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Orchestration of systems of mobile robots for border protection, search and rescue, and personal security

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Modern mobile robots have increasingly practical capabilities.

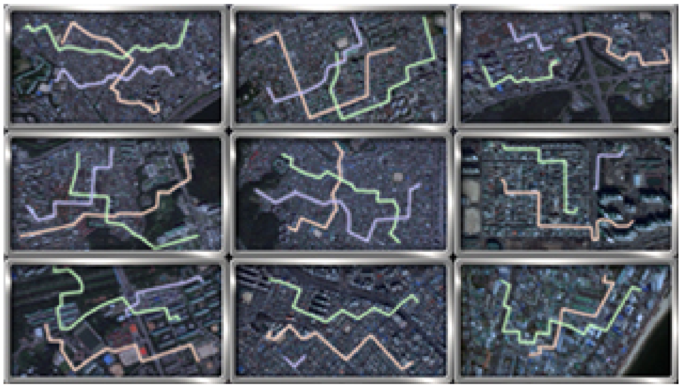
Amazon.com is developing unmanned aerial vehicles (UAVs) or drones for package delivery. Autonomous cars can safely navigate our streets without a driver. Yet, while the capabilities of such mobile robots are impressive, how useful is a single mobile robot? What is required for mobile robots to contribute to applications that directly benefit society – social applications – are systems of robots working cooperatively to address large-scale opportunities.

To support large-scale social applications such as border patrol, search & rescue, and city-wide security services, hundreds or thousands of mobile robots must work in tandem to jointly pursue the system objectives. In addition to the robots themselves, a truly autonomous system must be supported by automatic fuel/energy replenishment depots. If the mobile robots are to deliver relief supplies, these depots must also replace the depleted supplies. Figure 1 depicts a UAV landing on an energy depot.

While rudimentary methods can be used to plan the activities of all of these resources, in the context of social applications, efficiency is essential. Well-coordinated border patrol systems will improve national security. Efficient search & rescue will cover more area quickly so that more survivors can be located. See the main image for a concept of UAV search & rescue at sea. Highly productive security escort systems will improve the security coverage provided to the customers (see Figure 2). In this context, intelligent allocation of system resources drives improved security and even saves lives.

At Korea Advanced Institute of Science and Technology (KAIST)'s xS3D lab, Professor James R. Morrison and his students are developing methods to efficiently orchestrate the activities of systems of mobile robots together with fuel and supply depots. They have employed the mixed integer linear programming (MILP) model to characterize the physics of such systems. As the social applications they are targeting are best served by large scale systems with many robots and depots, they have developed fast algorithms to solve the MILP models and determine efficient task plans for the system resources.

Future systems of mobile robots will use such task orchestration methods to enable efficient operation. As a consequence, UAVs can work in concert to keep our borders more secure. In the event of a disaster, colleagues, friends, and loved ones may be found and rescued more quickly. Our cities and campuses can be made safer by a more efficient and organized system of UAVs.



Provided by The Korea Advanced Institute of Science and Technology (KAIST)

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