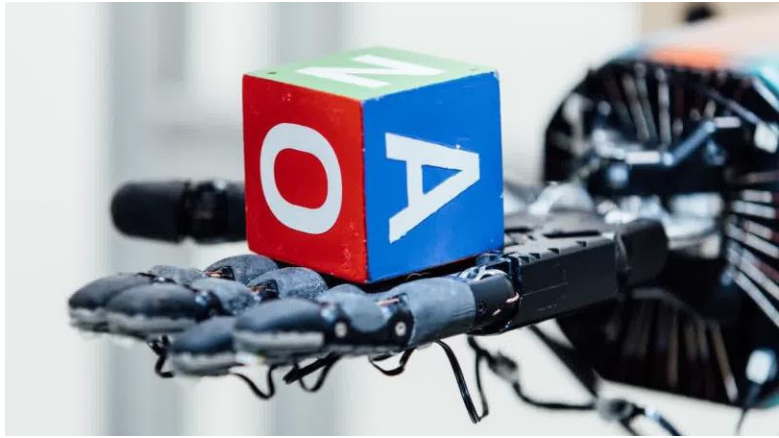


Towards Effective Tactile Identification of Textures using Hybrid Touch Approach

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Soh

Motivation



In Hand Manipulation

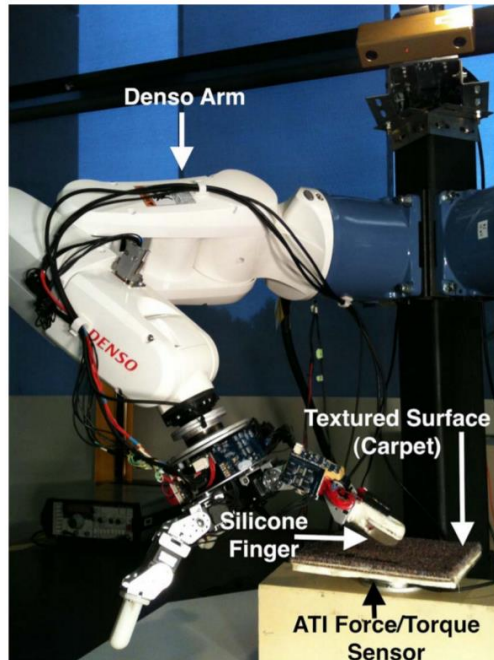


Object Grasping

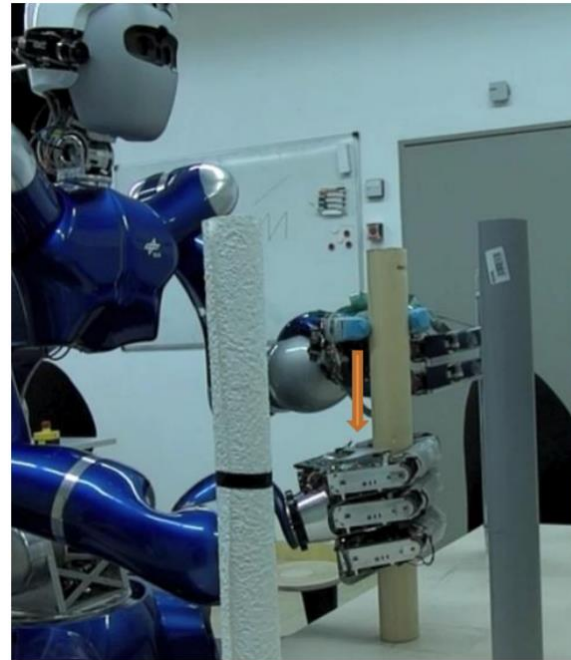
Texture classification is important

State-of-the-art Setup

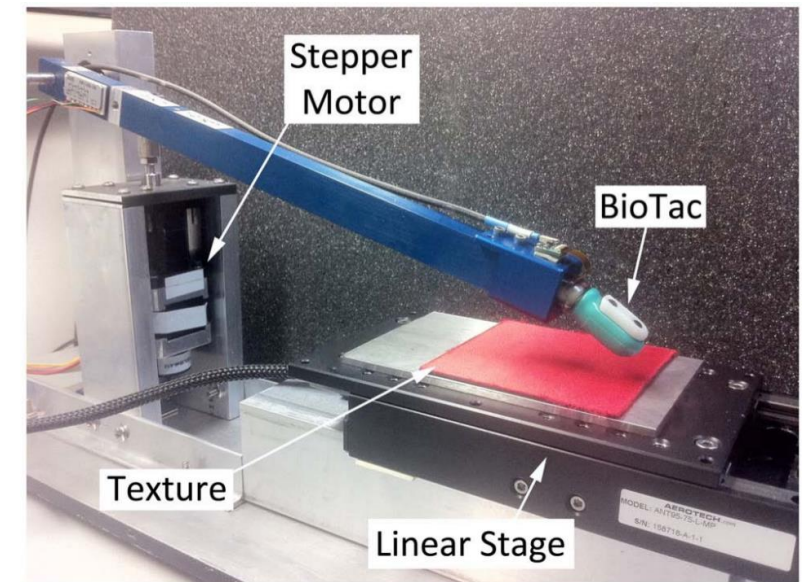
[1]



[2]



[3]



- Imposing constant force and velocity during motion
- Linear trajectory
- No tactile dataset available

[1] Jamali, Nawid, and Claude Sammut. "Majority voting: Material classification by tactile sensing using surface texture." *IEEE Transactions on Robotics* 27.3 (2011): 508-521.
[2] Baishya, Shiv S., and Berthold Bäuml. "Robust material classification with a tactile skin using deep learning." *2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2016.
[3] Fishel, Jeremy A., and Gerald E. Loeb. "Bayesian exploration for intelligent identification of textures." *Frontiers in neurorobotics* 6 (2012): 4.

Sliding features

- **Discrete Fourier transform** (DFT) for tactile signal $y^{(k)}(t)$ within range $[t_n, t_m]$:

$$Y_f^{(k)} = \frac{1}{\sqrt{N}} \sum_{t=t_m}^{t=t_n} e^{-\frac{j2\pi ft}{N}} y^{(k)}(t)$$

where N is signal length and $k \in [1, 23]$ are classes.

