UNIVERSITÀ
DEGLI STUDI
DI PADOVA

DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

DEPARTMENT OF INFORMATION ENGINEERING

BACHELOR'S DEGREE IN COMPUTER ENGINEERING

Fusing vision and inertial measurements for autonomous navigation in narrow channels

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Graduation date: – – —-

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Abstract

This thesis addresses the design, development, and validation of an automatic system for detecting roll, pitch, and yaw of an autonomous boat. The main objective is to create a low-cost, low-power, and easily transportable solution capable of accurately determining the boat's attitude. To achieve this, both computer vision and an onboard inertial sensor will be used. By fusing data from these two sources, a precise estimate of the boat's attitude will be made available to the entire system. For the computer vision part, two cameras will be used to exploit stereo vision. The attitude estimation will be processed on a Raspberry Pi 5, chosen for its low cost. For this purpose, ArUco Tags—two-dimensional fiducial markers commonly used in robotics and augmented reality for pose estimation—will be employed. Regarding the inertial sensor, the onboard device will provide velocities and accelerations along the three axes. Finally, an extended Kalman filter, which will utilize both inertial and computer vision data, will be applied to reduce drift and improve the accuracy of roll, pitch, and yaw estimation.

Introduzione

In recent years, the field of **autonomous systems** has played an increasingly central role in robotics. All this has also been made possible thanks to solutions such as **Robot Operating System 2 (ROS2)**, which is one of the platforms for the development of robotic applications. This has been achieved thanks to its *modular architecture*, support for *real-time communication*, and its *open-source* nature, which has made it an excellent choice even for advanced robotic systems.

This thesis is part of the **Autodocking project**, focused on the ability of a boat to navigate and dock autonomously. Although the structure and the basic control systems were already in place, a **computer vision–based system** for autonomous navigation was missing. My contribution was related to the creation of a **ROS2 node**; more specifically, I dealt with the entire **pipeline** ranging from **image acquisition**, **attitude estimation**, and subsequent **sensor fusion** with the inertial sensor data. To achieve this, I needed a **ROS2 node** that handled the acquisition of images from the various cameras installed on the boat and their publication on a *topic*, so that my algorithm could access them.

Chapter 1

Titolo di capitolo

1.1 Titolo di sezione

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1.1.1 Sub-section title

Figure 1.1: Image caption

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Listing 1.1: caption text

Inserimento bibliografico [1] [2] [3]

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