The NUbots Team Extended Abstract 2024

Joe Bailey, Clayton Carlon, Stephan Chalup, Liam Craft, Joel Ferguson, Angelique Herfel, Dexter Konijn, Sam McFarlane, Alexandre Mendes, Johanne Montano, Thomas O'Brien, Corah Oliver, Jesse Perrin, Mikyla Peters, Ysobel Sims, Cottrell Tamessar, and Jesse Williamson

Newcastle Robotics Laboratory
The University of Newcastle, Callaghan 2308, Australia
Contact: nubots@newcastle.edu.au

Lessons Learned: For the RoboCup 2023 competition, the team updated all systems, with some systems overhauled completely. The team used a new behaviour, localisation and odometry system, walk and kick engine, and integrated a new subcontroller. A new Visual Mesh network was use and major improvements were made to the debugging system, NUsight. With all of these changes, the team faced issues with not having enough time to test and tune the new system, particularly with robots still being built and upgraded days before leaving for the competition. Despite these issues, the team was able to score a goal and win a game for the first time with the current platform. For RoboCup 2024, the team will allow for enough time for tuning and testing to ensure a smooth system, and will not plan any hardware upgrades close to the competition.

Major Problems: In the 2023 drop-in games, the team had issues with their robots running into other robots consistently. This resulted in a poor performance. Hardware issues around servos overheating and seizing were major problems. Furthermore, the kick engine lacked stability and was turned off for the competition. Localisation experienced issues at times with the position flipping to the other side of the field and inaccuracy when the robot fell over.

Robot Avoidance and Team Behaviour: One of the major problems at RoboCup 2023 was the lack of coordination of the robots. During drop-in games, they ran into other robots. In normal games, they lacked the ability to dynamically change their strategy for the number of robots on the field. Robot-to-robot communication has been developed since the competition and will be used to improve self and object localisation. It will also be used to dynamically determine the strategy of the robot - whether offensive or defensive. Currently, the Visual Mesh [2] accurately segments robots as robots, however the team needs to use this information to determine the location of robots in the world. This information will then be integrated into the path planning module to avoid walking into robots. Some issues within the vision system have hindered this development, with bug fixes in the field convex hull calculation recently being completed.

Hardware: In the 2023 competition, the NUgus robots subcontroller was upgraded to the OpenCR. Despite its successful integration, we encountered significant challenges, including issues with connectivity, frequent breakages, and complex cabling. To address these problems, we are developing a more efficient and reliable alternative: the NUSense subcontroller. This new subcontroller is designed to provide ultra-fast polling, exploiting multiple buses for high-frequency communications and redundancy. The electronics and PCB design is completed and most of the Dynamixel firmware to communicate with the servos has been developed. All that is left is the USB communication.

The NUgus platform, based on the iGus platform [1], encountered challenges with components breaking upon impact from falls. This year, we are focusing on implementing protective measures, such as the addition of bumpers, to mitigate damage from such incidents.

Odometry and Localisation: The team's ability to localise was greatly enhanced last year with the overhaul of the localisation and odometry systems. However, the robot sometimes failed to localise to the right side of the field on startup or lost its position as it makes its way towards the opposing goal. Some updates to the particle filter weighting method have been made to fix these problems. Additionally, major update to include field line features in addition to raw field lines points is being investigated.

Stability and Kinematics: In recent competitions, the NUgus robots demonstrated significant advancements in walking capabilities. However, the current walk engine is an open-loop system, which inherently limits its robustness. This limitation becomes evident in the face of disturbances or manufacturing inconsistencies and gear backlash. To address these challenges, our team is integrating feedback control mechanisms into the walk engine. This addition aims to enhance the robot's balance and stability by actively responding to dynamic conditions and unforeseen disturbances. The feedback control system will use real-time sensory data to adjust the robot's movements, ensuring a more stable and adaptable walking pattern. A PID controller for torso position and orientation regulation has been implemented and has shown promising results in preliminary tests, significantly improving the robot's balance.

Another significant upgrade in our approach involves the kinematics system itself. We have transitioned to using a more accurate model by employing a URDF (Unified Robot Description Format) file. This file is generated directly from a CAD model using the onshape-to-robot API [3]. Furthermore, we are exploring the development of an optimisation pipeline for kinematics calibration, aiming to reduce the impact of manufacturing variances and improve repeatability across platforms.

References

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