CSC2515 Introduction to Machine Learning
Project Proposal

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Problem Definition

This project is an extension of the Neural Cloth Simulation (NCS) paper by Bertiche et al. Although their proposed model could simulate a wide variety of cloth dynamics with a high degree of realism, a limitation of the model stated by the authors is that it can only be trained for one body model or garment type. The computational cost of animating clothing can be greatly reduced if one model can be trained to simulate multiple garments. In this project, we propose a modified model that can generalise across clothing types by taking an augmented cloth point-cloud as input.

Literature Review

Traditional cloth simulation methods use physics-based simulations, but recent advancements favour neural networks for efficiency. Bertiche et al. propose the NCS framework that learns cloth dynamics by disentangling static and dynamic deformations, which can be seen as an effective encoding in a lower-dimensional space.

Model-Agnostic Meta-Learning (MAML) offers a way to handle varied tasks by training models to quickly adapt with minimal data. This approach aligns well with cloth simulation, where flexible representations are needed across different garment types (Finn et al). Meanwhile, Hsu et al extended meta-learning to unsupervised settings, acquiring useful representations from unlabeled data. This can benefit cloth simulation by adapting to different garment features like size or flexibility.

Goal

The goal of this project is a new model that can predict deformations for more than one type of garment. Our approach to designing this model will begin with the modification of the existing Neural Cloth Simulation (NCS) model architecture. NCS models are trained by garment type, so garment deformations are predicted from body motions without information about garment type as input. Our new model will need to recognize different garment types in the input so that the output will have the correct dimensions. Furthermore, a generalised representation for the garments will need to be created such that the different garment types can be compared. A practical solution for representing different garment sizes is zero-padding, where smaller items are padded to match the feature vector size of larger garments. This ensures a uniform size of all the clothing representations. The garment representation will be concatenated to the body motion representation and used to train the new model. The performance of the new model will be evaluated qualitatively through renderings of the cloth dynamics as was done in the original NCS paper. If the model is found to be able to generalise to two garment types with acceptable quality, the limits of generalizability will be explored. The training costs for the new models will be compared to the training costs of individual models trained for each garment type.

References

[1] Bertiche, H., Madadi, M., & Escalera, S. (2022). Neural cloth simulation. *ACM Transactions on Graphics (TOG)*, *41*(6), 1-14.

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[3] Hsu, K., Levine, S., & Finn, C. (2018). Unsupervised learning via meta-learning. *arXiv preprint arXiv:1810.02334*.