UNIVERSITY OF SALERNO

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ROBOTIC FRAMEWORK FOR DEVELOPING OF UNMANNED VEHICLES

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Abstract

Unmanned Vehicles, known as UVs, have been developed to accomplish difficult, tedious, and unpleasant missions for human beings. Their usage started in military applications; subsequently, specific industries adopt them to increase the productive capacity of their factories already automated with industrial robots relying on the mobility and autonomy offered by these vehicles. However, unmanned vehicles could operate in many other sectors - like in agriculture, construction, logistic, customer service -, facilitating and improving the quality of life in general. It is necessary to increase its development and implementation substantially to achieve this.

As we will show in this document, progress in the area of mobile robotics, especially in the field of unmanned vehicles, has been essential and proliferates. However, it is not robust yet to be reliable and accepted beyond the controlled environments in which they operate nowadays. The enlarged area to cover, due to mobile capabilities, plus the risky missions they need to accomplish, increases the complexity of autonomous steering and control of such a vehicle. For this reason, the modeling considerations to achieve the task of autonomous driving is considered complex and reserved to humans (Litman T., 2018), due to the high frequency of interactions with other mobile objects, which requires sensing and acting capabilities in real-time bases, with an essential degree of intelligence and skills.

An essential step in their development is the robotics environments for developing and testing unmanned vehicles, these computational environments incorporate and centralizes all technologies, in their broadest sense, related to robotics. In both professional and academic literature, these environments are called with different names, such as robotic middleware, robotic platform, and robotic framework. Their degree of development and their capacities are not homogeneous, being those specialized and commercial branded who have reached essential levels of maturity and acceptance. As it is the case of X-Plane, a platform for the simulation of autonomous flights of many well-known aircraft, the Federal Aviation Administration (FAA) can even certify the implementation if they also count on certified hardware.

Some conventional robot models are offered in these robotic environments, which are highly used for research in robotics. It is an essential contribution to the robotics community to get the research efforts to concentrate on the central issues of their work. However, it does not help much if there is a need to test a new robot model from scratch, where the initial main effort is in the modeling and evaluation of behavior in order to redesign the model itself. These environments also offer standard robotic functionalities that come to help in both cases.

Then, the complete development of a new unmanned vehicle, from a 3D model creation to the real prototype testing, requires an ad-hoc platform in every step of the process. It also requires a good understanding of kinematic and dynamic modeling, added to programming skills and powerful simulation environments. To our knowledge, no open-source robotic environment or system can cover the complete process of UVs development robustly and quickly. Some of them are powerful in control and simulation; others help a lot in algorithm development; some others accept mathematical formulation naturally; others deal very well with the communication systems.

Thus, one solution is to integrate some of these platforms and benefit from their advantages. For this reason, we have thought to develop an integrated framework that facilitates the design of unmanned vehicles, initially in simulation, capable of fulfilling autonomous behavior, performing tasks like path planning, location, mapping, and safe navigation by avoiding obstacles in the ground and air environments. We initiate by evaluating the offer, by installing and testing some robotics middleware in order to choose the platform that allows the best integration capabilities with robust applications at each step of unmanned vehicle modeling from scratch.

Doing in this way, we integrate different robotic platforms and tools to build a framework in which it is possible to have all the standard functionalities by type of unmanned vehicle. Therefore, when the need for a new vehicle arrives, it is possible to create and add a new model, with its peculiarities (characteristics and capabilities). Thus, our robotic framework, called UNISA-UVF, is designed to facilitate the modeling, simulation, and testing of unmanned vehicles. UNISA-UVF is a sensor-based robotics system that uses model-based and learning-based approaches.

Also, in our framework, it is possible to create different versions of the same vehicles with slight variations in the description of their morphology, which facilitates the collaborative missions in which several UVs are required to carry out them together. Therefore, we reserve a workspace in which we have implemented some classic group activities such as leader-follower or cooperative-SLAM. Having built our framework on the open-source middleware Gazebo-ROS, we can take full advantage of code reusing.

Our framework will allow the Industrial Engineering Department of UNISA to build and test unmanned ground and air vehicles in simulated environments with the possibility of testing physical prototypes with much less effort. Our framework, designed to be completely reusable, also allows integration with MATLAB/Simulink and X- plane in order to increase this capacity, by using 3D design software for vehicle modeling.