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The use of drones in organizing the Olympic Games

Summary

The rapid development of technology, commonness and versatility of technological ideas in the environment around us are not without influence on the forms of human activity - including sports-related, tourism and recreation activities. Increasingly lower production costs of complex and miniaturized devices, and therefore, their universality and accessibility cause changes, which affect, unfortunately, positively or negatively the idea of noble sportsmanship. With precise time measurement technique the winning player can be unmistakably indicated, but also the abuse of technical solutions can lead to pathological and thus unsportsmanlike behavior. This takes the form of so-called doping technology, such as when muscular strength of man is assisted by the force of inventions (Kowalska 2011). This article presents some aspects of the use of modern technology in the organization of sports events, with particular emphasis on Unmanned Aerial Vehicles (drones) during mass sports events, which are the Olympic Games with using the monographic method, analysis and criticism of literature. The article presents the use of drones in areas such as geodesy and cartography, construction supervision, control and realization of investment projects, monitoring of facilities, security of mass events, conducting and planning search and rescue, delivery of shipments, logistics, insurance and assessment of damage, or mobile hot-spots to provide access to Internet services for large areas.

Key words: modern technologies, Unmanned Aerial Vehicles (drones), sport events, the Olympic Games.

JEL codes: F52, H56, L67, L82, Q55

Introduction

Modern technology influences many aspects of human activity, including physical activity, which forms can be seen in various aspects of tourism, recreation and sports (Nadobnik, Łubkowska 2014).

In development of modern technology and it's influences on our reality, one can notice phenomena that many judge extremely different - either positively or negatively. Computers and robots can replace people in hard, exhausting physical jobs, which are carried out in dangerous conditions. On the other hand, automation of production processes can be recognized as a direct cause of unfavourable changes in the job market, including rise of unemployment or changes in human habits regarding forms and ways of spending free time.

Particularly worrying seem to be reorientations in the physical activtiy sphere of young generation, which is in large extent the receiver and consumer of information technology (Zysnarska and others 2008).

The positive aspect of technological developement is that it makes for the handicapped people possible, to return to normal life and even participate in sport competition. There are known cases of sportsmen, who as a result of genetic defects, unfortunate accidents or diseases return to competition, thanks to advanced technological solutions. Contestants, who achieve very good results with carbon fiber artificial limbs and rival able-bodied contestants, become not only outstanding popularisers of the sports concept, recreation and physical activity, but also give hope and strenght to other handicapped people.

Technological achievements allow to overcome problems, faults and imperfections related to restrictions of the human body. However, it is necessary to discuss and set limits between equalizing chances of handicapped contestants and abusing technological solutions, observed in many aspects of sport rivalry.

The unfavourable, negatively judged behaviours between the disciplines of sport and technology are described as abusing modern technological solutions, commonly called "technology doping". Especially reckognized and widely discussed was the detection of electric engine, found in the frame in one of the contestant's bicycle during cross-country world championship in Heusden-Zolder in 2016[1]. Another documented instances of such phenomenon are i.e. banned modifications of ski and swimsuits.

Technology, and particularly solutions based on electronics and information technology enrich the environment, in which modern man lives, works and rests. Sport without new technology would be certainly different, compared to the one that accompanies our civilization. The form of transmission and influence on millions of fans would be, without a doubt, less entertaining. Nowadays it is hard to imagine mass sport events, championships and Olympic Games without television broadcasts, attractive visualisations of the score and precise measurement devices, which declare the winner, when the results are very close.

In the year 1932, for the first time in the history of Olympics, a task of measuring time was assigned to a swiss company *Omega*, which sent to USA thirty stopwatches and one watchmaker. The stopwatches measured time with 1/10 second precision. During the Olympic Games in London in 1948, the precision of these devices increased to 1/100 second (Berry 1968). The Olympics in Atlanta in 1996 were operated by 196 technicians, alongside with 100 tonnes of measurement devices[2] from Switzerland. For the first time radars were used, in order to record the acceleration of sprinters. For the first time events from the olympic arena were filmed and broadcasted through television, during the Olympic Games in Berlin in 1936. Back then the television signal reached 19 TV receivers located in the capital city of Germany (Walters 2008).

