Sensor Team Six
Home Depot Connector Type Identification

Joseph Doughty, Christopher Fox, Nicholas Korzik, Matthew McBrien, Lindsey Robirds
Advisor: Dr. Matthieu Bloch

Problem Statement

Customers often go to Home Depot stores to purchase replacement screws for projects. However, if they don't know the specifications of the screw they require, then they may need to ask a Home Depot Associate for help identifying it. This takes up time that the Associate could spend doing other work in the store, and may negatively impact customer experience depending on how long this process takes.

Solution

Our solution is intended to be installed in the Fasteners aisle of Home Depot stores. The device uses a Raspberry Pi computer to control the lighting, camera, display, data transfer, and user interface.

To identify the customer's connector, the device will take a photo of it and transfer the image to a desktop or cloud processor. The processor will then execute parameter extraction and classification algorithms on the photo to determine which screw the customer supplied. Finally, the result is transferred to the device where it is displayed to the user.

Results

Accuracy
Parameter extraction
- Total Length 96% accuracy
- Screw Width 100% accuracy
- Head Type 94% accuracy

Classifier (25 Screws)
- Holdout method (80:20): 98% accuracy
- Manual testing: 93% accuracy

Time
Full execution
- 1.8 - 8.4 seconds based on screw length
- Average 3.9 seconds

User Experience
Fully autonomous classification
- Requires only one click from user
- Displays part picture, object segmentation, stock image and part description

Parameter Extraction

DSP Techniques incorporated in algorithm
- Edge detection for object segmentation
- Image rotation to align object on vertical axis
- Morphological Transforms for shadow reduction
- Six Unique Parameters extracted
1. Total length (in)
2. Body length (in)
3. Body width (in)
4. Head width (in)
5. Head width location (in)
6. Thread Count

Classification

Once parameters are extracted from screw, we use a random forest classifier to determine screw type.

Create database of parameters
- Use database to train classifier
- 10 sets of parameters for each screw

Implement Random Forest Classifier
- Predictions are quick on our dataset
- Provided accurate results for prototypes
- Generally avoids overfitting

Image Acquisition · Object segmentation · Parameter Extraction · Classifier Result

System Block Diagram

LED PCB · Screw Database · Camera Module · Raspberry Pi · Image Processing Algorithm And Classifier · LCD Touch Screen · User Input · Results Display

