Chapter 15
Unmanned Aerial Vehicles for Smart Cities:
Estimations of Urban Locality for Optimization Flights

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ABSTRACT

In this chapter, the authors are presenting opportunities for the use of unmanned aerial vehicles (UAV) in town. Methods for the optimization of flight routes of UAVs in the dependence of target tasks in the city are presented, for example, area monitoring; search and rescue operations; retransmission of communication (in places, where the antenna coverage cannot be set due to terrain specifications); organization of logistics as the safe, cheap, and fast transportation method of goods; for aerial photography, for controlling traffic; for the provision of the first aid to people in emergencies; unmanned taxi. It is done using air navigation information and mathematical methods. Authors suggest dynamic programming methods, GRID analyses, expert judgment method, and fuzzy-logic methods for estimation of risk/safety of flights in the city. Optimization of flows and flexible redistribution of UAV routes in multilevel airspace is provided according to air navigation requirements and standards.

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BACKGROUND

In recent years, Unmanned Aerial Vehicles (UAVs) became very popular in developed countries as one of the effective solutions to some tasks in city and agriculture areas (Austin, 2010; Chekunov, 2010; Gulevich, 2012; Sładkowski, 2019) in logistic as the safe, cheap and fast method of transportation of cargo; for aerial photography; for controlling road traffic. Nowadays UAVs are used to perform many tasks that were previously difficult to solve such as observation and monitoring missions in hard-to-reach places (forest, mountains, sea, rivers, lakes, big parks); monitoring forest fires; search and rescue operations; alternative performance of a difficult agricultural activity (aviation chemical work); relaying of communication signals in places where antenna coverage cannot be set because of terrain; for first aid to people in various life situations. Earlier since 1961 UAVs were widely used in some military operations (Austin, 2010; Chekunov, 2010). Now UAVs are effective both in military and civil aviation (Kreps, Zenko, 2014; Ignatiev, 2010; Sładkowski, 2019; Bondarev, Jafarzadeh, Kozub, 2014).

UAVs have several advantages, namely low operating cost, simplicity, availability. UAVs may be used there, where the usage of manned aircraft is impractical, expensive or dangerous. The main advantage of using UAVs is areas with extra high risks to humans or large and inaccessible areas with the necessity in control single or group UAVs flights in cities or agriculture terrain (Bondarev, Jafarzadeh, Kozub, 2014).

The use of a single-operating or a group of UAVs is opening a big variety and a principally new level of complexity of target tasks and missions lowering the presence of a human itself while task execution of smart governance in the future cities. The diverse application of UAVs is ensuring the utmost safety, economic efficiency, precision and quality, minimal environmental impact and complying with other essential requirements and parameters in future smart cities. Meeting these expectations and requirements would be possible with the introduction of operation management, decision support systems and control systems capable of supporting versatile and autonomous teams of UAV performing a wide range of complex tasks and activities with separation of roles in the team and with minimal human control while supporting the highest standards of safety (Austin, 2010; International Civil Aviation Organization (ICAO), 2015; Gulevich, 2012). In some cases, the use of a single UAV becomes ineffective. It is advisable to group (collective) use of UAV (Austin, 2010; Bondarev, Jafarzadeh, Kozub, 2014; Bondarev Shmelova, Kucherov, 2015; Shmelova, Bondarev, Kucherov, 2016; Shmelova, Bondarev, Lazorenko, Burlaka, 2019; Shmelova, Sterenharz, Burlaka, 2019; Shmelova, Kovalyov, Dolgikh, Burlaka, 2019):

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