Electric Sheep Humanoid Kid-Size League 2020

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Abstract. In this paper we provide information displaying the suitability of the team *Electric Sheep* to qualify in RoboCup 2020 by highlighting the lessons learned, the improvements made thus far, our expected competition abilities and the current state of the team. 2019 was our first year of competition where we brought three robots all designed from scratch by our team. Although we experienced many issues before and during the competition, we survived the first (drop in) round and fulfilled our duties for the competition, whilst collecting invaluable data, validating various operational systems and learning from well established teams.

1 Major Problems & Lessons Learned

Timing was a major factor of the team's performance in the 2019 World Cup, with funding secured late, parts ordering was delayed and testing pushed to the competition itself. We now push to secure funding earlier and take advantage of our maturing platform.

Testing was pushed back due to finding, which in turn meant that our testing of the new platform was compromised. We have made and continue to make an effort to continuously test the platform, some of which is documented on our social media.

Power hindered us during the 2019 competition, where the humanoid platform put large stress on electronic parts and many components were damaged. We have been actively developing our own power solution to control voltage, current, monitoring and motor control board capabilities. This will largely simplify the platform's internal electronics.

2 Improvements

Since the competition we have published our CNN-based **vision** system *xYOLO*, a small XNOR hybrid network capable of 10 FPS (frames per second) on a Raspberry Pi 3 [1].

Another large improvement has been the switch towards using fully smart-motor driven **hardware** based on the Feetech smart motors, particularly the SM30 and SM40BL, where the legs, arms, head and chassis have all been iterated upon. This allowed us to remove power hardware, reduce heating and reduce the weight. These changes also required rethinking 3D printed horn mounts which are now largely strengthened. Some of these changes were inspired by our move to Fusion 360, where were able to simulate stresses on parts.

The move to smart motors has significantly changed the **motor control** software, where we now have two motor controllers (upper body and lower body). Switching from 12 smart motors with no feedback to 20 motors with high detail feedback has required us to more efficiently control the motors to utilize the available 1Mbit/s RS485 bandwidth. With the introduction of a **debug** interface we were able to rapidly develop the software, which includes the ability to configure the entire system live, with configuration changes surviving power loss.

3 Status of Implementation

In the current state of the platform we are able to demonstrate basic robot behaviour, including listening to the game controller, team communication, detection of the ball and goals, getting up and walking. We actively work on walk stabilisation and begin to investigate kicking and searching for the ball.

4 Expected Outcome

We have several active projects that are likely to yield results before competition:

- **Power PCB** – This is an effort to reduce internal platform complexity, increase safety and space ergonomics.
- **Compute board upgrade** – We have purchased Nvidia Jetson Nano development boards as an upgrade to the Raspberry Pi 3B and currently work towards porting our software platform.
- **Camera upgrade** – We have purchased Logitech C920 USB web cameras as an upgrade to our unbranded cameras and are configuring them for use on our platform.
- **Object detection** – We intend to detect balls, goals, lines and robots to allow for higher level play.
- **Material Science** – As part of our ongoing design of the platform, we look to increasing strength whilst decreasing cost and weight with 3D printed models.
- **Localization** – We are adding the ability to detect landmarks, as well as using other tracking inputs such as odometry and optical flow.
- **Cooperative team play** – With increased information about the state of the world, we will be able to share information with team players and inform game-play behavioural decisions.

We also continue our research into humanoid walking and custom motors.

References

1. Barry, D., Shah, M., Keijsers, M., Khan, H., Hopman, B.: xYOLO: A Model For Real-Time Object Detection In Humanoid Soccer On Low-End Hardware. In: IVCNZ. IEEE (2019)