Optimization of Robotic Arm in Assistive Robotics

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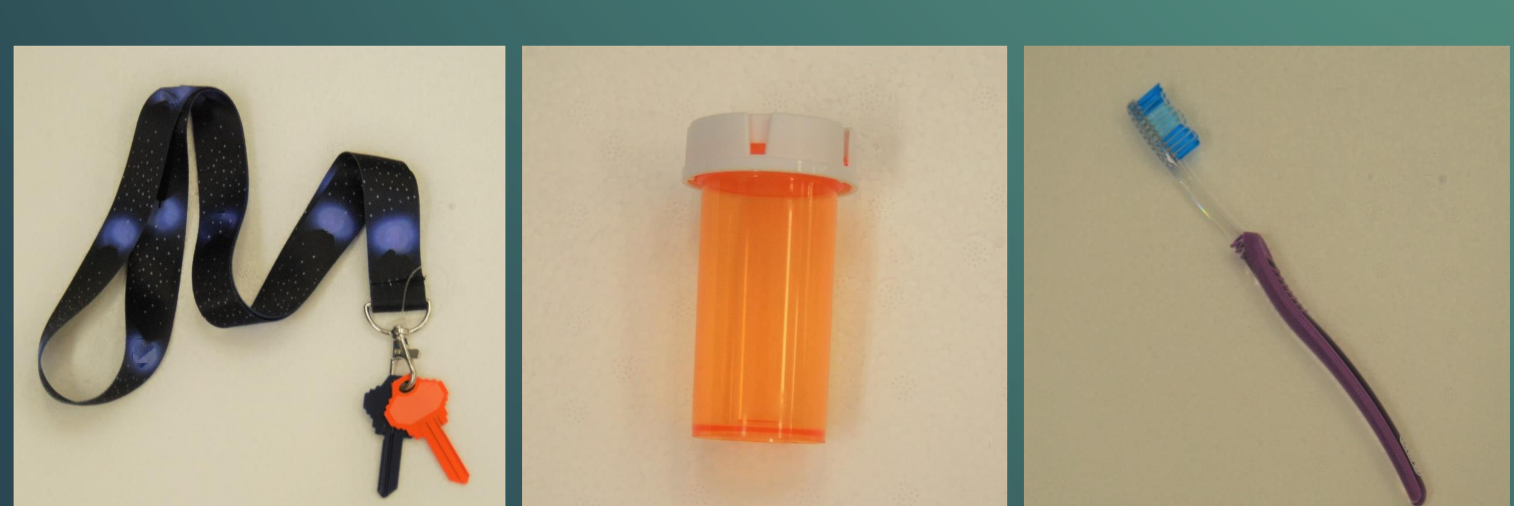
Introduction/Background

- Smart Homes are effective at activity recognition and health assessment.
- The next step for Smart Homes is physical intervention.
- Robotic Activity Support (RAS) is a robotic assistant that provides physical intervention in Smart Homes.
- RAS components rely on activity learning, object recognition and tracking, object manipulation, and user interaction to provide activity support.
- The goal of this research is to identify the performance and limits of the current robot platform for localization and object manipulation.

Methods

- A TurtleBot robot platform and PhantomX Pincher Arm were tested in a smart home laboratory environment.
- Robot movement was tested on surfaces including tile, carpet, and concrete.
- Robot movement was evaluated in terms of position and direction accuracy.
- Object manipulation was tested on objects including pill bottles, toothbrushes, hairbrushes, watches, remotes, keychains, phones, and silverware.
- Manipulation was evaluated in terms of ability to grasp the object and number of overload or overheating errors.



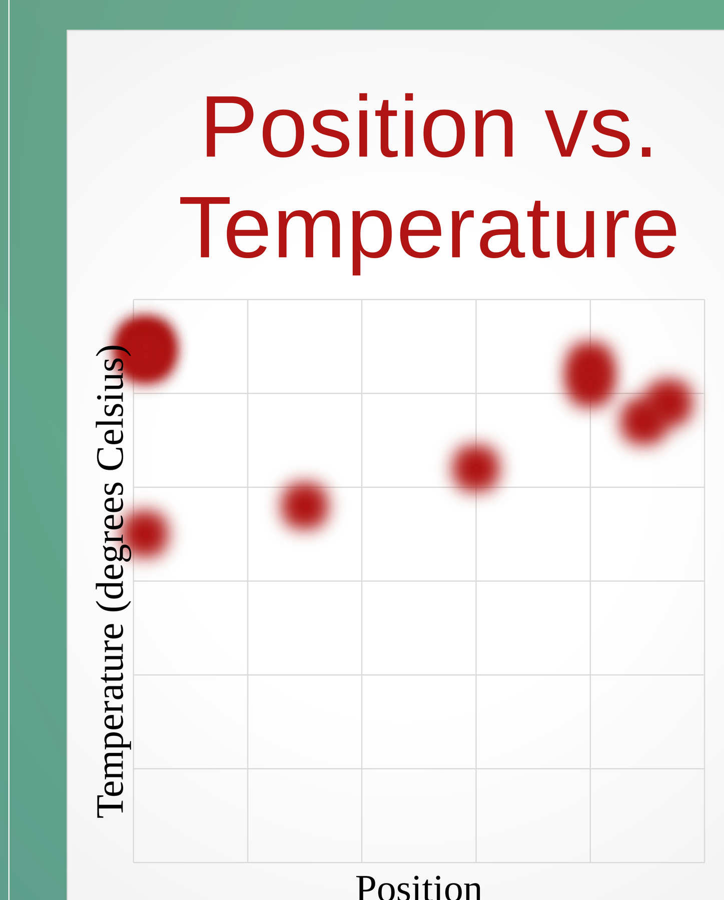
Objects that the arm can pick up. These are limited by width, weight, and orientation.

