BIOMIMETIC MILLISYSTEMS LAB

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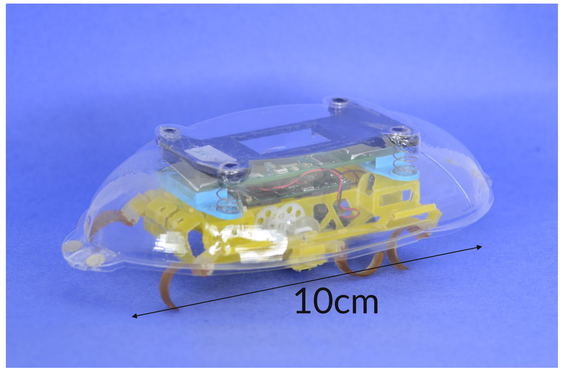
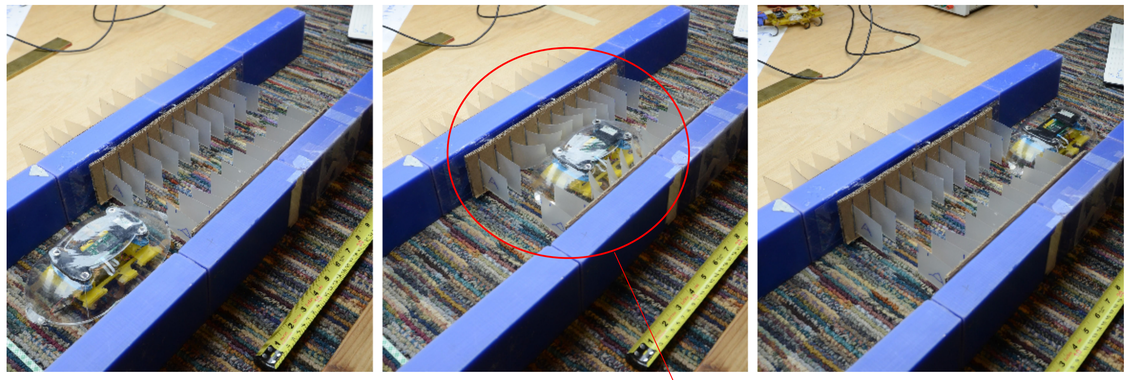
Terrain Classification with Force-Torque Sensor Equipped Millirobot

Tactile robot in natural environment.



Robot model with tactile shell.

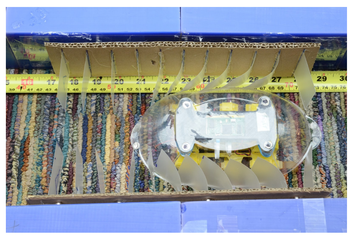


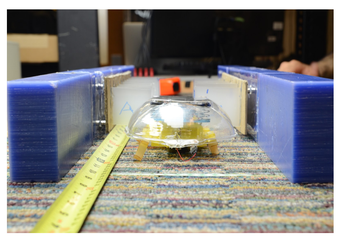
High resistance region

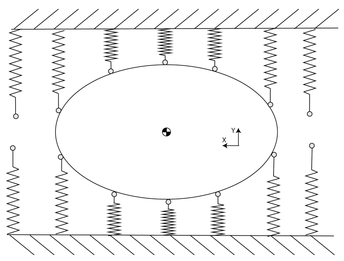
Objective

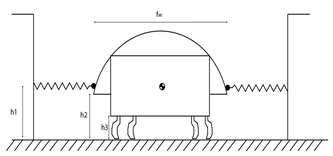
Goal:
Distinguish low and high resistance regions.

Why?
- Low vision environments, e.g. Dirt,
- Navigating through brush or dense compliant obstacles









Method

- Our experiment setup has 3 states: start (no touch), traversal (touch) and exit (no touch).
- Dataset consists of all the experiments from 4,6,8 and 10cm flap widths.
- After segmenting and applying windows we labeled the data as touch (1) or no touch (0).

- Training Set:

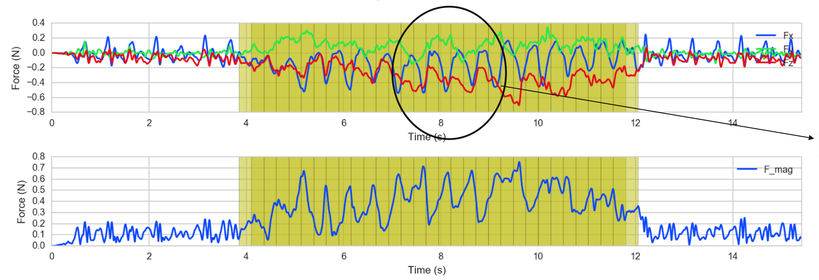
772 samples (1) + 853 samples (0).

- Test Set:

Single experiment with 4cm.

Results

- Input: shell forces, Fx, Fy,Fz, Gyro, Accelerometer, Leg Positions and Velocity.
- Trained random forests, gradient boosted trees, RBF SVM, and Neural Network
- All had a 10-fold CV average ROC score >.9



Classifier	10-fold CV avg ROC
Random Forests	97.4%
Gradient Boosted Trees	**97.6%**
RBF SVM	97.3%
Neural Network	92%

Gradient Trees Top Features	Random Forests Top Features
Fz_max	Fx_skew
Fx_skew	F_mag_energy
F_mag_max	F_mag_mean
Fz_mean	Mx_std
My_min	F_mag_max