Learning a Centroidal Motion Planner for Legged Locomotion

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I. Background

Reduced models have a long history in controlling robots. Especially for controlling quadrupeds simplified models like approximating the whole body by the base have been used lately. However, to execute more complex motions on legged systems like bipeds, it is necessary to take the whole body dynamics into account. While there has been progress in developing and speeding up whole body motions optimizers [1], these optimizers are still too slow to optimize motions in real time. In this abstract, we outline a way to speedup an existing motion optimizer using machine learning techniques.

II. Method

To speedup the whole body motion optimization, we train a neural network to predict the centroidal motion of the robot. For this, we optimize first gaits using a classical whole body motion optimizer for static walks and jumps. Given the current state and past history of the robot as well as desired contact sequences in the future, we regress the neural network policy to these outputs. We use an inverse kinematics solver on the predicted centroidal quantities to predict the motion of the robot and use the computed whole body states as input to the network. The computed motions are then tracked using a whole body controller.

III. Results & Discussion

In our experiments on the real Solo12 robot platform, we show [2] that the robot is able to execute the motions generated by the centroidal neural network. The tracking performance is similar to the one when using the classical whole body optimizer. Using the centroidal neural network, our method predicts up to 41 times faster than the classical optimizer. In particular, this allows to run the computation in real time.

IV. Conclusion

In this work we show that using a neural network it is possible to speedup a classical whole body motion optimization problem. We demonstrate the results using two different motions on a real robot platform. In the future we plan to apply our method to more complex humanoid platforms.

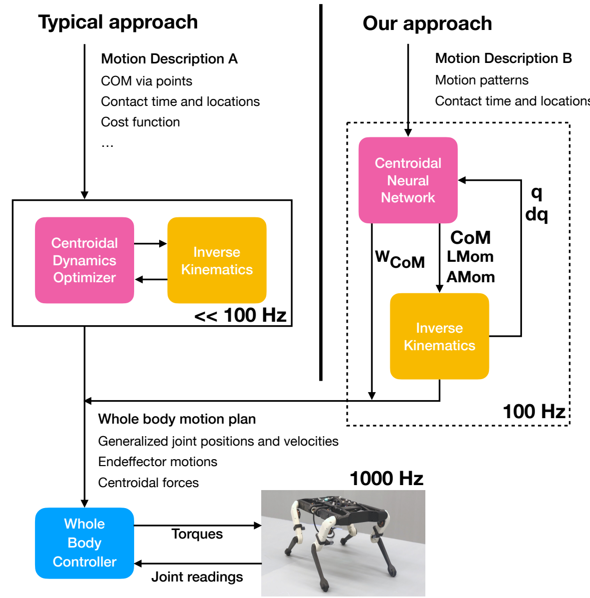

Fig. 1: A motion description gets mapped to a whole body motion plan. In typical approaches (left side) this happens using a whole body motion optimizer (e.g. [1]). Our approach (right side): a centroidal neural network predicts the next desired centroidal quantities which are mapped to whole-body motions through inverse kinematics. The centroidal neural network gets feedback from robot state (positions and velocities). This method easily runs at 100 Hz.

V. Acknowledgements

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References

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