Development of a neuro-inspired control system for quadrupeds to emulate sensorimotor processes in animals

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Objectives and scope

Animals are highly adept at locomotion and navigation under challenging terrains, capable of responding to a sudden stimulus with extraordinary agility and dexterity. Such behaviour is highly desirable for legged robots and results from the evolution of neural pathways for adaptive locomotion and embodied decision making. This project proposes a novel neural network architecture and its deployment on a quadruped to study how a sensorimotor processing model and quadruped behaviour evolves with experience.

Motivation

The project proposes a novel neural network architecture and optimization of the same using Reinforcement Learning to emulate the evolution of sensorimotor processing with experience. The neural network combines Central Pattern Generator theory with Deep Neural Networks to emulate different aspects of hierarchical multi-loop sensorimotor processing with a one-to-one mapping between the proposed architecture modules and the nervous system's involved processing centres.

Methods followed

The development of the novel architecture involves incremental training of a DDPG as modules for desired behaviour are added through the following iterative process:

- Formulation of Reward/Loss for desired behaviour
- Reinforcement Learning of Deep Deterministic Policy Gradient for learning with experience
- Addition of new modules for more sophisticated behaviour
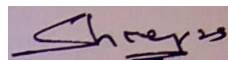
Deliverable

The following deliverables were proposed at the start of the project:

1. A Quadruped Platform for the deployment of developed neural network
2. A Simulation Model of the Quadruped Platform for RL
3. A DDPG for learning with experience
4. A Neural Network Model for Sensorimotor Processing

Progress made so far

Of the four deliverables proposed, work on the quadruped platform, simulation model using ROS and DDPG using TensorFlow is complete. Incremental development of neural network architecture is in progress, with the architecture at the current development stage capable of emulating gait in a straight line at different speeds.

Signature of the student: *Shreyas*   Date: March 10, 2021

Progress made by the student is: ~~very good~~/good/~~satisfactory/poor/very poor~~.

Regularity of the student in contacting the adviser: ~~very good~~/good/~~satisfactory/poor/very poor~~.

Signature of the adviser(s): V.S.C.   Date: 17/Mar/2021