Gesture Recognition in a Therapeutic Robotic Dog

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Introduction

Therabot™ is a therapeutic assistive robotic dog that is intended to act as a support companion for people diagnosed with Post-Traumatic Stress and trauma-related disorders.   In order for it to provide optimal support, it is important to understand how the humans using it will interact with it. To accomplish this, a network of sensors has been implemented to record data to determine how the user touches and interacts with this robotic therapy dog. This sensing system provides valuable information that can be used to distinguish between different behaviors the patient may use when interacting with the robot, and can be used to determine an appropriate response to the gesture.
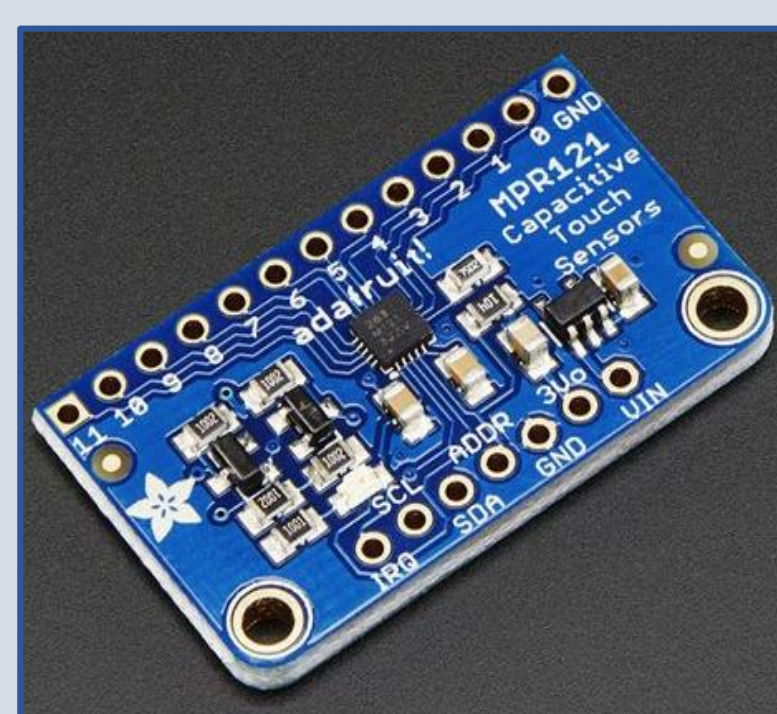
Sensor Design

Capacitive Touch Sensors
- Sense change in capacitance due to the presence of a charged element such as a human's hand
- Using Adafruit 12 Key Capacitive Touch Sensor Breakout MPR121