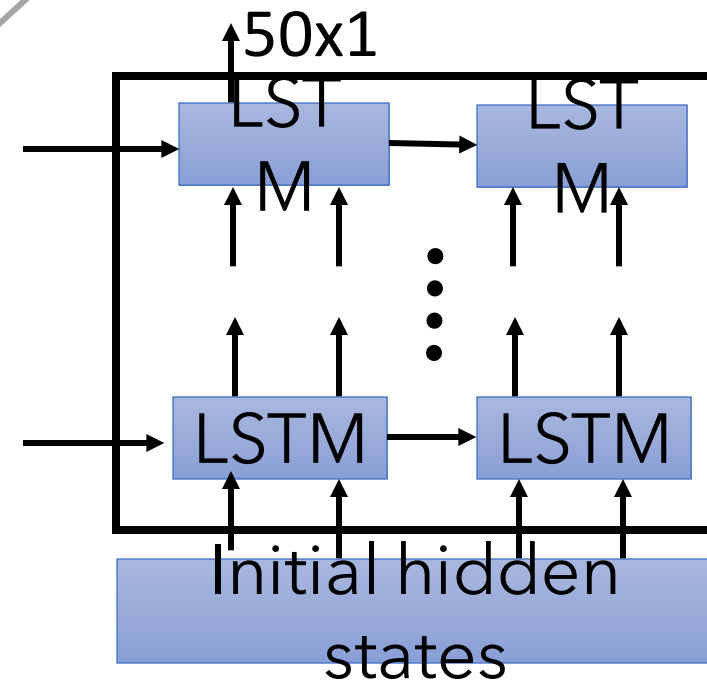
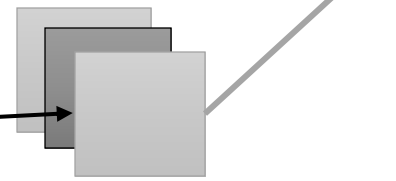
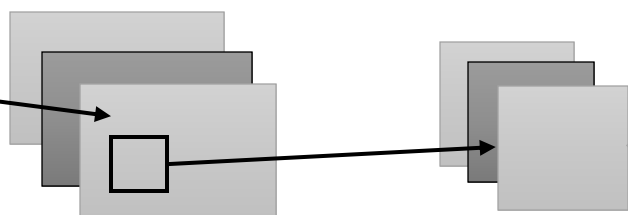
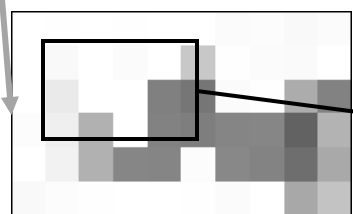
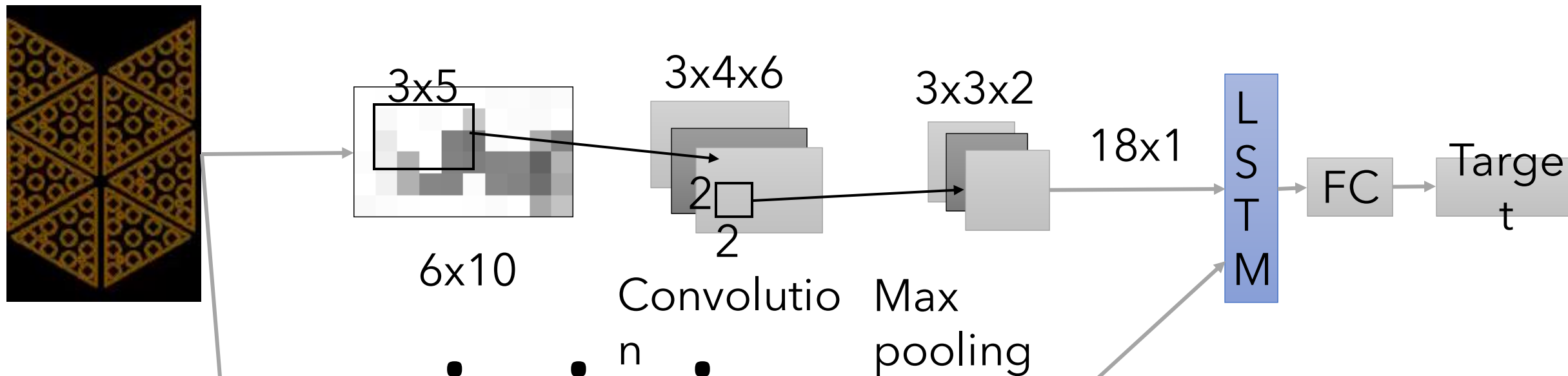
- **Roughness** is defined as the logarithm of sum of power in the interval of $[A, B]$

