Journal

Contents

Monday 29-01-2024 (project week 0)

Kristoffer

- At Beumer
- Started project
- Had meeting with Jonas discussing what to start with the first 2 weeks
- Read these papers:
  - A visual introduction to Gaussian Belief Propagation [1]
  - Distributing Collaborative Multi-Robot Planning With Gaussian Belief Propagation [2]
- Tried compiling examples from https://github.com/aalpatya/gbpplanner but faced issues with missing X11 headers, even though they were installed on my system.

Jens
At Beumer

- Starting with a meeting all three (Kristoffer, Jens, Jonas)
- Read papers:
  - A visual introduction to Gaussian Belief Propagation [1]
  - Distributing Collaborative Multi-Robot Planning With Gaussian Belief Propagation [2]
- Successful compilation and run of examples from https://github.com/aalpatya/gbpplanner.
  - Successfully created custom environment to attempt to highlight weaknesses of the current implementation.

Tuesday 30-01-2024 (project week 1)

Kristoffer

- Worked from home.

- Created GitHub repository https://github.com/AU-Master-Thesis/gbp-rs as we want to rewrite the https://github.com/aalpatya/gbpplanner in Rust.
- Looked at different Rust simulation/visualization tools to use.
  - https://macroquad.rs/
  - https://nannou.cc/
  - https://bevyengine.org/
- Decided to go with **bevy** as it has a lot of community support/solutions and we thought its ECS system is really cool!.
- We read through the introduction book for bevy, to learn the core concepts behind the ECS paradigm and how applications are structured in bevy.

Jens
From home
- Set up Rust project structure
- Looked at the visualisation tools with Kristoffer, discussing which to go with.
- Learned Bevy and ran some examples
  - Wrote some of the examples out and mix-matched some of it to learn how it all fit together.

Wednesday 31-01-2024 (project week 1)

Kristoffer
- At OrbitLab
- Continued to have issues compiling the code for https://github.com/aalpatya/gbpplanner.
- We both decided to re-flash our OS with NixOS.
- Spent some getting acquainted with the terminology and methodology of how to do things in NixOS
- Create a `flake.nix` for both our Rust port and `gbpplanner` to create a reproducible environment, where we can compile and run the code without issue.

Jens
At OrbitLab
- Re-flash OS to NixOS
  - Learn NixOS and contemplated using hyprland
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Thursday 01-02-2024 (project week 1)

Kristoffer
- At OrbitLab
- Continued learning about NixOS and setting up our development environment, with the tools we like to use.

- Spent some time trying to port the code from https://colab.research.google.com/drive/1-nrE95X4UC9FBLR0-cTnsIP_XhA_PZKW?usp=sharing#scrollTo=NzotHENoaY6g to our Rust implementation.

Jens
At OrbitLab
- Setting up NixOS and hyprland
- Migrating gbpplanner to Rust

Friday 02-02-2024 (project week 1)

Kristoffer
- Worked from home.
- Continued our attempt to port the code from https://colab.research.google.com/drive/1-nrE95X4UC9FBLR0-cTnsIP_XhA_PZKW?usp=sharing#scrollTo=NzotHENoaY6g to our Rust codebase.
  - Jens wrote the code, while we both discussed how to port the Python code to Rust.

Jens
From home
- Rust migration

Monday 05-02-2024 (project week 1)

Kristoffer
- At Beumer
- Read recent survey paper from 2023 [3].
  - No mention of any paper/approach using Gaussian Belief Propagation.
  - Many newer paper use AI methodologies.
    - Neural Network based
    - Genetic Algorithms
      - Ant Colony
      - artificial bee colony algorithm
  - Lin–Kernighan–Helsgaun heuristic algorithm (dunno, names sounds interesting)
  - Dynamic Particle Swarm Optimization (PSO) [ref: 126,128]

Jens
At Beumer
- Struggling to set up hyprland with displaylink
- Ended the struggle, and joined Kristoffer in continueing the Rust migration.

Tuesday 06-02-2024 (project week 2)

Jens
From home
- Collaborative coding to migrate to Rust
  - Fixed a lot of compiler errors

Wednesday 07-02-2024 (project week 2)

Jens
At 5124-139
- Attempted to continue for a while with the generic factor-graph gbp library we have been attempting to make, however, it had become too much of a headache so:
  - Started over, in a much simpler fashion
  - Supported with chatGPT
  - Supported as sparring partner, and made sure to understand things more precisely
  - Also added journal entries for all my previous weeks

Thursday 08-02-2024 (project week 2)

Kristoffer
At 5124-139
- Continued working on the rewrite of gbpplanner in rust.
- Spent some time playning around with the C++ Eigen library, to confirm how variaous matrix operations and matrix slicing work, to correctly port them to rust.
- Reread parts of the methodology section, to better understand some of the math.

Jens
At 5124-139
- Working with Kristoffer to continue translation to Rust.
- Decided to split the work load.
  - I looked at Bevy, and learned further how to work it.
  - Implemented an input-manager, such that the user can press keys on the keyboard or gamepad to interact with the simulation.
  - Applied some keybinds like movement, boost to change movement speed, and toggling of a dynamic unknown object in the simulation.
    - The toggling is currently only done by setting alpha to 0/1, which should later also disable/enable the actor's hitbox.

Friday 09-02-2024 (project week 2)

Jens
At home
- Decomposed input and objects in the Bevy ECS architecture.
- Watches episodes 1, 2, and 3 of the Bevy tutorial series.

- Decomposed the system even further to have movement handled by itself.
  - This introduced a bug where movement of objects don't stop.
- Reworked the project with a 3D scene and 3D camera.
- Created and asset loader, to handle the loading of the 3D models.
- Changed the moveable object to be a 3D model.

Kristoffer
From home
- Found a similar paper to the [2] called Robot Web [4], that had

some interesting demo videos on their website.
- My intention is to read it over the weekend or next week, to see how it differs from [2].
- Continued working on the port to Rust.
  - Abstracted the robot radius into a trait `BoundingBox`, where i am right now creating a impl for a `BoundingBox2d`
  - Created an abstraction for the `CommunicationMedia`
  - Tried using Julia to verify some of the math, but had issues getting the `Distributions` package to compile on `NixOS`
- Still need to figure out how Messages are exchanged between robots, in a way that it is decoupled from running the simulation in a single thread with the same address space to a multiprocess system.

16 weeks 4 days left to hand-in deadline 😣

Bibliography

[1] J. Ortiz, T. Evans, and A. J. Davison, "A visual introduction to Gaussian Belief Propagation", *arXiv preprint arXiv:2107.02308*, 2021.

[2] A. Patwardhan, R. Murai, and A. J. Davison, "Distributing Collaborative Multi-Robot Planning With Gaussian Belief Propagation", *IEEE Robotics and Automation Letters*, vol. 8, no. 2, pp. 552–559, 2023, doi: 10.1109/LRA.2022.3227858.

[3] N. Abujabal, R. Fareh, S. Sinan, M. Baziyad, and M. Bettayeb, "A comprehensive review of the latest path planning developments for multi-robot formation systems", *Robotica*, vol. 41, pp. 1–26, 2023, doi: 10.1017/S0263574723000322.

[4] R. Murai, J. Ortiz, S. Saeedi, P. H. Kelly, and A. J. Davison, "A robot web for distributed many-device localisation", *IEEE Transactions on Robotics*, 2023.