Automated Carousel Inspection System (A.C.I.S)

Amir Mashayekhi, Austin Rosinski, Huey Jackson
Advisor: Dr. Rao Kilaparti

Department of Engineering Technology

NORTHERN ILLINOIS UNIVERSITY
College of Engineering and Engineering Technology

Abstract

The inspection process is often overlooked when considering the development of a product. Given its clear importance, we found a way to improve the procedure by using *automation* and *image processing*.

We created a method inspired by current automated optical inspection (AOI) systems that inspects printed circuit boards (PCBs) to determine *if* and *where* part defects exist. We then created a sample PCB with 10 parts to test if our system is capable of finding missing or defected components on a board.

Theory

Our system uses an image sensor and computer vision to break down images into a graph of pixels.

Each pixel coordinate (x, y) contains 3 values ranging for intensities of 0 to 255 (8-bit)
- Red - Green - Blue

A change in pixel intensity compared to our desired product can help us find defects on the PCB. Specific defected part locations will be shown on the graph as a coordinate system for accessibility.

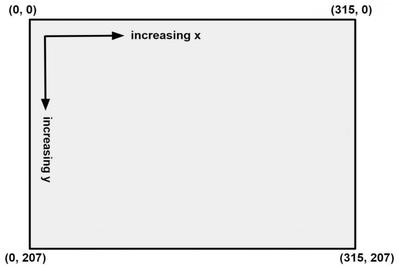

Figure 1: pixel intensity graph

Goals

- **Eliminate:** operator error / fatigue from process
- **Portability:** small and light to set up anywhere
- **Accessibility:** easy to use and interpret results
- **Cost-effective:** cheap alternative to AOI systems
- **Interchangeable:** printed tray easy to change for different PCB sizes and operations

Materials and Methods

System components:
- 3D printed tray (PLA)
- Motor (stepper) + drive
- Image sensor + mounts
- Raspberry Pi controller

A microcontroller is used to automate and display results. It can process 135 components on the PCB.

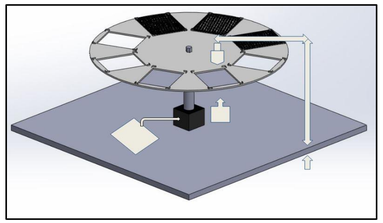

Figure 2: system components

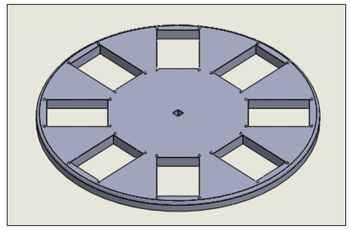

Figure 3: 3D printed tray

Procedure:
1. Motor turns tray so PCB reaches inspection point
2. Sensor acquires image of PCB, compares to original
3. If it passes, motor turns tray to next station. If it fails, system stops / sends error
4. Once a PCB passes, it can be ejected

Results

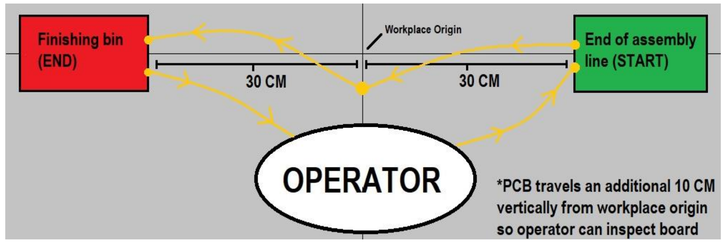

Figure 4: workstation assumption for human inspection

Using Predetermined Time Standards (PTS) and the workstation assumptions in *Figure 3*, we can estimate how long it would take for an operator to inspect our specific PCB sample versus our system's total cycle time. We determine that it would take an operator **48.86 seconds per 8 boards**, versus our system time of **26.82 seconds per 8 boards**.

Discussion

Based on the times for both inspection processes and assuming a typical workday with 7 hours of operation time, we determined that a human could inspect roughly **3,752 PCBs** per day versus our system inspecting **6,832 PCBs** per day. The difference is near **3,080 more PCBs** inspected daily by our system**.**

NOTE: these statistics only apply to our own PCB sample, which has 10 parts. Most real-world PCB operations have well over 60 total parts; more components only affect human inspection time and not our system's, increasing the difference in PCBs inspected daily in our favor.

Conclusions

Our automated inspected system proves to inspect PCBs at a faster rate than a human. This is beneficial for a company because it saves time in the inspection process, which could be a potential bottleneck in the overall cycle time of a product. Addressing this can save money in the long run through efficiency in manufacturing.

A few obstacles that must be addressed when utilizing our system are overheating the microcontroller, vibration of the tray due to the motor, and proper PCB ejection.

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