UNMANNED TRAFFIC MANAGEMENT 4D PATH PLANNING TECHNOLOGIES FOR DRONE SWARM TO ENHANCE SAFETY AND SECURITY IN TRANSPORT

Rapports

Informations projet

LABYRINTH

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Periodic Reporting for period 2 - LABYRINTH (UNMANNED TRAFFIC MANAGEMENT 4D PATH PLANNING TECHNOLOGIES FOR DRONE SWARM TO ENHANCE SAFETY AND SECURITY IN TRANSPORT)

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Résumé du contexte et des objectifs généraux du projet

Ensuring transport safety and security is one of the EU's main priorities, as it is spotlighted in WHITE PAPER–Roadmap to a Single European Transport Area, which sets out a comprehensive strategy leading to reach a safer, more efficient and sustainable civil road, rail, air and waterborne transport. However, even though some of the EU's main policies are aimed at making transport more sustainable -the European Commission has fixed the goal to reach zero fossil fuel emissions by 2050- safety must not be neglected, especially when focusing on road civil transport, which means the larger number of injuries and deaths.

With this aim, in 1993 the European Council adopted the decision of creating a Community database of road accidents, the CARE project (Community database on Accidents on the Roads in Europe). According to the latest data from EC, road traffic accidents in the Member States of the EU claim about 25,100 lives in 2018. Despite this gradual decrease in both the number of accidents and the number of road deaths experienced during last decades (a decrease of 21% respect from 2010), a stabilization around the current trend can be observed (a reduction of 1% compared with 2017) that is making unreachable the EU-goal of 15,750 deaths by 2020 2.

Regarding to other means of transport, although maritime (6,812 injuries and 683 fatalities in 2011-20173) and aerial (1,054 injuries in 2014-20184) do not represent as many consequences as the road one in EU, maintaining a high level of safety implies high costs and efforts in monitoring, surveillance and maintenance of vehicles (vessels, aircrafts) and infrastructures (airports, seaports…). Facts such as the presence of birds on runways (bird strikes with airplanes is a relatively common issue in airports), the incursion of external drones (or UAVs) in airports facilities (which have already provoke temporally closures) or needed inspections of the condition of ships, involve high costs and time, reduce efficiency and question the safety of these means of transport in terms of public opinion.

To face this situation, the emergence of drone technologies has been identified as a potential efficient way to implement solutions capable of improving the safety and efficiency of the civil transport for both people and goods, thanks to the ability of the latest devices to carry out fast inspection, surveillance operations, loading of small goods, their high accessibility for hard-to-reach areas or their ability to collect and transmit information such as images or videos in real time, combined with an enhance in telecommunications, remote guidance technologies, and the increase in the loading capacity and energetic autonomy of these vehicles.

the main objective of the project is to create and validate new swarm drone applications to enhance safety, security and efficiency in the civil system transport, through the research and development of drone swarming 4D (3 spatial dimensions + time) path-planning algorithms -for implementation in Ground Control Stations- and new U-space services (drone swarm deconfliction and flight planning) supporting drone swarms auto-guidance.

Travail effectué depuis le début du projet jusqu'à la fin de la période considérée dans le rapport et principaux résultats atteints

jusqu'à présent

During this first reporting period, all the implemented actions have been aimed at:

-Development and implementation of the UTM server logic
-Development of the path planning algorithms
-Implementation of the APIs to communicate path planner and UTM; and UTM with GCS
-Implementation of GCS add-ons for it to communicate with the UTM
-Implementation of the web interface for the communication pilot-UTM

3 new drone-based applications tested in a controlled environment for: i) Infrastructure (docks) inspection during commercial operations and after extraordinary weather conditions or after accidents, with difficulties to access; ii) Continuous monitoring of the gates as well as the vessels mooring at the port to improve the security of transport infrastructure and facilities, avoiding sabotage and terrorist actions; iii) Dredging operations monitoring to avoid the floating of sediments.

Progrès au-delà de l'état des connaissances et impact potentiel prévu (y compris l'impact socio-économique et les conséquences sociétales plus larges du projet jusqu'à présent)

Although there are previous experiences on the development of route planning techniques using Fast Marching methods, being the UC3M-Robotics Lab research group a reference in this field, with several scientific publications the difference between these works and LABYRINTH approach is that, up to date, these investigations have been limited to the planning of individual UAVs or certain coupled formations, while LABYRINTH aims to scale up the method to multi-vehicle problem solving.

In this project, a decoupled algorithm based on Fast Marching for multi-UAV planning problems, where each UAV plan or is planned individually (taking into consideration the locations of the other robots and the observed unmodeled obstacles), is proposed. The idea is to plan each vehicle individually and to detect and manage the interactions with other drones. This will allow to plan for all the paths in a centralized way but also it would allow if the drone has certain capacity of computer that the drone in emergencies might plan its trajectories. Plans will be periodically reevaluated to verify the existence or not of interaction between plans and feasible paths and if necessary, modify its initial plan.
The question (and challenge) then is how to determine when the local planning capabilities are able or not to cope with the interaction between two or more robot plans.
As a result of this, this research will suppose two main disruptive aspects respect from current SoA:
- Dynamic and static multi-robot management.
- Computational cost optimization.
The breaking result of this research will be a 4D path planner module. For the deployment of this new method, the new route planner will be embodied in a new U-SPACE System integrated by a Ground Control Station and a cloud platform which will run the new algorithms and, continuously interacting with the managed drones

The project will have a very important economic impact for the members of the consortium and will open new business niches for the EU economy in the global markets, making possible to create new disruptive business models that replicate the results of the simulations.
-New business models as outcomes of transport use cases simulated in the project, addressing both:
- Public procurement: to public entities in charge of managing transport facilities or regulating transport (public seaports or airports, national road transport public authorities, medical assistance services…).
- Private procurement: to private entities in charge of managing transport infrastructure or provide services them (private seaports or airports, private roads, entities sub-contracted by the public administration for the maintenance of transport infrastructures…).
-New business models and applications directly derived from the replication of use cases proposed in the project to other fields. Some of detected opportunities are bird-scaring drones use to protect farms, drones to carry out surveillance activities against intruder.
- The project aims to drastically reduce drones' dependence on human pilots and increase the scalability of drone swarming applications. However, the new applications and business models will mean the need to create highly skilled jobs related to.

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