**Primary tasks important for Sewts**

* Straightening the towel
* Straightening the T-shirts or other garments
* Folding
* Sewing automation

**Velum pipeline**

* Towels in bin
* Picked by robot using just the camera depth data (one with the least depth)
* Placed on a seam creation system
* GNN for segmentation (foreground, background) > Control extraction > Different crops along the contour > Crops fed to ResNet (Classification into background, seam region and towel) > Grasp candidate generation
* <https://www.youtube.com/watch?v=JoqB3MjkqGI>
* [velum\_functional\_diagram.pdf (dropbox.com)](https://www.dropbox.com/s/o22cvo14oz559y1/velum_functional_diagram.pdf?dl=0)

**Patrick**

* Dataset would need to be generated for new types of towels or other textile data
* So, synthetic dataset needs to be generated by simulation
* But synthetic data does not work as well as real data
* Master’s Thesis topic :

1. Find out why the simulated data does not give better results
2. Prepare better simulated data

Resources :

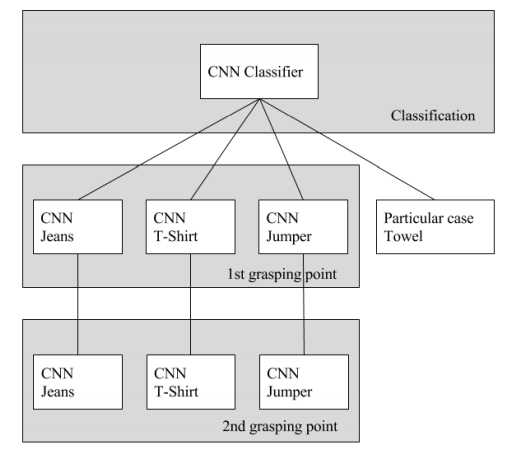
* <https://github.com/utkuozbulak/pytorch-cnn-visualizations>
* <https://arxiv.org/pdf/1909.03418.pdf>
* <https://arxiv.org/pdf/1704.03296.pdf>
* <https://arxiv.org/pdf/2002.11434.pdf>
* <https://github.com/utkuozbulak/pytorch-cnn-visualizations>
* <https://distill.pub/2018/building-blocks/>

**Marvin**

Get grasp poses directly from images using Yolo

**Master’s Thesis Topics**

1. Active garment recognition and target grasping point detection using deep learning



1. Model-free deep reinforcement learning approach for straightening the towels without demonstration

* Pick-and-place policy trained in simulation
* Transferred to real robot using domain randomization

[Learning to Manipulate Deformable Objects without Demonstrations (google.com)](https://sites.google.com/view/alternating-pick-and-place)

1. Model-free imitation learning approach with simulated demonstrations

* Approach is pulling fabric corners instead of using pick points
* Imitation Learning- Learn Reward function by demonstrations

[fabric (google.com)](https://sites.google.com/view/fabric-smoothing)

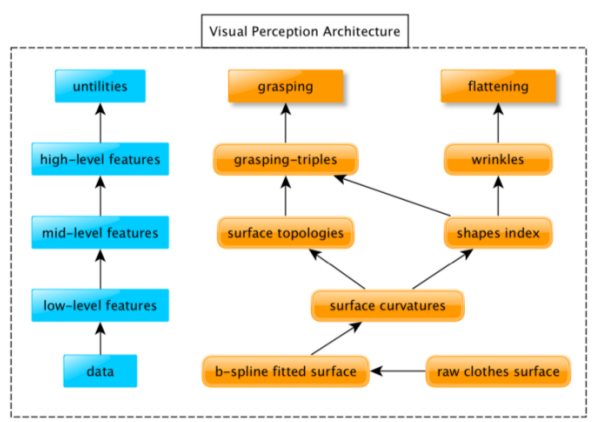
1. Model-based reinforcement learning approach- Planning over image states for folding

[VSF for Fabric Manipulation (google.com)](https://sites.google.com/view/fabric-vsf/home#h.lccba2juliii)

1. Model-based reinforcement learning approach- Planning over latent states for folding

[Learning Predictive Representations for Deformable Objects Using Contrastive Estimation (google.com)](https://sites.google.com/view/contrastive-predictive-model)

1. Visually guided manipulations (Conventional Computer Vision approach)



1. Inverse Reinforcement Learning

* Policy learnt through demonstrations
* Type of imitation learning

[A brief overview of Imitation Learning | by SmartLab AI | Medium](https://medium.com/@SmartLabAI/a-brief-overview-of-imitation-learning-8a8a75c44a9c)

1. 6 DOF Grasping Approach using Deep Learning
2. Grasp pose estimation using alternate Deep Learning pipelines
3. Autonomous folding of garments

[IEEE Xplore Full-Text PDF:](https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6095109)

1. Dynamic cloth manipulation using Deep Reinforcement Learning

* Controlling non-grasped points as well

[1910.14475.pdf (arxiv.org)](https://arxiv.org/pdf/1910.14475.pdf)

