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Editorial Open Access

Micro Air Vehicles

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Editorial

With increasing occurrences of tragic events in recent times, the development of Micro Air Vehicles (MAVs) to be utilised in search and rescue operations has become more and more important. MAVs equipped with remote sensing instrumentation offer numerous opportunities in disaster related situations. Using MAVs can pro-vide a critical support to search and rescue operations. MAVs are agile, fast, can exhibit autonomous behaviours and hence perform operations hard to execute by human operators, at low operating costs. MAVs are well-suited for remote data collection and monitoring, due to their ability to form a multi-hop communication network.

In a typical scenario such as earthquake, tsunami or hurricane, a swarm of MAVs equipped with a 802.11 or Zigbee radio are deployed in an area of interest, perform sensory operations to collect evidence of the presence of a victim, and report their collected data to ground stations over the MAV network. On surface, the MAV network may appear to be very similar to ad-hoc networks, extensively studied by the networking community. However, one of the major distinctions of the proposed network is the dynamism and timescale where the vehicles may connect/disconnect with each other for a very short duration of time. Given the short connection opportunities, it is critical that a MAV can collaborate with other MAVs to quickly finish neighbour discovery so as to maximise the contact time. Moreover, the inter-node interference can also impact the neighbour discovery mechanism, which in turn can further reduce the overall network throughput. In the previous work, it has been shown that the difference in the altitude of the MAVs' three dimensional movements can have a significant effect on the signal strength variability due to the relative monopole antenna orientation. Therefore, the reliable data collection in MAV network remains a challenge.

Generally, the hardware platforms are built based on off-the-shelf, electrically-powered quadrotors. Typically resembling a small bird, these MAVs y at low altitudes and low speed. They are significantly cheaper than the other fixed-wing aerial vehicles. Given their small size, MAVs possess autonomous hovering capabilities for manoeu-vring into inaccessible places such as tunnels and tight enclosed labyrinths with obstacles. The payload they can carry is in the order of a few hundred grammes. With the current battery capacity available, the flight time of the MAVs is restricted to a few tens of minutes. An aerial sensor network composed of a swarm of low-cost bird sized MAVs. Compared to single-MAV systems, multi-MAV systems have advantages such as scalability and survivability. To maximise and maintain the net-work coverage, a network of MAVs flying in a formation has to locate each other in the 3-D scenario. The formation and dynamic adaptation of the network topology in 3-D space is important for the coverage of the 3-D environment and the effective data collection. In order to reduce the cost of operation, it is desired that MAV has limited communication and detection capabilities. Hence, the positioning of MAV should work in a distributed and unsupervised mode. The control of such MAVs is a decentralised control problem, as only local information is available to each MAV for the control. To address the above mentioned issues, the aim is to develop a set of simple decentralised control laws that steers a group of MAVs autonomously to form a formation of flight and, at the same time, move along a given path at a given speed.

Furthermore, a multi-hop heterogeneous wireless communication network consisting MAV network and Wireless Sensor Network (WSN) on the ground has been studied. The MAV-WSN hybrid system must also be concerned with the reliable data collection challenge. The MAVs can relay the data to a remote base station, which can help save energy for the ground sensors in the WSN. However, the aerial link on MAVs is not always connected due to the movement of MAVs. As a result, routing data in the MAV network causes significant delay. To achieve maximum through-put with lowest latency and energy consumption, the energy-efficient and real-time routing protocol is required to reduce the network energy consumption while guar-anteing low latency, by flexibly selecting a combination of Air-Air, Air-Ground, Ground-Air or Ground-Ground link at each hop in the MAV-WSN.