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Analysis of UAV for delivery of medicines to socially vulnerable people

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Abstract. This article provides a theoretical overview of drug delivery via unmanned aerial vehicle (UAV). Drug delivery using UAVs can be significantly faster and more efficient than using traditional delivery methods, especially in remote or hard-to-reach areas. The UAV is highly maneuverable and accurate, making it possible to deliver medicine to places where accessibility and safety are major concerns. Using UAVs for drug delivery can reduce transportation costs and reduce delivery times, which can increase patient convenience and satisfaction. In this regard, the drone must be very reliable in navigation, as well as accurate in performing its functions. In addition, it carrying capacity will be limited to ensure the safety of drug delivery. According to the experience of commercial projects in this direction, the biggest problem in delivering cargo using UAVs is not navigation, not the position of the route, but the landing of the delivered cargo.

Keywords: *UAV, transport, aircraft, medicine.*

1. Introduction

The relevance of the theoretical research is confirmed by the fact that in current conditions, medical units, depending on their purpose, should be able to quickly provide medical care in any situation, both in difficult terrain and in difficult weather conditions.

The practical significance of the theoretical analysis is to increase the mobilization readiness of medical units, ensuring prompt delivery and transportation of equipment and medical supplies to save lives and provide emergency medical care is inextricably linked with the design, tactical and technical characteristics and capabilities of UAVs, as well as the use of UAVs for transportation of medicines to the elderly, as well as people from the socially vulnerable segment of the population of our country. This idea will not only ensure rapid delivery of medicines, but can also save many lives.

Due to the intensive development and implementation of new generations of air-based technical systems, there is a widespread use of unmanned aerial vehicles (UAVs) in various fields of activity.

2. Current projects

In the modern world, medical UAVs can be used for the rapid delivery of medical supplies to disaster zones, conflicts, accidents, as well as to areas that are difficult to reach due to terrain in difficult weather conditions.

Since the end of 2022, the German company Georgiev in Bavaria has been collaborating with doks.innovation GmbH, doks.inventairy GmbH and Stadtentwicklung Bebra GmbH on the REGUAS project.

The project is focused on the «Concept of regulated regional deliveries based on UAVs» or the use of unmanned systems for the transport of multi-dimensional cargo and medicines in rural regions. Specifically, the project is looking at ways to improve the delivery of goods and further urbanization efforts in the Magistrat der Stadt Bebra in the northeastern region of Hesse in Germany. This interdisciplinary event is funded by the German Federal Ministry for Digital Technology and Transport and is one of the few cutting-edge projects in the field of AAM design and integration in Germany.

«This is a relatively small city that is interested in innovation because it really wants to attract more people from much younger age groups» Georgiev explained.

To help the city of Bebra attract more residents, researchers are studying current transportation and logistics problems and looking for ways to use drones and AAM to improve services. They aim to determine how to integrate automated driverless vehicles to transport higher value-added goods in rural areas without negatively impacting quality of life and the environment, while also supporting the revitalization of rural communities. They are also looking for ways to make existing rural communities more attractive to as many people as possible to live in.

«My team covers several domains», Georgiev said. «..., firstly, we see what is happening there now with transport and mobility in general. We are also studying demographic data and survey responses to determine the readiness and expectations of citizens and relevant experts for the use of drones as a complement to existing logistics systems and an upgrade to the entire logistics system».

To best serve current and future residents, Georgiev and his colleagues envision a «holistic approach» in which a regional logistics center would be located in the core of the city. «And local logistics centers will be located at regular meeting points in villages where people can go and pick up their belongings», he said. Local distribution centers will also offer social services for residents, and people will have the opportunity to come to these centers and participate in the delivery of goods and medicines to other residents, especially the elderly or people with disabilities.

«...for example, someone can pick up their own items, but also set up a time to pick up items or medications for other citizens, such as the elderly, and even help with daily activities in their home on an hourly basis. They can deliver goods by car or bicycle, and we can complement this with drones for more urgent or even emergency cases, such as drug delivery», Georgiev explained.

According to Georgiev, there will be physical demonstrations of the transportation and delivery system. In addition, the researchers are working intensively on a larger publication to prove the viability of the concept.

3. Requirements for operational use

Cases often arise when it is necessary to urgently deliver a medical product from one point to another with minimal loss of time, because in such moments related to the life and health of people, every second is precious, which once again emphasizes the relevance and practical significance of the research issue in the field of UAV use for medical purposes.

The use of UAVs for medical purposes can significantly reduce the time for transportation and delivery of biomaterials, devices and medical equipment, while economic costs can be significantly reduced, which will ultimately save human lives [1], in particular:

-prompt delivery of medical tests and medications to medical institutions;

- notifying the population about antiviral measures;

-monitoring of crowded places, quarantine zones, vehicle traffic;

- treatment of potentially contaminated areas with antiseptic and disinfectants;

-prompt contactless delivery of food and essential supplies to quarantine zones.