Sensors are extended with conductive thread sewn into Therabot's fur
- Allows for direct contact with the sensor
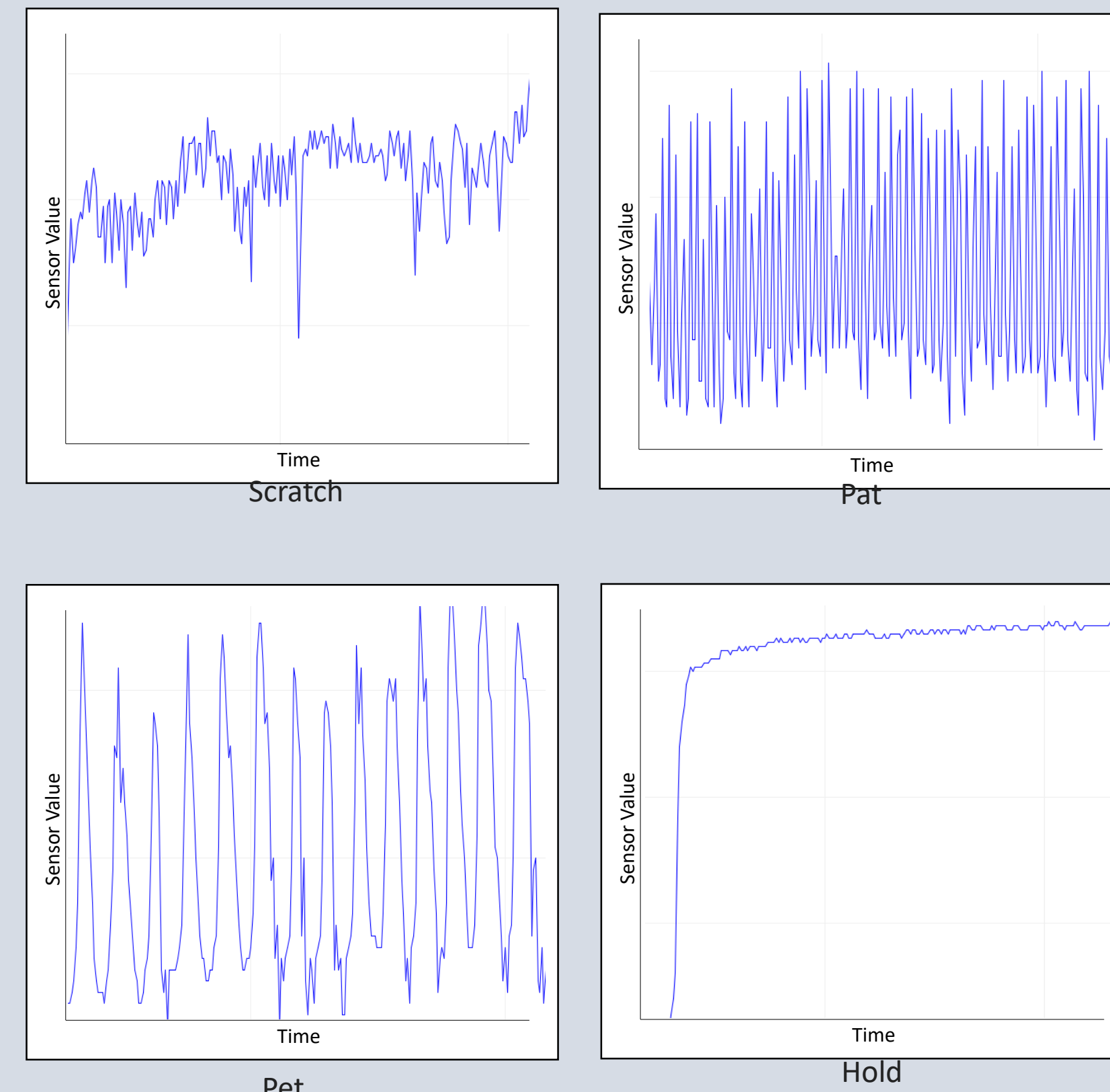- Reduces interference of the insulating fur

Capacitive Sensor

Conductive thread sewn into the underside of fur

Approach

Scratch

Pat

Pet

Hold

- 4 gestures were classified: scratch, pat, pet, and hold
- To classify, the following attributes were considered for each sensor over a 1.5 second period:
  - Maximum Value
  - Minimum Value
  - Average value
  - Number of peaks
- The following attributes were also considered about groups of sensors:
  - Direction of movement
  - Amount of movement
- The Waikato Environment for Knowledge Analysis (Weka) software was used to determine the best algorithm to classify the gestures

Algorithms Considered

Algorithm	Accuracy
Random Forests	**98.54%**
K-Nearest Neighbors	97.46%
Multilayer Perceptron	92.36%
LogitBoost	89.96%
Logistic Regression	87.00%
Naïve Bayes	86.40%

Results

Training Data

hold	pet	scratch	pat	none	
569	3	0	0	0	hold
2	**1047**	7	1	0	pet
0	15	**590**	6	0	scratch
0	3	8	**607**	0	pat
0	0	0	0	**222**	none

Random Forests Confusion Matrix from 10-Fold Cross-Validation

Real-Time Classification

hold	pet	scratch	pat	none	
473	20	4	0	0	hold
2	**745**	10	16	11	pet
0	124	**526**	31	1	scratch
0	78	3	**505**	2	pat
0	0	0	0	**400**	none

% Correctly Classified: 89.77%

Conclusion

A capacitive sensing system has been created to detect touch on fur fabric. This sensing system can be used to collect data on different tactile behaviors in order to enable recognition of these behaviors using machine learning strategies, with the random forests algorithm proving to be most accurate.

Acknowledgements

References

- A. Flagg, D. Tam, K. MacLean, and R. Flagg. Conductive fur sensing for a gesture-aware furry robot. In *IEEE Haptics Symposium*, 2012.
- Allen, Jeff et al. "Introducing the Cuddlebot: A Robot That Responds to Touch Gestures." In Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction Extended Abstracts, 295- 295: ACM, 2015.

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