Auto Assembly Assistant

Cognitive Assistant for Model Car Assembly

Andrew Wong, Jiaxing Wu
Mentor: Junjue Wang
Advisors: Dan Siewiorek, Roberta L Klatzky

Introduction

In car assembly, manual assembly still plays a crucial role despite increasing automation.
With the **human in the loop** comes two challenges:

- Novices need to be trained for sophisticated tasks and closely supervised
- Even with experienced workers, human error is a major source of lost productivity in manufacturing

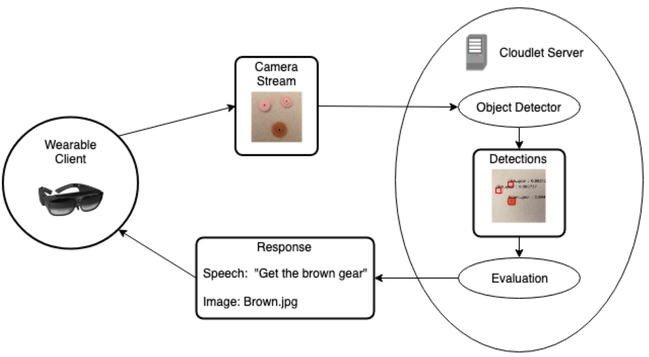
To explore solutions to these challenges, we present a cognitive assistant that:

- Guides a user through the steps of building a model car
- Prompts alerts and corrections when a mistake is made

System

Auto Assembly Assistant (AAA) uses the client-server model:

- Client: Smart device with a camera, for mobility and availability
- Server: Cloudlet machine, for performance



Workflow:

1. Client sends its camera stream to the cloudlet
2. Cloudlet detects objects of interest using ML-based computer vision
3. Cloudlet sends back an appropriate response based on detected objects
4. Client plays response to the user, in the form of audio-visual feedback

Conclusion

AAA is a model car assembly cognitive assistant that applies:

- **Context:** Pick up small parts using surrounding features
- **User Collaboration**: Recruits user to discern similar parts
- **Image Processing:** Employs traditional methods on top of ML methods to determine part orientation

Possible follow-on projects from these lessons learned:

- Exploring other assembly tasks to discover more general challenges and solutions to designing cognitive assistants
- Implementing a state-based approach where state changes are tracked instead of a strict steps-based script
- Applying other image processing techniques such as gradients, contours, and color filtering

virtual instruction manual that **catches mistakes** and helps you **fix** them

Problem: Similar Parts

Object detectors have difficulty distinguishing similar-looking parts especially at certain visual angles.

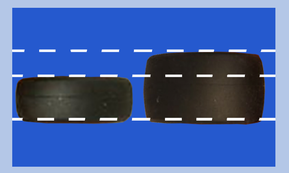
To distinguish two types of wheels:

- Direct the user to hold the wheels a certain way that highlights their distinguishing features

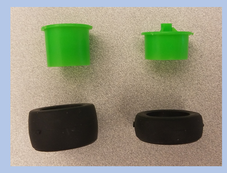
General Solution: User Collaboration

Use user collaboration to create ideal view and improve classification accuracy.

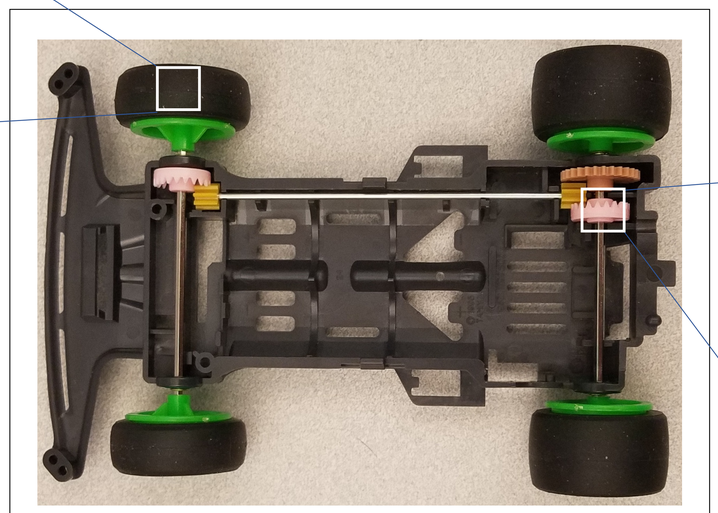
Different methods of User Collaboration:
Match: Show a picture of the desired visual angle
Legend: Put up a legend to line the part against
Configuration: Have users arrange parts



legend



configuration



Problem: Small Parts

Small objects aren't picked up due to down-sampling

To pick up small washers:

- Include the surrounding frame during training

General Solution: Context

Make use of surrounding visual features to "enlarge" small parts

Problem: Orientation

Our object detector does not give orientation, which is critical in assembly.

To detect the orientation of this gear:

- Split the detected image in half
- Calculate the average pixel value

General Solution: Combining Traditional Image Processing

Use ML-based object detection to crop interesting objects.
Apply image processing to extract information e.g. orientation.

Technical Report

Related Work: Other Cognitive Assistants

Lego Ribloc Ikea

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Human-Computer Interaction Institute