1. Robotic Sewing

[1803.08478.pdf (arxiv.org)](https://arxiv.org/pdf/1803.08478.pdf)

1. Velum with T-shirt or a different garment
2. Visual Grasp Point Localization, Classification and State Recognition

[gpl-classif-sr\_cloth\_manipulation.dvi (upc.edu)](https://upcommons.upc.edu/bitstream/handle/2117/113083/1901-Visual-grasp-point-localization,-classification-and-state-recognition-in-robotic-manipulation-of-cloth--An-overview.pdf)

1. Learning Dense Visual Correspondences in Simulation to Smooth and Fold Real Fabrics

[2003.12698.pdf (arxiv.org)](https://arxiv.org/pdf/2003.12698.pdf)

1. Multiple garment classification, segregation and straightening
2. Self-supervision
3. Depth sensing
4. Dense object descriptors
5. Realistic synthetic dataset generation
6. Wrapping clothes
7. Learning by demonstration
8. Evaluating Domain Randomization
9. Goal conditioned Fabric Manipulation
10. Imitation Learning for Motion primitives

References :

1. <https://www.researchgate.net/publication/320129416_Active_garment_recognition_and_target_grasping_point_detection_using_deep_learning>
2. <https://arxiv.org/pdf/1610.05824.pdf>
3. <https://bair.berkeley.edu/blog/2020/05/05/fabrics/>
4. <https://arxiv.org/pdf/2003.05436.pdf>
5. <https://arxiv.org/pdf/2003.09044.pdf>
6. <https://arxiv.org/abs/1910.04854>
7. <https://arxiv.org/abs/1910.13439>
8. <https://arxiv.org/pdf/1610.05824.pdf>
9. <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6095109>
10. <https://pdfs.semanticscholar.org/2583/0322d2d66df70502efa9f9607bf9ebd2f933.pdf>
11. <https://arxiv.org/pdf/1910.14475.pdf>
12. <https://arxiv.org/pdf/1803.08478.pdf>
13. <https://sastrarobotics.com/ultrasonic-sewing-robots-transform-clothing-industry/>
14. <https://upcommons.upc.edu/bitstream/handle/2117/113083/1901-Visual-grasp-point-localization,-classification-and-state-recognition-in-robotic-manipulation-of-cloth--An-overview.pdf>
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16. https://arxiv.org/pdf/2003.12698.pdf
17. [Home - Softwear Automation](https://softwearautomation.com/)
18. [ResearchGate](https://www.researchgate.net/publication/221785950_Intelligent_Robotic_Handling_of_Fabrics_Towards_Sewing/link/00b49515f02334e059000000/download)
19. [RI Seminar : Pieter Abbeel : Deep Learning for Robotics - YouTube](https://www.youtube.com/watch?v=WGza-jN4CZs)
20. [Deep Reinforcement Learning: Pong from Pixels (karpathy.github.io)](http://karpathy.github.io/2016/05/31/rl/)
21. [Reinforcement Learning Course | DeepMind & UCL - YouTube](https://www.youtube.com/playlist?list=PLqYmG7hTraZBKeNJ-JE_eyJHZ7XgBoAyb)
22. [MLSS Cadiz - YouTube](https://www.youtube.com/channel/UCBOEQxX6zdihFB3VxxJdgHg/playlists)
23. [Gym (openai.com)](https://gym.openai.com/docs/)
24. [Deep Reinforcement Learning for Robotic Arm Manipulation - YouTube](https://www.youtube.com/watch?v=ub4ZyegbTSw)
25. [Composable Deep Reinforcement Learning for Robotic Manipulation - YouTube](https://www.youtube.com/watch?v=0I5kl4dns_Q)
26. [Transporter Networks: Rearranging the Visual World for Robotic Manipulation - YouTube](https://www.youtube.com/watch?v=496UVuAdOP4)

**Prospective companies :**

**Ideas :**

1. Grasp garment on one end, follow the folding trajectory (Material properties should be considered in the trajectory design)
2. Human approach of folding a towel : Identify corner from an image-> random orientation of the towel (shaken or picked randomly)-> find corner from the image->found corner-> robot one picks it. Robot 2 identifies edge and slides along it Or robot 2 finds a corner picks it-> robot 2 moves towards robot 1-> hands over to robot 1-> moves back to the pocket and pulls it-> fold generated
3. Sewing operation using Reinforcement Learning
4. Manual sewing operation
5. Cutting of a fabric using robot manipulator
6. Ironing a shirt using robot manipulator using imitation learning
7. T shirt printing using robot
8. Representation Learning ([RepresentationLearning.pdf (tum.de)](https://www.in.tum.de/fileadmin/w00bws/i06/Thesis_Proposals/RepresentationLearning.pdf))
9. Hindsight Experience Replay
10. Learning with structured inductive bias and priors

**Possible Topics :**

* Imitation Learning
* Reinforcement Learning – Rewards as the exposed seams, goal configuration
* Reinforcement learning with priors (like humans) to speed up the learning

