

# Improving Interaction-Based Object Recognition using Multimodal Input

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## RESEARCH QUESTIONS

Does the simultaneous utilization of multiple sensory modalities improve the ability of a robot to classify objects using exploratory behaviors?

If so, to what extent?

## RELATED WORK

Previous research in object recognition has traditionally utilized only one modality. This research builds upon previous work by combining multiple modalities of input into one prediction.

- Interactive Learning of the Acoustic Properties of Household Objects (2009) - Jivko Sinapov, Mark Wiemer, and Alexander Stoytchev
- Early Integration of Vision and Manipulation (2003) - Giorgio Metta, Paul Fitzpatrick

## RESEARCH PLATFORM

Upper-torso humanoid robot with two Barrett arms and two Barrett hands and an expressive head.



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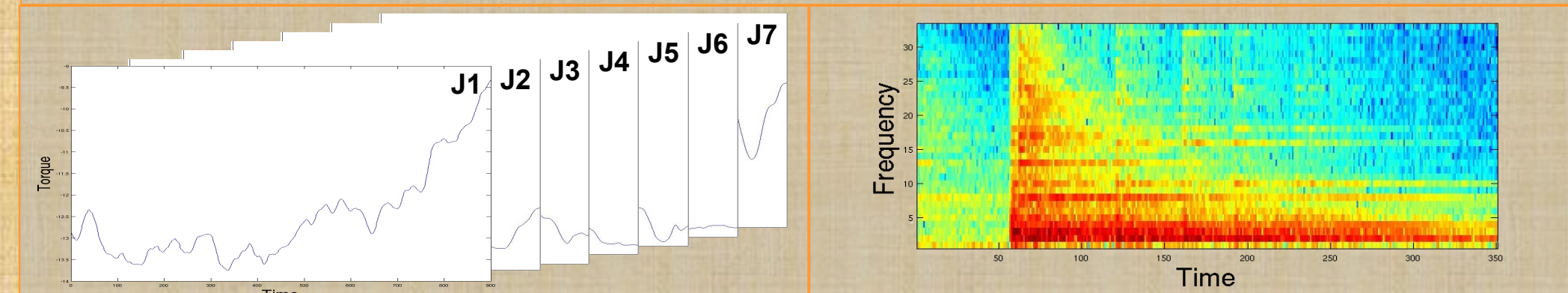
## INTERACTION

The robot interacted with 50 objects and gathered auditory data and proprioceptive data (joint positions and torques). The robot performed five exploratory behaviors ten times on each object. The robot performed a total of 2500 interactions.



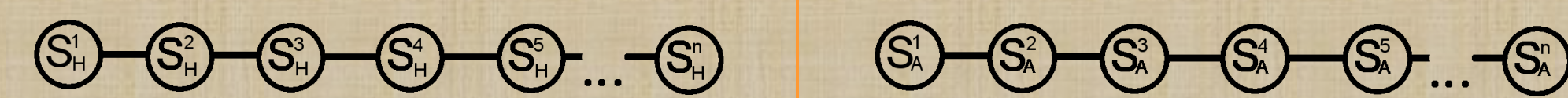
## PREPROCESSING

The audio data was preprocessed with a 33-frequency-bin fourier transform. The proprioceptive data was filtered and smoothed.



## SEQUENCE GENERATION

A self-organizing map was used to generate sequences of tokens for each data point.