[1] http://sport.tvn24.pl/kolarstwo,129/silnik-w-rowerze-rozwscieczyl-uci-zlapiemy- was-predzej-czy-pozniej,615518.html [access: 10.04.2016].
[2] For comparison in the 2006 Olympics in Turin there were used more than 220 tonnes of measurement devices.

New seamless swimsuits are another spectacular achievement of technology that allow the swimmers to reduce water resistance by 5%. In a short time from their introduction in 2008, 100 world records were broken in the discipline of swimming. As a consequence the so-called shark skin was ultimately considered as prohibited swimsuit categorized as technology doping, which was reflected in changes suggested by International Swimming Federation FINA and national associations, including Polish Swimming Federation[3].

These examples point out with how fast progress we have to deal. The instances mentioned above, despite the fact that they relate exclusively to equipment and technology of precise time measurement, ski and swimsuits, artificial limbs ect. indicate how modern technology, electronics and information technology enter every branch of human activity, including of course sport.

Chosen types of drones

UAV − Unmanned Aerial Vehicle (or UAS − Unmanned Aerial System) popularly called a drone, is a device drifting in air without a pilot. They are commonly known at least from the end of 90' of 20th century, as a tool against terrorism. Just as many other reckognized and commonly used technological devices, they origin in military. Predecessors of present drones were autonomous war machines used during the First World War. These planes, equipped with simple robotics and explosives, were crashing themselves in suicidal flights into enemy targets. Modern technical solutions allow to transport missiles on drones, therefore they are no longer single-use devices. Thanks to high quality camrecorders and cameras, drones are used for area reconnaissance. Currently, these machines allow to stay in air for over 80 hours. A flight at the several thousand meters altitude causes that drones can be practically invisible for the enemy. The navigation is possible due to wireless connection between the pilot, who stays in a safe place on the ground, and unmanned vehicle carrying out precisely all the commands.

Dynamic technological development, especially based on miniaturization and accompanied by decrease in electronics production prices, led to popularization of devices and discovery of new, previously unknown areas of drone use. Nowadays there is no problem to buy a device equipped with complicated technological solutions. For the equivalent of a couple of hundred dollars, one can become an owner of quadrocopter, hexacopter or octocopter. These solutions vary not only in the number of engines, but above all in parameters and receivers, dependent on demands and potential use. That means, whether the drone is going to be only a toy, used recreacionally, or find use in the amatour or professional utilization. Almost every model from the above mentioned categories can be equipped with a GPS module, making possible to set a route of the flight and it's autonomical return to the beginning, a barometer allowing to maintain programmed height, a gyroscope stabilizing flight, a compass keeping orientation in airspace and plenty of other devices, including camrecorder and

[3] http://www.polswim.pl/regulaminy-i-przepisy [access: 24.04.2016].

camera. Obviously, along with demands and expectations, the potential area of use changes. In the case of unmanned vehicle utilization in organizing mass events, a couple of main areas of use can be distingushed, which ,of course, apply to organizing the Olympic Games.

Drones in land surveying and cartography, building supervision, inspection and during carrying out projects associated with organizing the Olympic Games

Drones already find their use in the phase of initial planning and managing of the terrain, i.e. for land surveyors, architects and planners. UAVs allow for recognition of the area, in which new public utility buildings, settlements, or i.e. sport infrastructure is going to be built. Drones allow to create precise orthophotomaps[4]**.** During the flight above the terrain, with the use of installed cameras and specialist software, new digtal and, above all, extremely accurate maps are created. The use of drones allows to considerably decrease the costs of investment and increase the quality of received cartographic image, in comparison with previous technical solutions. Until now, creating cartographic image was based on photographing the Earth surface from planes, helicopters, balloons or satellites. Currently construction, technical supervision and carrying out construction project can be conducted more often and precisely. An example of device, with which ground structure can be researched is American-made drone − Topcons Sirius Pro[5]**.** Relatively small size of this UAV and and an engine driven by electicity causes that construction supervision tasks can be conducted inside sports halls, swimming pools, as well as other sports buildings. Another example of drone used for building project monitoring and process automation in construction industry[6] is Chinese product called DJI Phantom II[7]**.** This model thanks to relatively low price and having very good technical parameters, high quality materials and well though out structure, is often used by specialists in many industries, including engenieering and construction companies.