(<https://arxiv.org/pdf/2010.11944.pdf> )

([Comparing humans with the best Reinforcement Learning algorithms - YouTube](https://www.youtube.com/watch?v=Ol0-c9OE3VQ))

([Randomized Prior Functions for Deep Reinforcement Learning (nips.cc)](https://papers.nips.cc/paper/2018/file/5a7b238ba0f6502e5d6be14424b20ded-Paper.pdf))

([Overcoming sparse rewards in Deep RL: Curiosity, hindsight & auxiliary tasks. - YouTube](https://www.youtube.com/watch?v=0Ey02HT_1Ho))

([1709.06977.pdf (arxiv.org)](https://arxiv.org/pdf/1709.06977.pdf))

**Background Research :**

* Fabric Manipulation challenging due to difficulty in modelling system states and dynamics
* Deep model-free methods trained from exploration or from demonstrations work reasonably well for specific tasks like smoothing
* Deep model-based methods have more potential for generalization to a variety of tasks, provided that the learned models are sufficiently accurate.
* Plan – Trajectory that takes it from start point to goal point

Policy – Choosing a trajectory from a set of all possible states or initial conditions

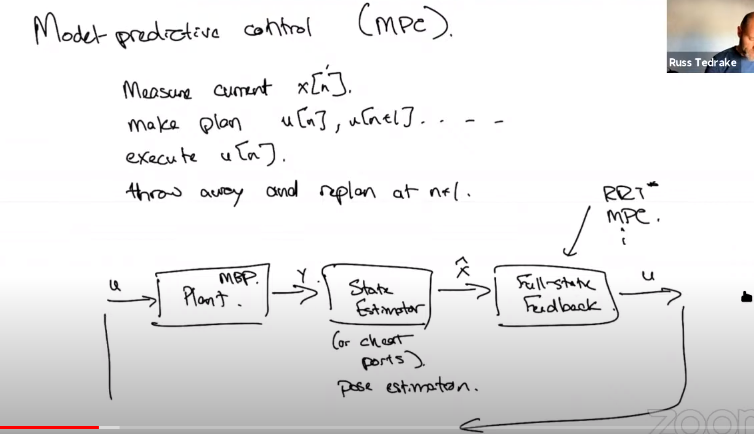
* MPC – Way to turn a planner to a feedback policy

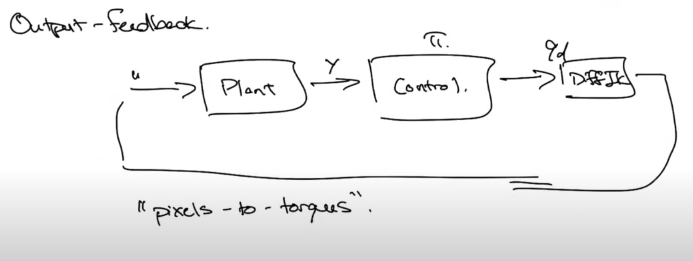
Measure current state x[n]

Plan for next states u[n], u[n+1], …

Execute u[n]

Throw away calculated plan and replan at n+1





Optimal Feedback control : u=pi(y)

Reinforcement Learning : Optimal Feedback Control , esp. in model-free (No plant model required)

Adaptive Control – Model Free control

**Resources :**

1. [Four Novel Approaches to Manipulating Fabric using Model-Free and Model-Based Deep Learning in Simulation – The Berkeley Artificial Intelligence Research Blog](https://bair.berkeley.edu/blog/2020/05/05/fabrics/)
2. [Lecture 17 | MIT 6.881 (Robotic Manipulation), Fall 2020 | Reinforcement Learning (Part 1) - YouTube](https://www.youtube.com/watch?v=kQfagO8mBiU)
3. [Lecture 18 | MIT 6.881 (Robotic Manipulation), Fall 2020 | Reinforcement Learning (Part 2) - YouTube](https://www.youtube.com/watch?v=J7yG3daCY9c)
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5. [GraspAdaptation\_viaDomainRandomization (.pdf (kit.edu)](https://alr.anthropomatik.kit.edu/downloads/ProjectProposals/GraspAdaptation_viaDomainRandomization%20(.pdf)
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10. [Robotics: Research (tu-berlin.de)](https://www.robotics.tu-berlin.de/menue/research/)

Sample Thesis

[MBRL\_Benchmarking\_\_MSc\_Thesis\_Proposal\_.pdf (kit.edu)](https://alr.anthropomatik.kit.edu/downloads/ProjectProposals/MBRL_Benchmarking__MSc_Thesis_Proposal_.pdf)

**Smoothing ideas**

* Hang fabric in the air and allow gravity to “vertically smooth” it
* Hang fabric in the air using one robot, mount a camera to capture vertical image and select the lower most point as the grasp point which can then be used to grasp from another robot

**Model-free visual reinforcement learning**

* **Reward function linked with the amount of seam**
* **Using simulated images to avoid sim-to-real transfer (Seam segmentation map)**

**Proposal**

**Plan**