## FEATURE EXTRACTION AND CLASSIFICATION

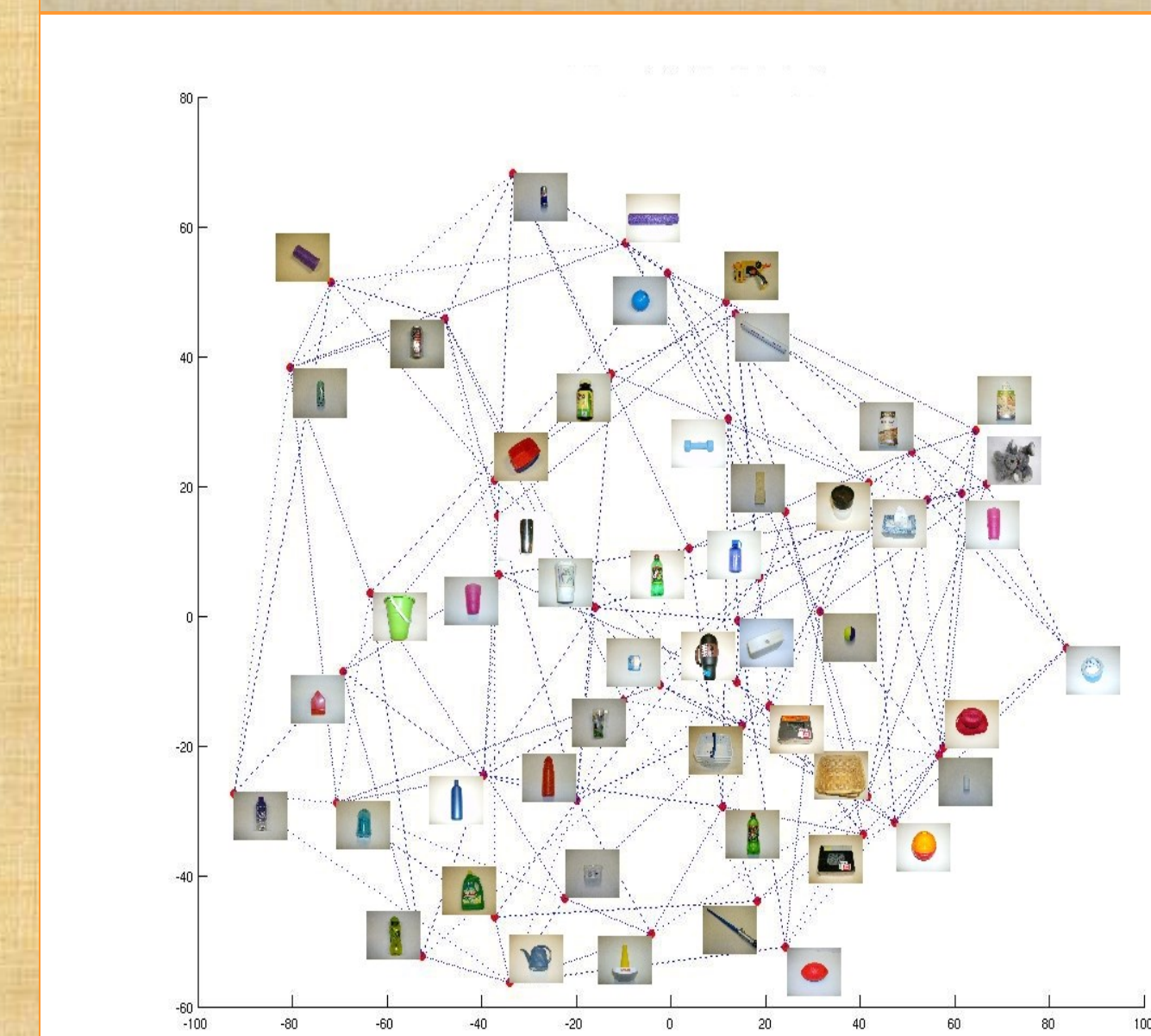
Finally, a global alignment algorithm was used to calculate the distance between each data point. This was used by a k-nearest-neighbors classification algorithm to predict the object class.