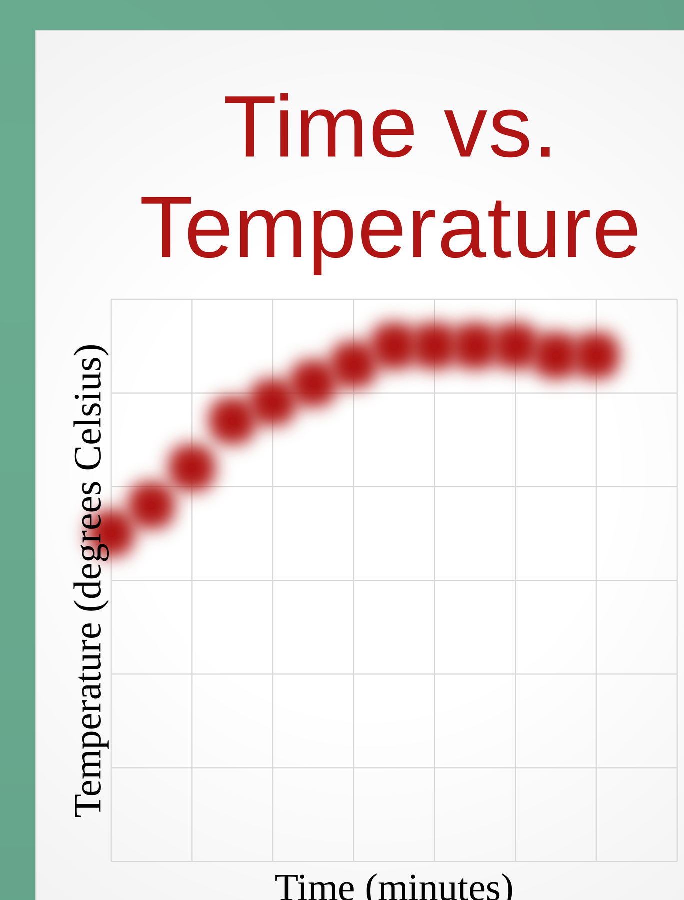
Results

Surface	Odometer Error
Carpet	1.3%
Tile	3.8%
Concrete	6.4%

The TurtleBot was moved one meter forward and the reported movement was recorded. Surfaces with less grip for the wheels resulted in greater inaccuracy.

- Inaccuracies in robot movement occur due to the wheels slipping.
- Errors occur most commonly on smooth surfaces like concrete.





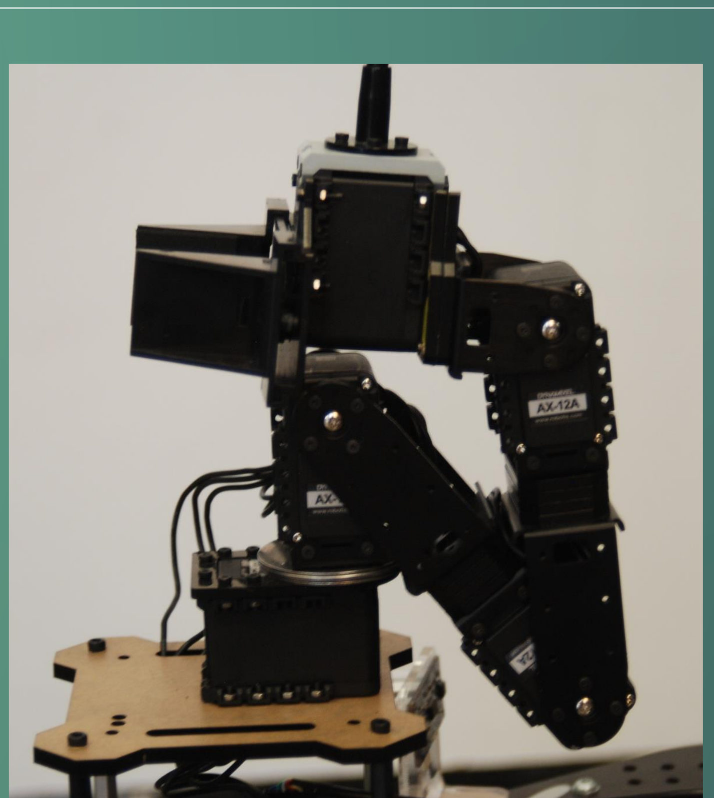
Graphs showing the relationships that temperature has with both position and time. Temperature was taken every minute while the robotic arm was active. The graphs show no relationship between position and temperature and a positive relationship between time and temperature.