In the year 2015, a couple of months before the opening ceremony of the Olympic Games in Rio de Janeiro 2016, event organizers presented a video[8], made with the use of a drone, which demonstrated from the bird's perspective a flight over the Olympic Park and another buildings, which were in the last phase of constuction.

The photo 1 displays in the foreground Carioca Arenas Stadium, Rio Velodrome Olympic Stadium on the left and Rio Olympic Arena in the top right side of the picture[9]. The picture is a single frame taken from the film, which introduces the area of the finishing construction to the viewer in an entertaining way.

[4] Orthophotomap − terrain image created as a result of transformation of plane photos into planar coordinate system.
[5] http://www.equipmentworld.com/drones/ [access: 24.04.2016].
[6] http://raffaello.name/projects/flight-assembled-architecture/ [access: 24.04.2016].
[7] http://www.equipmentworld.com/drones/equipment/ [access: 24.04.2016].
[8] http://sport.tvn24.pl/najnowsze,135/rio-2016-film-z-lotu-drona- przedstawiajacy-arene- igrzysk-olimpijskich,620684.html [access: 24.04.2016.]
[9] http://www.rio2016.com/en/news/new-drone-video-takes-viewers-inside- barra-olympic- park-the- heart-of-the-rio-2016-games [access: 24.04.2016].

Photo 1

A part of constructed Olympic Village in Rio de Janeiro

Source: Cidade Olimpica Rio 2016.

Drones in monitoring and securing safety of the praticipants during sports events

Military, police, uniformed services and security companies use different types of drones, depending on fulfilling specific tasks. Relatively simple in construction UAVs, equipped only with monitoring system are usually controlled manually from a command center on the ground. More complex machines allow to autonomously translocate according to flight plans saved in memory. Precise solutions based on satellite navigation technology allow for an automatical area patrolling, whereas additional drone equipment, in the form of camrecorders and video broadcast devices, allow continuous broad area monitoring. Additional sensors i.e. racting to emitted infrared light allow area monitoring in difficult wheater conditions or at night. As a consequence, the service resposible for security can react effectively i.e. during big sports events, depending on the potentially dangerous situation, or if the public order is threatened, due to large number of people or unfavourable occurences.

In the case of 2016 Rio de Janeiro Olympics, the organizers decided to make use of US-Israeli made drone called Hermes 900[10]**.** This UAV is equipped with 17 camrecorders, making possible for security and the police to track potentially dangerous behaviour of fans, or all possible human and vehicle activity over 100 square kilometers area. The drone has

[10] https://www.elbitsystems.com/elbitmain/area-in2.asp?parent=3&num=31&num2=31 [access: 24.04.2016].

advanced sensors, which are able to identify the driver's face and license plates from the couple of kilometers altitude above the observed area.

Another model that was prepared to work as Brazilians describe **"„**anti-manifestaciones**"**[11] is Mofeta[12] drone designed for special tasks. The manufacturer equipped this "flying policeman" with two high-power speakers, two high quality TV cameras, four paintball guns and additional stroboscope lights and blinding lasers. The Rio de Janeiro police intends to be prepared with equipment that will find special use in dispersing aggresive and threatening the public safety fans.

Drones used in journalism, photography and TV broadcasts from the Olymic Games

Drones, thanks to high quality photographic equipment and high definition cameras, find their use in situations, in which acquiring video material from the running track or the turf - the place of sport events - is inadvisable for the safety of contestants or participants. Another important issue is that every TV broadcast should be entertaining for the viewers. Using TV helicopters is very expensive and broadcasts with their use from the inside of sports facilities impossible. UAVs perform in such tasks outstandingly. News agencies and television networks often time use an American drone Aerigon[13]**.** This complex device costs around 50 000 dollars, weights 13,5 kilogramm, and can be upraded with 100 000 dollars worth Phantom Flex4K camera, alongside with additional lense selected for the needs or financial abilities of the client. In the case of the Olympics, Olympic Broadcasting Services (OBS)[14] agency selected by MKOI is responsible for TV production. This organization owns exclusive rights to broadcast all the events from the sports facilities and the Olympic Village in Rio 2016, PyeongChang 2018 and Tokyo 2020. Therefore, every TV station that wants to broadcast the Olympics, has to buy the signal from the OBS. During the Winter Olympics in Sochi 450 TV cameras were used. Some of them, for the first time, were placed on drones.

