

Presentation Mobile Robotics

GROUP 10
MICRO-452

Overview and task attribution

- Vision : Georg Schwabedal
- Global Navigation : Eugène Bergeron
- Local Navigation : Cyril Goffin
- Kalman Filter : Florian Tanguy
- Motion Control : Cyril Goffin & Eugène Bergeron & Florian Tanguy

Vision

- Responsible for : safe passage points, goal and thymio information (in mm).
- Implementation :
 - *Map building.*
 - Gaussian Blur filter, thresholding
 - ArUco markers detection
 - Obstacle detection
 - Homography matrix computation
 - Transition to real world coordinates
 - *Robot localization*
 - ArUco markers detection
 - Transition to real world coordinates

Global Navigation

- Responsible for: sequence of points (in mm) and angles (in rad) to follow to reach goal.
- Implementation:
 - *Initialization of visibility graph*
 - Add every obstacle contour points as nodes
 - Add goal and start as nodes
 - *Creation of visibility graph*
 - Adding every edge of the contour of the obstacles
 - Add every edge that doesn't collide with an obstacle
 - *Search for the optimal path*
 - *Conversion to the sequence*
 - Only keep the points of passage
 - Compute the angle of each segment

Local Navigation

- Responsible for: Avoiding dynamically introduced obstacles during navigation.
- Implementation
 - *Real-Time Obstacle Detection*
 - Utilizes 8 proximity sensors to monitor the robot's immediate surroundings
 - *Dynamic Speed Corrections*
 - Artificial Neural Network (ANN) computes wheel speed corrections for obstacle avoidance
 - Weighted sums of sensor inputs determine speed corrections.
 - Left and right wheels have different weight sets for tailored navigation responses.
 - *Benefits*
 - Ensures smooth and efficient obstacle avoidance in dynamic environments.
 - Enhances adaptability and responsiveness for autonomous navigation.

Kalman Filter

- Responsible for: Estimate the robot's pose $[x, y, \theta,]$ with high accuracy despite noisy data from odometry and the camera.
- Key Advantages :
 - *Drift Correction: Reduces odometry errors using precise camera data.*
 - *Sensor Fusion: Combines multiple data sources*
 - *Efficiency: Recursive updates allow real-time processing with minimal memory usage.*
- Core Principle:
 - *Assumes Gaussian noise to simplify computations.*
 - *Take into account the error on the process and in the measurements*
 - *Correction of the noise for better estimation of the pose of the robot*
- Outcomes:
 - *Accurate, real-time pose estimation with low computational cost*

Motion Control

- Responsible for : Enable smooth and precise path-following for the Thymio robot by controlling wheel speeds and motion alignment
- Implementation :
 - *Odometry Function*
 - Update robot's position $[x,y,\theta]$ based on wheel speeds and previous pose.
 - Using a speed conversion to consistent units, simplifying code and enabling dynamic path adjustments
 - Homography matrix computation
 - *Astolfi Controller*
 - Guide the robot along a path using nonlinear control designed for differential-drive robots.
 - Drives toward the target, reducing speed as it nears
 - Adjusts orientation to align with the next waypoint
 - Resumes movement smoothly for accurate path-following.
 - Ensures stable navigation for tasks like exploration or delivery in dynamic environments.

Thank you!!!