Along with this, to improve the quality and effectively implement the assigned tasks, it is planned to use developed medical modules that allow the prompt delivery of biological materials and equipment for emergency medical care.

In turn, to solve the problems of delivering medical equipment, it is advisable to use an unmanned aerial vehicle that has elongated support struts that allow the medical module to be placed in the lower part, which helps to reduce the center of mass of the device and increase its stability during flight. In this case, the medical module must be manufactured in the form of a streamlined container, the lid of which must be equipped with a fastening mechanism and an air filter connecting the container cavity with the atmosphere. The container body is divided into cavities to accommodate test tubes with biomaterials installed in guides that hold them in a vertical position. Place a container with disinfecting liquid equipped with release valves in the center of the container. At the bottom of the container compartments, place sensors to control the leakage of biomaterials. In this case, each sensor for monitoring the leakage of biomaterials must have a corresponding solenoid valve that connects the container with the disinfecting liquid to the container compartment in the event of leakage of biomaterials.

This device will allow the transportation of biological materials by air over distances using a medical module while maintaining aerodynamic stability and a smooth landing.

An unmanned medical complex for transporting medicines [2] is presented in Figure 1.

Figure 1. Unmanned medical complex for transporting medicines

This device will make it possible to transport medicines by air over distances using a medical container while maintaining aerodynamic stability and a smooth landing.

A special feature of transporting biological materials is that everything is done automatically. A vertical takeoff and landing unmanned aerial vehicle of a multi-rotor type operates as follows: the operator checks the serviceability of the unmanned medical module, the state of charge of the battery, the functionality of the navigation equipment and video camera, after which he places the test tubes in a container with samples of biomaterials and docks them to the container lid attached to the bottom aircraft. During ascent, the control operator raises the aircraft to the required height and sends it to the laboratory. If the pressure changes from rising to altitude, it will be balanced by connecting the container cavity with the atmosphere through an air filter. In case of violation of the integrity of tubes with biomaterial (possibly contaminated), the biomaterial flows into the lower part of the container, being an electrolyte, it switches the contacts of the sensor for monitoring the integrity of the tubes. Electric current from the power source is supplied to the windings of the solenoid valve, which is responsible for neutralizing the contaminated cavity of the container.

When transporting medicines using UAVs, the safety of clients must be considered. In particular, the movement of elderly and disabled people along city streets causes both discomfort and increased danger for them. Crossing roads, stairs, weather conditions, and ice in winter are risk points for all persons whose movement is difficult.

Delivery of medicines by drones will not only make it easier, but also protect people's lives. Process automation always frees up space and saves time.

Hospitals and clinics, serving all segments of the population, are always busy and stressed. By eliminating the need for the elderly and disabled to visit medical service points once again, it will reduce the burden on medical workers.

In the case where a client receives medications for which timely consumption is important, automated delivery by drones can ensure timely delivery. Infrastructure and logistics facilities will be the basis for the subsequent development of UAV technology in the Republic of Kazakhstan. Also, these technologies are currently also poorly developed among the CIS countries. Exporting infrastructure will increase both the economic potential and prestige of Kazakhstan.

As well as delivering medicines in areas with a high risk of infection, UAVs can be used with a high risk of infection.

The increased demand for drug delivery services caused by the COVID-19 pandemic may be an opportunity to develop the UAV drug delivery market.

Continued technological advancement may lead to the development of new types of UAVs that can provide more efficient and accurate drug delivery.

It should also be noted the weaknesses of using UAVs for drug delivery

- Limiting the UAV's payload capacity may limit the amount of medicine that can be delivered at one time. Some medications may be extremely sensitive to temperature and other conditions, which may limit their use when delivered over long distances. The need to accurately calculate routes and energy consumption to ensure that medications are delivered on time and in good condition.

- Expensive equipment, the cost of attracting specialists in this field. Obviously, mastering new technologies does not come cheap.

You can also easily conclude that attracting the use of UAVs in commercial projects is and will for a long time be an initiative of large companies, creating greater competition pressure for smaller business projects in the same industries.

But one way or another, all innovative technologies passed this way, such as cars, the Internet, and a little later became available to the masses.

- use in certain weather conditions Due to both the design of UAVs and the nature of aircraft in general, weather conditions are a major factor in risk calculations. All those problems that remain relevant in the use of commercial aircraft also remain relevant and are aggravated within the limits of the size and design of drones.

- Navigation and communication. Due to the design of the UAV, all energy-consuming elements are located in close proximity to each other, and also require a large supply of electricity, but also limiting the size of the batteries, batteries or generators. These factors raise the problem of electromagnetic compatibility of navigation, communication and information storage devices used.

The use of UAVs in urban environments adds the problem of noisy communication channels, and increases the risk of system failures, since not only the devices themselves, but also people or private property may be damaged.

