On Standardised UAV Localisation and Tracking Systems in Smart Cities

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Abstract

Smart Cities - In the near future, more than two thirds of the world's population is expected to be living in cities and hence, with the aim of being proactive and finding innovative and sustainable solutions, governments have made smart cities one of their priority areas of research. Smart cities are sustainable, inclusive and prosperous greener cities that foster enabling smart Information and Communication Technologies (smart ICT) like Internet-of-Things (IoT), cloud computing and big data to facilitate services such as mobility, governance, utility and energy management.

UAVs - As these services depend heavily on data collected by sensors, Unmanned Aerial Vehicles (UAVs) have quickly become one of the promising IoT devices for smart cities thanks to their mobility, agility and customizability of on-board sensors. UAVs found use in a wide array of applications expanding beyond military to more commercial ones, ranging from monitoring, surveillance to parcel delivery and more demanding applications that require UAVs to operate in heterogeneous swarms in a shared low-altitude airspace over populated cities.

UTM and Standardisation - However, as the number of UAVs continues to grow, UAV deployment in smart cities is faced with a set of fundamental challenges in their safe operation and management. These challenges emphasize the need for establishing globally-harmonised regulations and internationally-agreed-upon technical standards to govern the rapid technological advancements, as well as ensure a fair economy by encouraging market competition and lowering barriers to entry for newcomers. One incorporated solution, we probe, is a distributed UAV Traffic Management System (UTM).

Project Overview

This work is part of the *DESTINATION* project – Unmanned Aerial System Traffic Management with Distributed Decision Making (*illustrated below*), where standardised localisation and tracking is key in realizing such UTM.

The goal of this project focuses on the following three objectives:

- Developing a resilient, scalable and efficient localisation and tracking system for UAVs;
- Developing an optimised cluster-based communication system for flying ad-hoc networks (FANETs);
- Finally, a distributed decision-making system exploiting efficient automatically generated local routing rules/strategies.

The developed models, will be evaluated/validated in an incremental way utilising the HPC platform of the UL managed by PCOG.

Theoretical Simulations → Optimise Parameters

Physical Simulations → Realistic models using Gazebo

Real Tests → When feasible – using PCOG UAVs

Acknowledgment

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Standardisation

This work focuses on studying the fundamental technical requirements, specifications and functions of such UAV localisation and tracking system and analyses current SDOs efforts such as those put forth through:

- **EUROCAE WG73**
- **EASA**
- **ISO TC20/SC16**

→ On UAV Systems

- **ISO JTC1/SC41** → On IoT and related Technologies
- **ISO JTC1/SC27**
- **GDPR**

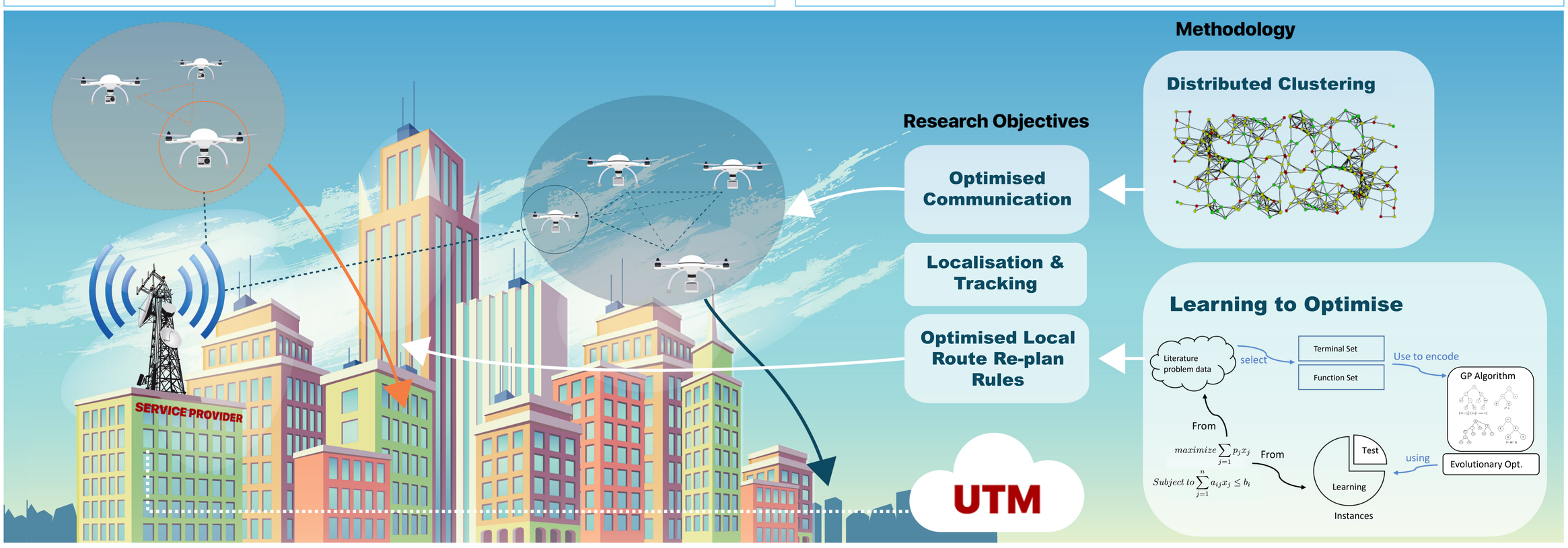
→ On Security, Privacy and Data Protection

To identify and prioritise future research questions aiming to contribute towards bridging the gap between research and technical standards.

Expected Outcomes

The expected project deliverable is a novel UTM with distributed decision making that embeds:

- A novel UAV localisation and tracking system for smart city applications;
- A novel distributed clustering algorithm for FANETs that permits to improve information sharing via a reduction of communication overhead;
- Local re-routing decisions based on rules generated by novel "learning to optimise" methods;
- Contributions to technical standardization at both at EU and International level.



References

[1] "U-space Blueprint." SESAR Joint Undertaking. Accessed March 09, 2018. https://www.sesarju.eu/u-space-blueprin.

[2] Aweiss, A. S., Owens, B. D., Rios, J., Homola, J. R., & Mohlenbrink, C. P. (2018). Unmanned Aircraft Systems (UAS) Traffic Management (UTM) National Campaign II. *2018 AIAA Information Systems-AIAA Infotech @ Aerospace*.

[3] Dorronsoro, B., Ruiz, P., **Danoy, G.**, Pigné, Y., & **Bouvry, P.** (2015). Evolutionary Algorithms for Mobile Ad hoc Networks. Nature Inspired Computing Series. John Wiley & Sons.

[4] Schleich, J., **Danoy, G.**, Dorronsoro, B., & **Bouvry, P.** (2014). Optimising small-world properties in VANETs: Centralised and distributed overlay approaches. *Applied Soft Computing, 21*, 637-646.

[5] **Danoy, G., Brust, M. R., & Bouvry, P.** (2015). Connectivity Stability in Autonomous Multi-level UAV Swarms for Wide Area Monitoring. *Proceedings of the 5th ACM Symposium on Development and Analysis of Intelligent Vehicular Networks and Applications - DIVANet 15*.

[6] **Brust, M. R.**, Zurad, M., Hentges, L., Gomes, L., **Danoy, G., & Bouvry, P.** (2017). Target tracking optimization of UAV swarms based on dual-pheromone clustering. In Proceedings of IEEE International Conference on Cybernetics - CYBCONF, 1-8. **Best paper award.**

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