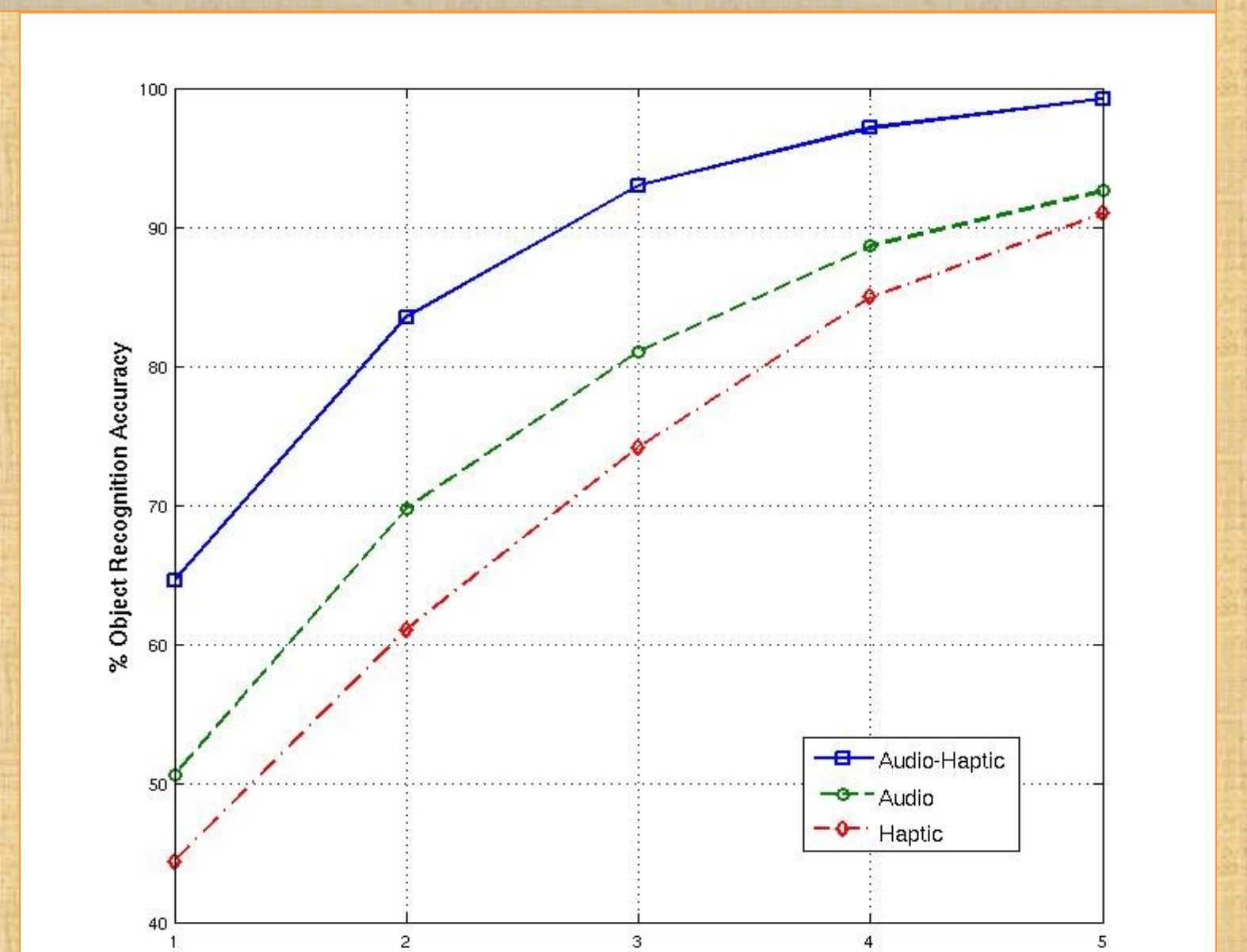
The 50 objects used in this study.



## EXPERIMENTAL RESULTS



A two-dimensional embedding of the discovered multimodal similarity between the objects, calculated using the Isomap algorithm.



Recognition rates improved as the number of modalities utilized and the number of exploratory behaviors used increased.

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