input disc.
3. **Process Automation** - Disc will be extracted from the source automatically using LEGO building sets. The final assembly will use suction to pick up one of the disks and move it from the source to final destination.

Materials Requested: 1 LEGO Mindstorms set, OAK-D-Lite Camera.
https://www.lego.com/en-us/product/robot-inventor-51515

References:

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https://docs.opencv.org/3.4/d7/dbd/group__imgproc.html

https://docs.opencv.org/3.4/d4/d70/tutorial_hough_circle.html

https://github.com/amarlearning/Finger-Detection-and-Tracking