Drones in rescue actions and emergency medical services druing mass sports events

In conjunction with the Summer Olympic Games in Rio de Janeiro 2016, the organizers and city authorities are expecting big interest from the fans in Copacabana beaches and worldwide popular Christ the Redeemer statue at the top of Corcovado mountain. As English-speaking journal The Rio Times[15] informed, the Olympics will be patrolled by

[11] http://www.elnuevoherald.com/noticias/mundo/america-latina/article18621945.html [access: 7.05.2016].
[12] http://www.efe.com/efe/america/tecnologia/presentan-en-brasil-un-dron-para- controlar-manifestaciones- a-distancia/20000036-2587693 [access: 24.04.2016].
[13] http://vipmultimedia.pl/sprz%C4%99t/2225-dron-wyposa%C5%BCony-w- kamer%C4%99-phantom-flex4k.html [access: 24.04.2016].
[14] https://www.obs.tv/ [access: 07.05.2016].
[15] http://riotimesonline.com/brazil-news/rio-politics/drones-to-be-used-in-beach- rescues-in-rio-de-janeiro/ [access: 07.05.2016].

Dragan Flyer X4-ES[16] drones with basic rescue equipment that allows the sinking to stay on the water surface until the rescuers arrive. Drones are additionally equipped with TV cameras, which allow precise observation from the altitude of several dozen meters over the beach or water surface. The devices will be controlled by specially trained pilots, who are going to be in contact with rescuers on fast boats with professional rescue equipment.

Drones providing access to data communication networks during the Olympic Games

Drones of the Titan Aerospace company that belong to Google Inc.[17] can perform long flights thanks to the solar panels. They have advanced technical solutions on board, which allow to transmit internet signal in the form of so-called hot-spot or Wi-Fi signal repeater. Their task is to deliver the Internet to places, where building a stationary infrastructure is unprofitable or where it is necessary to provide connection service to a large number of customers in set and short time - only during sports events. This is the case in Rio de Janeiro in 2016. The fans will have access to a computer network, which signal will be transmitted by UAVs hovering over the city. It is estimated that nowadays the internet and network services are the most preferably used technology in the history of mankind. Over the last years it has become the most capacious and fastest source of information (Kalecińska 2013).

Chosen legal aspects of using the drones

In Brazil, especially in Rio de Janeiro, one can observe significant social stratification resulting in social and economical problems. Only in Rio, there is more than 750 settlements called favelas, which are practically without the administrative or police control. As a result, they can generate a lot of trouble, while organizing and during the course of the Olympic Games in 2016 (Steinbrin 2013). In relation with many accumulated in Brazil political and social problems - that we recently witness - new regulations in Brazilian legal system in 2015 were introduced, i.e. concerning the use of drones. In terms of UAV flights, new proscriptions and civillian unit flight limits during all sport events, big gatherings, manifestation and demonstrations were set. The Brazilian law regarding the use of drones by private people is now very restrictive. The set penalty for breaking the law was significantly incrased[18].

Big mass sports events are held worldwide. Local regulations concering the use of drones vary considerably in each country. In Europe, big hopes are put into the development of unmanned aircrafts, which are expressed in the form of a large interest from the European Commission and member states. Liberal laws regarding the use of UAV are supposed to ensure competitive advantage for Europe, compared to the rest of the world. US authorities take very conservative stand against drone flights. It is understandable, due to an earlier experience with

[16] http://www.modelairplanenews.com/blog/2013/05/10/draganflyer-to- the-rescue/ [access: 24.04.2016].
[17] Google Kauft Drohnen-Anbieter Titan Aerospace" (text / html). Cashys Blog (in German). Cashys Blog [access: 24.04.2016].
[18] https://panampost.com/panam-staff/2015/04/17/brazil-to-unveil-new-drone- legislation-ahead- of-2016-olympics/ [access: 12.05.2016].

terrorism and wanting to secure the safety of citizens. According to US federal law, it is forbidden to make comercial drone flights and every flight should be agreed upon with adequate authorities. What is more, every drone heavier than 250 gramms has to be registered, according to Federal Aviation Administration (FAA) air law amendment in the year 2015[19].