- Restrictions in the legal sphere; the use of UAVs in urban conditions entails risks, since malfunctions and breakdowns of flying vehicles can result in damage to the life and health of people or damage to property. Legislative bodies around the world, where there has been or is planned to experience the use of UAVs, are considering all such scenarios.

It can be assumed that the use of UAVs in the private and commercial sectors will be severely limited.

- Possibility of terrorist attacks. Drones are already being widely used for illegal purposes. There are many articles and videos on the Internet that describe the use of drones to deliver illegal drugs, sabotage, and terrorist attacks. There are also materials on the use of UAVs to combat the illegal use of the same drones. Technologies change and develop, but one thing remains unchanged - innovation arms conflicts, and conflicts develop innovation.

- Abuse of legal use. Experience with the use of UAVs in the context of the COVID-19 pandemic has raised questions about the use of this technology to infringe on the personal freedoms of citizens. While in many countries the use of UAVs was limited to spraying antiseptics and delivering medicine, in authoritarian states drones were also used to monitor the population, cause physical harm to demonstrators, as well as for propaganda and control.

- Possibility of unauthorized access and theft of medicines from the container during delivery, which can damage the company's reputation.

4. Conclusions

In this article, we reviewed a theoretical review of drug delivery via unmanned aerial vehicle (UAV). We considered the type of transportation of medicinal drugs by air over distances. As well as the advantages and disadvantages of using UAVs for medical purposes. As the characteristics described above show, unmanned aerial vehicles have been able to solve a number of important problems: they have been able to travel the necessary distance with a payload, reduce the time it takes to deliver essential items, and provide much-needed supplies to doctors and patients. In the near future, the supply of medical drugs, consumables and other essential supplies using unmanned aerial vehicles will become an international trend. Today, several dozen projects in different countries around the world are using UAVs to deliver medical supplies to people in need.

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Халықтың әлеуметтік қорғалмаған топтарына дәрі-дәрмек жеткізу үшін ұшқышсыз ұшу аппаратын талдау

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Аңдатпа. Бұл мақалада ұшқышсыз ұшу аппараттары (ұшқышсыз ұшу аппараттары) арқылы дәрі-дәрмектерді жеткізудің теориялық шолуы берілген. Ұшқышсыз ұшу аппараттарымен дәрі-дәрмектерді жеткізу дәстүрлі жеткізу әдістеріне қарағанда, әсіресе шалғай немесе жету қиын аймақтарға қарағанда әлдеқайда жылдам және тиімдірек болуы мүмкін. Ұшқышсыз ұшу аппараты жоғары маневрлік және дәлдікке ие, бұл дәрі-дәрмектерді қол жетімділік пен қауіпсіздік алаңдаушылық тудыратын негізгі факторлар болып табылатын жерлерге жеткізуге мүмкіндік береді. Дәрі-дәрмектерді жеткізу үшін ұшқышсыз ұшу аппараттарын пайдалану көлік шығындарын азайтып, жеткізу уақытын қысқартуы мүмкін, бұл пациенттердің ыңғайлылығы мен қанағаттанушылығын арттыруы мүмкін. Осыған байланысты дрон навигацияда өте сенімді, сонымен қатар өз функцияларын орындауда дәл болуы керек. Сонымен қатар, дәрі-дәрмектерді жеткізудің қауіпсіздігін қамтамасыз ету үшін оның жүк көтергіштігі шектеулі болады. Осы бағыттағы коммерциялық жобалардың тәжірибесіне сәйкес, ұшқышсыз жүктерді жеткізудегі ең үлкен қиындық навигация емес, маршруттың орналасқан жері емес, жеткізілген жүктің қонуы болып табылады.

Негізгі сөздер: *дрон, көлік, авиация, медицина.*

Анализ беспилотного летательного аппарата для доставки лекарств социально незащищенным слоям населения

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Аннотация. В этой статье представлен теоретический обзор доставки лекарств с помощью беспилотных летательных аппаратов (БПЛА). Доставка лекарств с помощью БПЛА может быть значительно быстрее и эффективнее, чем при использовании традиционных методов доставки, особенно в отдаленные или труднодоступные районы. Беспилотный летательный аппарат обладает высокой маневренностью и точностью, что позволяет доставлять лекарства в места, где доступность и безопасность являются основными факторами, вызывающими озабоченность. Использование беспилотных летательных аппаратов для доставки лекарств может снизить транспортные расходы и сократить сроки доставки, что может повысить удобство и удовлетворенность пациентов. В связи с этим беспилотник должен быть очень надежным в навигации, а также точным в выполнении своих функций. Кроме того, его грузоподъемность будет ограничена для обеспечения безопасности доставки лекарств. Согласно опыту коммерческих проектов в этом направлении, самой большой проблемой при доставке грузов с использованием беспилотников является не навигация, не местоположение маршрута, а приземление доставленного груза.

Ключевые слова: *беспилотник, транспорт, авиация, медицина.*

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