$$r^{(k)} = \log\left(\sum \left(\frac{1}{B-A}\right) \sum_{f=A}^B Y_f^{(k)}\right)$$

- **Fineness** is defined as the centroid of the spectrum in the interval (M taxels):

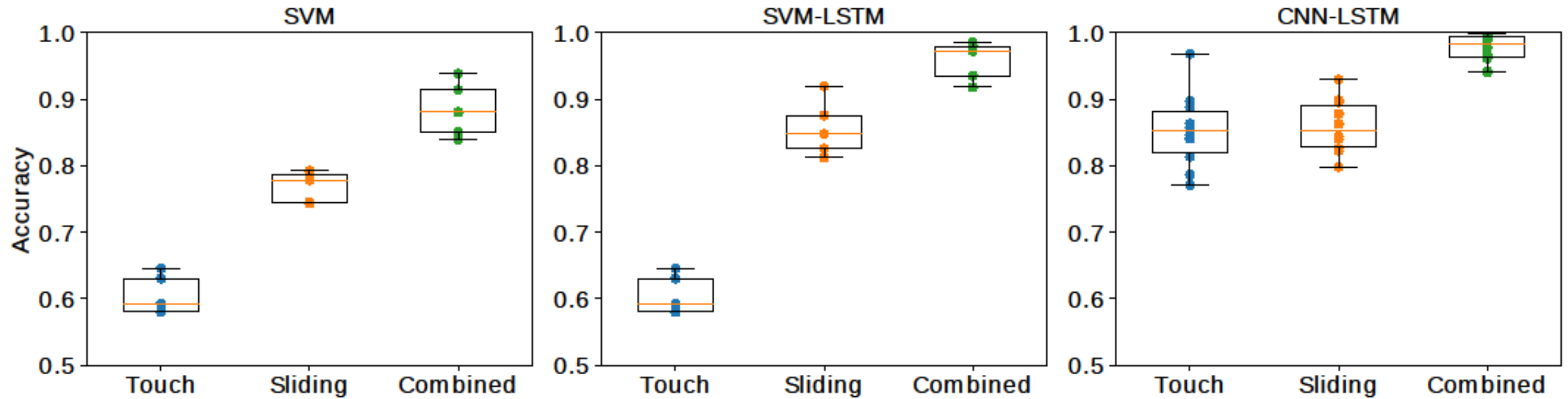
$$c^{(k)} = \frac{1}{M} \sum \sum_{f=A}^B Y_f^{(k)}$$