Polish air law allows the possibility of drone flights, however they must stay in the line of sight. The rules of using drones are dependent on the flight character and the weight of the drone. Detailed regulations were published in the 6th annex of Minister of Transport, Construction and Maritime Economy ordinance in 26 March 2013[20]. In the case of flights that are other than recreactional or sports, pilot qualifications certificate (Unmanned Aerial Vehicle operator) issued by Civil Aviation Authority is needed. The necessary condition to receive this certificate is to pass theoretical and practical exam, submit the results of medical examination and own suitable insurance policy.

Future and the limits of using drones in sport

Technological progress and decrease in production costs of devices based on advanced electrinics and its miniaturization causes drones to become more accessible and to find wider application, including sport.

One of the examples of a creative use of drones is known Itallian football club - Empoli. The coach Maurizio Sarrim introduced a drone, which task was to record training sessions above the football pitch. It was supposed to help in understanding, how the players take up positions and perform intended tactic[21].

The scientists of Stanford University Laboratory[22] presented an interesting idea that was in advanced development. They suggested using drones during the fencing training. The device was equipped with precise sensors and a computer, which interactively controlled the drone to evade the foil hits. Certainly, in the nearest future, the drones will have the possibility to be used during the training in other sport disciplines. Since a coulpe of years, a new category of UAVs can be observed - racing drones. They gain popularity also in Poland. Thanks to high speed flights and complex acrobatics, those races become very entertaining for the audience. In March 2016 in Dubai World Drone Prix[23] championship was held, while it is planned to organize World Drone Racing Championships[24] in October 2016 in the USA. Participants from 35 countries are going to take part in this event. Are we witnesses of forming a new sport discipline, or is it only a short-lived fashion associated with new electronic gadget? The question will be probably answered in a couple of years.

[19] http://www.faa.gov/news/updates/media/20151213_IFR.pdf [access: 12.05.2016].
[20] http://dziennikustaw.gov.pl/DU/2013/440/ [access: 12.05.2016].
[21] http://www.goal.pl/305940-drony-na-treningu-empoli.html [access: 12.05.2016].
[22] http://asl.stanford.edu/projects/real-time-kinodynamic-planning/ [access: 12.05.2016].
[23] http://www.worlddroneprix.com/ [access: 12.05.2016].
[24] http://droneworlds.com/ [access: 12.05.2016].

According to information delivered by Australian edition of **"**Business Insider**"**[25] magazine, Japan, which will organize the Olympic Games in 2020, due to a large deficit in the number of workers in labor market, is going to use robots and drones in some sports infrastructure construction. Using modern technology during organizing sports events has not only positive aspects. From the technical point of view, the biggest problem with drones is that they lack full flight autonomy, so as it would be possible to make a safe flight without a person controlling the device.

The media from time to time inform about dangerous accidents, which took place i.e. during sports competitions. As the American channel CBSNEWS informs, one of such events happened during the US Open in 4 September 2015 on the Louis Armstrong Stadium courts. During the Flavia Pennetty against Monica Niculescu match, a drone[26] crashed into stands. One can say about large luck, as the machine crashed into an empty sector, not occupied with spectators, so nobody was hurt.

This is not an only case of an incidient with the use of UAV during a big sports event. During the World Cup in 23 December 2015 in Itallian city Madonna Di Campiglio, the broadcasting drone crashed just behind Austrian skier Marcel Hirscher.

These examples are enough to show, how little there was for the drone incidents to end in a tragedy. UAVs in the current stage of development do not guarantee 100% safety of the contestants and their fans. Slow moving, heavy and hard to control machines can be a serious threat.

