Technical University of Denmark

Electro Technology

Bachelor project - Project plan

Integration of Odometry with Tracking Camera for Mobile Robot Localization

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Project Description

When navigating cars and ships we use GPS for the positioning, but when it comes to indoor navigation, a GPS signal is no longer sufficient. Because the signal must pass through large concrete and iron elements the signal becomes weak and thereby the position becomes inaccuracy. For that reason it is necessary to use a combination of different sensor technologies when you want to navigate a robots inside a house or in areas with weak GPS coverage. This project will look at the implementation of an internal coordinate system on an autonomous wheel-robot. To track the robot's position, the "Intel Realsense Tracking Camera T265" is used. However, some preliminary work has shown that the calculated position is not entirely correct.

The purpose of this project will be to improve the positioning data of the Intel Real Sense Tracking Camera T265 by adding wheel odometry to the already existing camera API. Afterward the camera will be mounted on a robot, which in the long term must be able to navigate only by using the improved position data.

Previous Work

In a previous project, the Intel Real Sense Tracking camera "T265" was tested, from which it could be deduced that the positioning was not accurate in some cases. It was a big problem to make accurate measurements when the camera was moved over large distances. Problems also occurred when T265 was tested in corridors or other places where there were several objects that were similar to each other. These measurements can be made more accurate by combining them with wheel odometry.

Expected Difficulties

During the research work, it is seen that there is no adequate documentation or explanatory comments for Intel's tracking camera T-265. Therefore, there will be some complications in seeing through the camera's already existing API system. Furthermore, the camera is prepared to use Python, where DTU's SMR robot's code is based on C. This means that if it is desired to continue to hold these platforms, then it will be necessary to share information between the two platforms. Furthermore the two programs runs at two different frequencies.

Project Objectives and Success Criteria

The overall goal is, as mentioned above, to improve the already existing output from the API of "T265" so that the positioning becomes precise enough to navigate a running robot (wheel driven) around at longer distances with some different movements. Furthermore a huge success criteria will be if it is possible to navigate around in places with repeating structures such as corridors, large storage etc.

The objectives and success criteria are to

- Learn to control the robot by using the SMR's mrc. This way, it is later possible to perform the necessary tests.

- Extract wheel odometry data from the robot
- Calculate the required variables such as velocity from the extracted data.
- Add the odometry data to the API of the tracking camera
- Test the application by executing some specified test cases
- Follow the project plan
- Create a report with all necessary specifications and documentation

Used Hardware Devices

- Intel Realsense Tracking Camera T265

The T265 camera is a small and light camera which contains two fish-eyes lenses which operate at a wide angle of 163 degrees (± 5 degrees), and an IMU consisting of a gyroscope and an accelerometer. The used sample rates are respectively 30 Hz for the camera lenses, 62.5 Hz for the accelerometer and 200 Hz for the gyroscope. These data from the different sensor frames and camera frames are converted into visual-inertialodometry in the API which runs on the Intel Movidius Myriad 2 VPU. This means that the camera gives a coordinates as an output which operates with 6 Degrees of Freedom (forward/backward, up/down, left/right, pitch, roll and yaw) in a three dimensional space. The pose output sample rate is given by 200 Hz.

The small and light design and the specifications make it available to use it for many different navigation/automation devices as e.q drones and robots in general. [1] [2]

- SMR Robot

The used SMR robot is a small wheeled robot, which is developed by DTU. The robot is an indoor four-wheeled robot. The two wheels in the rear end of the robot are connected to two separated motors. In the front of the robot two non omnidirectional wheels are mounted. This allows us to control the robot by regulating the speeds of the two rear wheels. The center point is therefore at the rear between the two steering wheels.To read data from the robot, the program rhd is used, which retrieves data from the SMR-robot and wait for the new data. The sampling rate for receiving data from the SMR is 100 Hz. [3]

Figure 1: The figure shows the SMR-robot, where the T265 is mounted on top of it

Schedule

Below the time schedule is shown. Here the estimated timestamps and critical deadlines are inserted.