CNN-LSTM



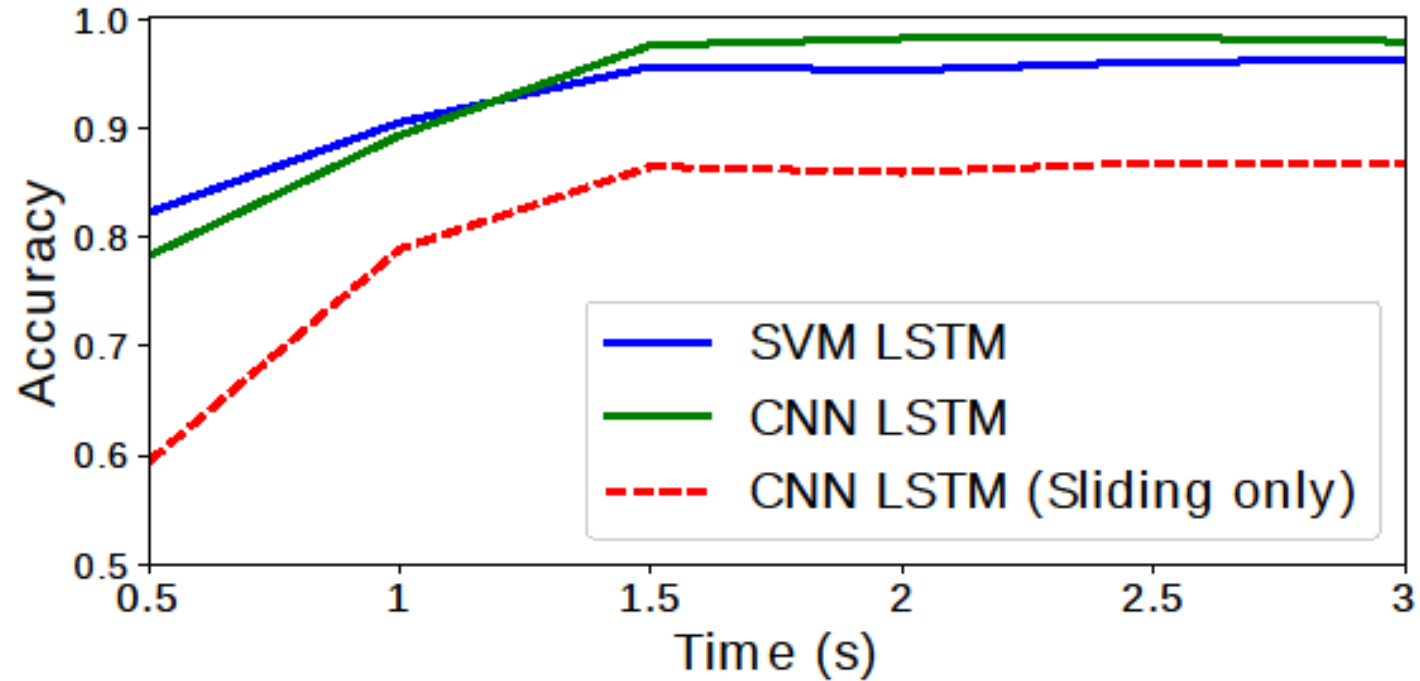
Number of layers	2
Hidden size	50
Dropout	0.8

Results



- CNN-LSTM performs best overall
- Touch gives distinguishing information about texture than sliding
- Combining Touch and Sliding gives the most accurate result

Results



Sliding about ~1.5 s is enough for texture recognition

Download

- Please download the dataset and let me know how it's been used 😊

