EE/CprE/SE 492 GROUP PROGRESS REPORT

Group number:
sdmay22-45
Project title: ***Machine Learning in an Embedded Systems Application***
Client: ***Dr.Rover***
Advisor: ***Dr.Rover***
Team Members: ***Tyler Ingebrand, Amy Wieland, Yi Ting Liew, Chris Hazelton, Sean McFadden, Nathan Bruck***

- **Project Summary:** *(Short summary about the project. What are the design goals? Has the direction or scope of the project changed? This should be about a paragraph in length.)*

In this project, we are seeing how machine learning can be incorporated into current or future courses at Iowa State. In doing this, we are using reinforcement learning to teach a robot dog how to walk. The robot will be trained in a virtual environment. This will then be deployed on our robot to walk in the physical world. Our goals are to demonstrate machine learning in an embedded application and to make recommendations on incorporating an embedded machine learning course for the department.

- **Accomplishments** *(Please describe/summarize as to what was done, by whom, when and, collectively as a group since the last report. This should be about a paragraph or two in length. Bulleted points are acceptable as well. Please keep only your technical details related to your project. Figures, schematics, flow diagrams, pseudocode, and project related results are acceptable, but please ensure that they are legible (clear enough to read) and to provide an explanation. If researching a topic, please add a few details about what was learned and how it is relevant to the project. If two or more people worked on a single task, be sure to distinguish how each member contributed to the task. Specific details relating to the assistance provided to other members may be included here.****)***

Amy: Since the start of the semester, I have been working on setting up the interfaces needed on the agent and embedded side of our project as well as the main application loop. The agent is responsible for retrieving the state of the embedded side and determining the action to be passed back to the embedded side. The embedded side will do the provided action and then provide its state back to the agent. By making the embedded and agent interfaces, we will easily be able to swap out different implementations of them without having to change the main application loop. This week, I began constructing a stretching agent implementation of the agent interface. The stretching agent will enable us to test that the robot can move through a range of motions (kind of like stretching), showing that all the motors are working properly.

Chris: I have been working with the embedded interface trying to set up a mock embedded side so that we can run values through them. I have also glimpsed over the articles that Dr. Rover sent in slack about security and I plan to look more in depth into those.

Tyler: I have been working on the Python virtual training with Sean. We found a good example of DDPG and TD3 that uses PyTorch instead of Tensorflow, so we switched to that. We also found a URDF model of the Petoi Bittle that we are adapting to our robots. We will have to modify it to reflect our changes. We originally intended to use MuJoCo as the simulator, but we also found that PyBullet works better for URDF models so we switched to that. We have the robot loading into an OpenAI gym type environment, and we were able to train a basic model to run on the robot, though the environment still needs some work.

Sean: I have been working with incorporating our URDF file of the robot into our virtual training environment with Tyler. I have modified the robot's starting position to a standing orientation. Each joint on the robot starts the simulation with a small amount of randomness to avoid overturning our model for one position.

Nathan: I have been working on the embedded side of the project, specifically, the hardware connections between the robot and the Raspberry Pi. Since the two pieces are now connected I am preparing to establish communication so we can push and pull values from the robot. To prepare for this step, I have searched out specific libraries for this, such as WiringPi, which is a pin based GPIO library for the Raspberry Pi.

Yi Ting: I have been working on creating a logger in C++. There should be around two methods required which is a constructor and a class that writes to the file. I wasn't very familiar with logging based on C++ and thus, I went through the understanding of logging under Java programming so that it gives me some idea of how it should be done. On the other hand, what I have done so far is printing a timestamp followed by generating the log files based on the logging levels.

Nayra: Started significant work but will be working on the servo testing on the embedded side of the project. This will involve wiring and testing the servos to ensure they are correctly calibrated so that they can work well with the Pi.

- **Pending issues** *(If applicable: Were there any unexpected complications? Please elaborate.)*

Python training: We need to add some finishing details to the environment to make it more accurate. For example, the initial state needs to be slightly randomized, we need the state to perfectly match the robots output, and we need a better reward function to shape it to the functionality we want better.

Loading Python Model into C++: We need to find the correct way to load our Python model, where we have done the virtual training, into our C++ project to then run on the robot.

- **Advisor Input/Signature:**

  Please select one of the options below and sign.

  ___x____ I am pleased with the progress the team is making.

  _____ The team's progress could use some minor improvements which I will discuss with them.

  _____ The team's progress has some major concerns that I will discuss directly with Dr. Bigelow

  bigelow@iastate.edu , 515-294-4177

  Signature: Diane T. Rover

- **Client Input/Signature:**

  Please select one of the options below and sign.

  ___x____ I am pleased with the progress the team is making.

  _____ The team's progress could use some minor improvements which I will discuss with them.

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