Image Data · Image Data · ID Result · ID Result · User Input

Direct Connection · Wireless Connection · Direct Or Wireless Connection
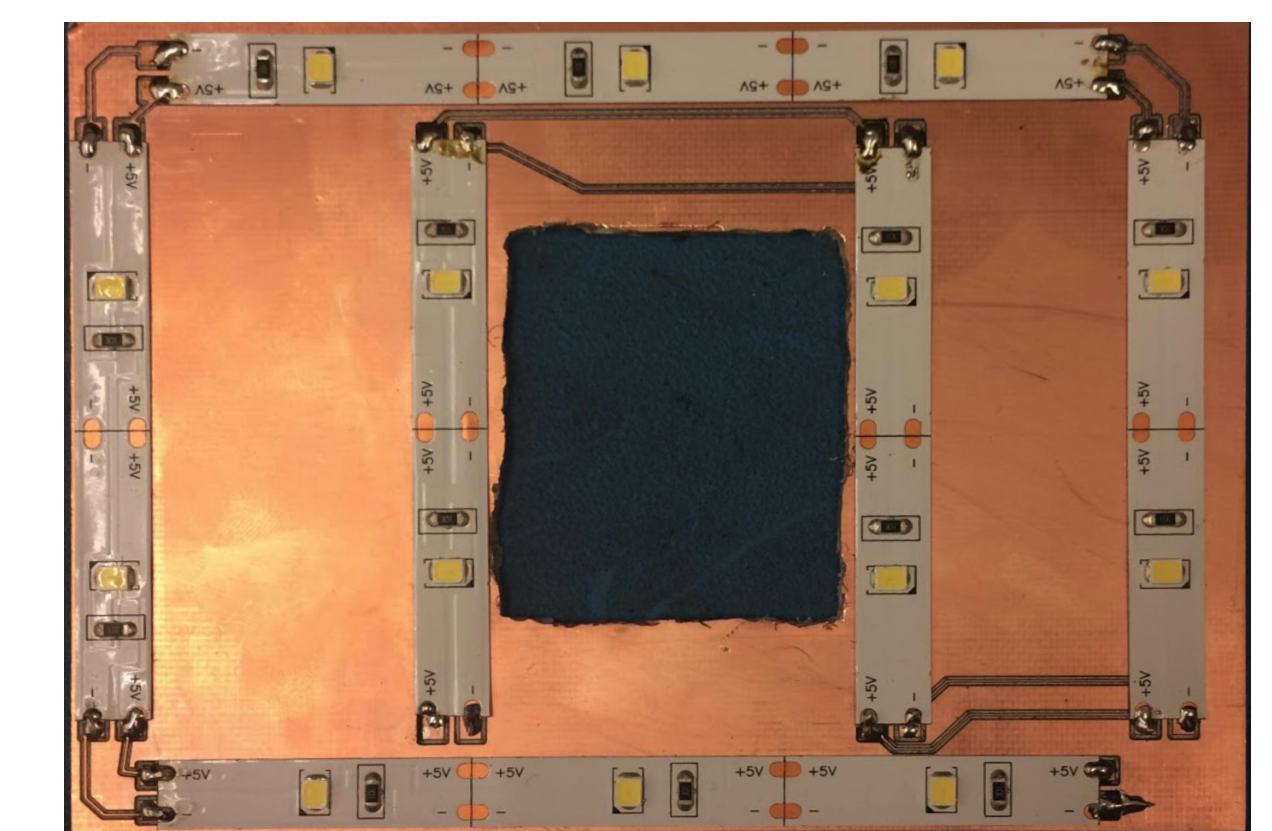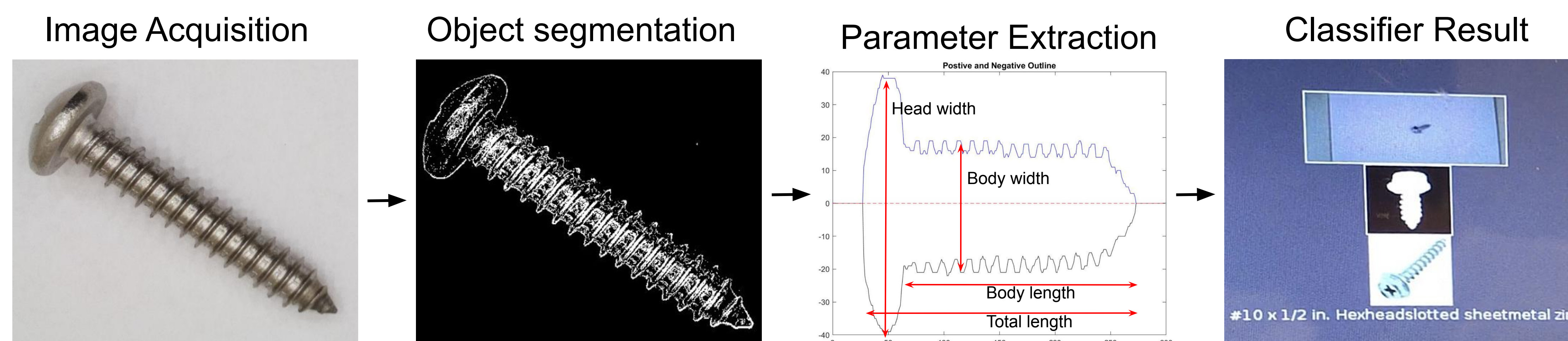
Trade-Offs

Height of picture vs pixels per inch (PPI)
- Increased height → Decreased PPI
- Decreased height → Limited maximum length of screw

PPI vs speed of algorithm
- Increased PPI → Decreased Speed
- Increased speed → Desired time less than 10 seconds.

LED ring vs LED PCB
- LED ring → Complicated, pre-made
- LED PCB → Easy, custom-made

Single LED vs LED PCB
- Single LED → Reduced brightness
- LED PCB → Increased brightness
- Single LED → Requires less power
- LED PCB → Requires more power
- Fabrication complexity increases with more LEDs

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