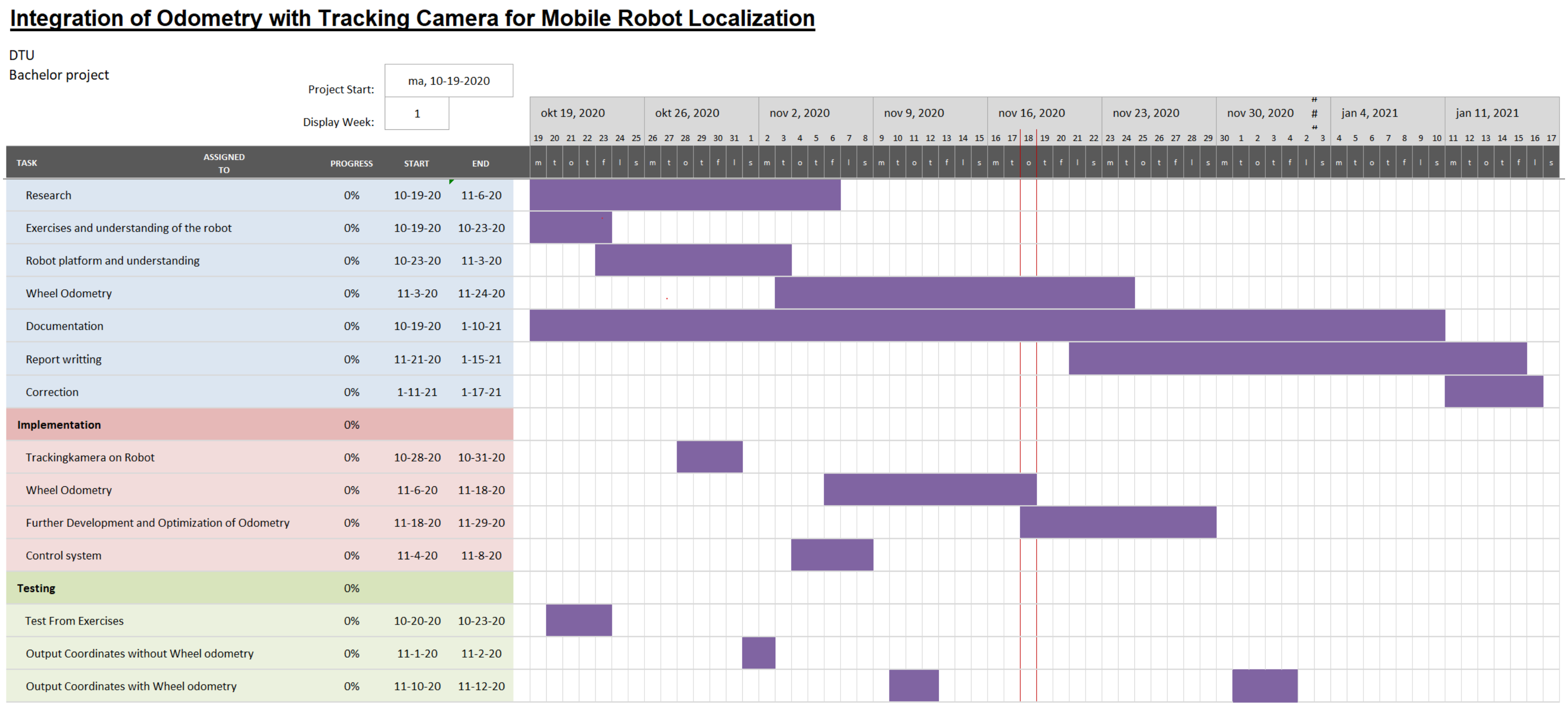

Figure 2: Timeline

Sub-components of the project plan

Theoretical and report

Project-plan

Create a comprehensive schedule for the project execution. The schedule must hold start and end dates for all activities and milestones, that need to be achieved during the project.

Research

Examine the overall topic of articles and other credible sources which describe facts of the given problems.

Exercises and understanding of the robot

In the first part of the project, It is needed to figure out how to run the robot on its existing coordinate system. This will be done to archive a better understanding of the robot, but also to gain insight into what is possible to achieve with the robot, and which input and output that can be reused from the exiting system. Hereby it is possible to see which modules that need to be developed and added to the existing control system of the robot. Furthermore, it will be investigated how the code of the control system is organized to figure out how to add new functionalities. This is necessary as no documentation of software implementation exists.

Robot platform

Examine and prepare the running robot's platform to output wheel-data. Furthermore, the wheel odometry calculation needs to be implementet.

Wheel Odometry

Investigate and prepare a possible solution for adding wheel odometry to the API of the tracking camera or the possibility of improving the positioning of the robot by implementing an external Kalman-filter.

Documentation

During the project, it is important to document the progress and the obtained result, so it is possible for use in later projects and for the thesis report.

Report writing

The project will be completed with a report. This report will describe the project in details including the considerations that have been done during the execution.

Correction

Before the final work will be handed in, a few days have been set aside to read through the assignment, to check that everything is formulated in a correct and understanding way, as well as it is possible to correct the text and errors.

Implementation

Tracking camera on robot

The camera must be implemented on the robot from which it is possible to get odometry data from the wheels. For use in future projects, it is important that the position output from the program can be used as a feedback signal to the controller of the robot.

Wheel Odometry

Implement the software for the API, so that the wheel odometry is included in the statistical calculations.

Further Development and Optimization of Odometry

To improve the code, the already performed code is fine-tuned and optimized. This part also acts as a buffer if time is needed for the odometry implementation, but also if something goes wrong and if there is a need for further investigations/implementations.

Control System

The already existing software is used to control the robot. The robot will get individual commands regarding the routes for the specified tests. This is to test the functionality and precision of the robot's navigation capability from T265. These tests will be programmed in the SMR-language in separated files.

Testing

Test From Exercises

Through the exercises, It is neded to test the results, to see if everything is as expected.

Output Coordinates without Wheel Odometry

After the implementation of the camera individual tests will be executed. Some different distances will be preformed to see the precision of the output-coordinates only from the tracking camera. The reaction of the camera will also be tested on different movements from the robot.

Output coordinates with wheel odometry

After the implementation of wheel odometry some new tests will be implemented with associated simulations. These tests are to see if there are any small errors caused by for example a long delay in the camera's output/input data and to see how the coordinates of robots react. The test results will be compared with results from a previous project without wheel odometry.

References

[1] https://www.intelrealsense.com/visual-inertial-tracking-case-study/

[2] https://www.intelrealsense.comwp-contentuploads/2019/09/Intel_RealSense_Tracking_Camera_Datasheet_Rev004_release.pdf

[3] Code for the SMR-robot given by Søren Hansen