- Robot arm locations and ranges were identified that result in overloads.
- No slippage was observed with objects that were grasped.
- Some objects could be held but not picked up (e.g., a mobile phone).
- A strong relationship was observed between time and temperature.
- No relationship was observed between position and temperature

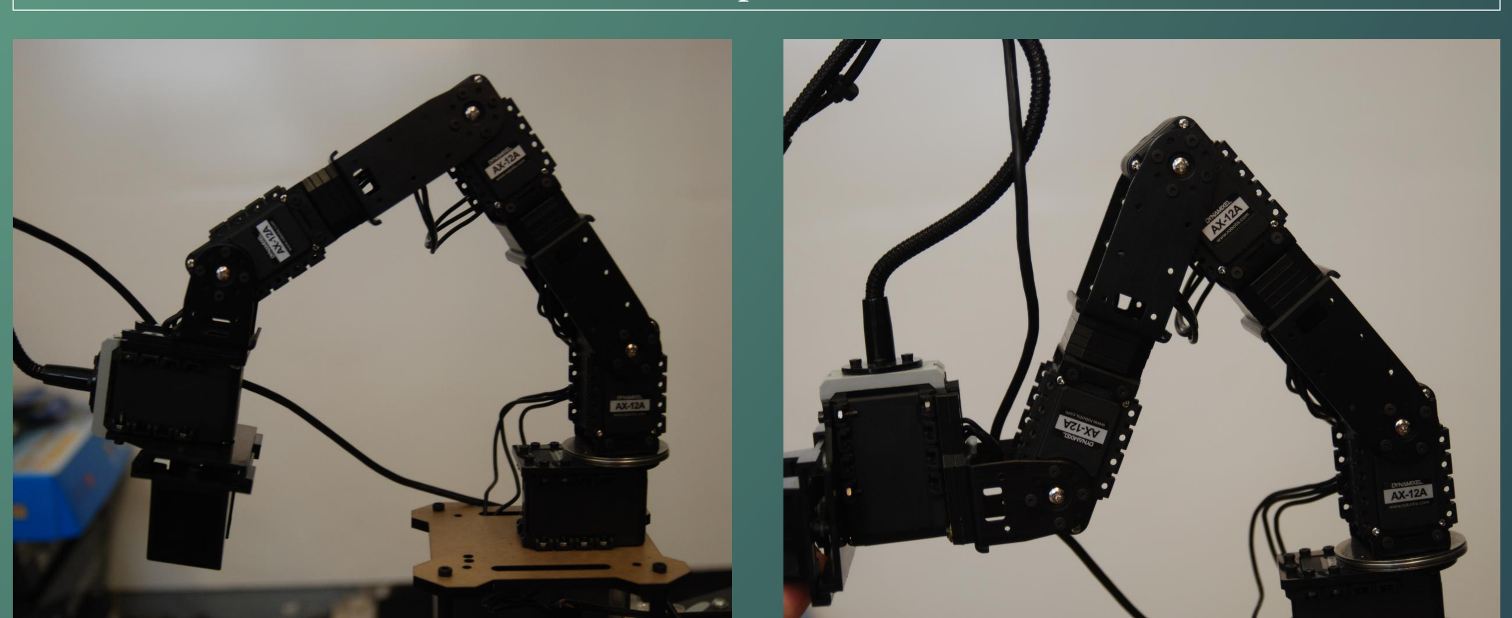
Conclusions

Experiments helped to identify the most effective use of the current robot platform and robot arm for the RAS system.

- The maximum speed of the servos should be set at 20% of the maximum speed to reduce stress on the servo motors and improve stability.
- Sensitive positions and ranges that frequently lead to overload should be avoided by using rest and active positions.
- The arm should be given time to recover between brief tasks.
- After an object is retrieved, the arm should return to the rest position while the platform is moving.
- Upgrading to a better arm will facilitate more degrees of freedom, a wider grip for more objects, and stronger servo motors that provide reliability and ability to lift heavier objects.



The PhantomX Pincher Arm in its rest position. This position makes for very little stress on the first and second servos. After retrieving an object, the arm can return to this position to rest.



The PhantomX Pincher Arm in two possible active positions. These positions allow the arm to retrieve objects from different angles without placing too much stress on the first and second servos.

Acknowledgements

This work was supported in part by National Institutes of Health grant R25AG046114.

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