Emergency landings, crashing into the ground and a possibility of crashing into another airship is a big threat for the safety of people in the place of the accident. Another danger caused by the easy access to drones can be terrorist acts and criminal activity. The short lifespan of drones and small battery capacity is also a troublesome issue. Due to using drones in closed rooms, they are powered mostly by an electric engine, what unfortunately has it's consequences in the form of short range and low stay in the air time. These are undoubtly challenges, which future scientists will solve, passing the consecutive limits of Unmanned Aerial Vehicles.

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[25] http://www.businessinsider.com.au/japans-komatsu-uses-robot- bulldozers-drones-for-construction-due-to-labor-shortage-2015-10 [access: 12.05.2016].

[26] http://www.cbsnews.com/news/scare-at-us-open-as-drone-crashes-into-stands/ [access: 07.05.2016].

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Użycie dronów w organizacji igrzysk olimpijskich

Streszczenie

Gwałtowny rozwój technologii, powszechność i różnorodność idei technologicznych w otaczającym nas środowisku nie pozostają bez wpływu na formy aktywności człowieka, wliczając w to czynności związane ze sportem, turystyką i rekreacją. Coraz niższe koszty produkcji skomplikowanych i miniaturyzowanych urządzeń i, zatem ich uniwersalność i dostępność powodują zmiany, które wpływają, niestety, pozytywnie lub negatywnie na ideę szlachetnej rywalizacji sportowej. Przy precyzyjnej technice pomiaru czasu można bezbłędnie wskazać zwycięzcę, ale też nadużycie rozwiązań technicznych może prowadzić do zachowania patologicznego, a więc niesportowego. Przybiera to formę tzw. technologii dopingu, takiej jak wówczas, gdy siłę mięśni człowieka wspomaga się wynalazkami (Kowalska, 2011). Artykuł przedstawia niektóre aspekty użycia nowoczesnej technologii w organizacji wydarzeń sportowych, ze szczególnym naciskiem na bezzałogowe statki powietrzne (drony) podczas masowych imprez sportowych, jakimi są igrzyska olimpijskie, z zastosowaniem metody monograficznej i analizy krytycznej literatury. Artykuł przedstawia użycie dronów w takich obszarach jak geodezja i kartografia, nadzór budowlany, kontrola i realizacja projektów inwestycyjnych, monitoring obiektów, bezpieczeństwo imprez masowych, prowadzenie i planowanie poszukiwań i ratownictwa, doręczanie przesyłek, logistyka, ubezpieczenia i ocena szkód czy mobilne hotspoty zapewniające dostęp do usług Internetu na dużych obszarach.

Słowa kluczowe: nowoczesne technologie, bezzałogowe statki powietrzne (drony), wydarzenia sportowe, igrzyska olimpijskie.

Kody JEL: F52, H56, L67, L82, Q55

Применение дронов в проведении олимпийских игр

Резюме

Бурное развитие технологии, популярность и разнообразие технологических идей в окружающей нас среде не остаются без влияния на формы активности человека, включая деятельность, связанную со спортом, туризмом и отдыхом. Все меньшие издержки производства сложных и миниатюризованных аппаратов и, следовательно, их универсальный и общедоступный

характер вызывают изменения, которые влияют, к сожалению, положительно или отрицательно на идею честного спортивного соперничества. Благодаря высокоточной технике измерения времени можно безошибочно определить победителя, с другой же стороны злоупотребление техническими новинками может вести к патологическогому, следовательно, неспортивному поведению. Это принимает форму так называемой технологии допинга, такой, когда силу мышц человека вспомогают изобретениями (Kowalska, 2011). Статья представляет некоторые аспекты применения современной технологии в проведении спортивных мероприятий, с особым упором на беспилотные летательные аппараты (дроны) по ходу массовых спортивных мероприятий, какими являются олимпийские игры, с применением монографического метода и критического анализа литературы. Статья представляет применение дронов в таких сферах как геодезия и картография, контроль за строительными работами, контроль и осуществление инвестиционных проектов, мониторинг объектов, безопасность массовых мероприятий, планирование и проведение поиска и спасения, отгрузка товаров, логистика, страхование и оценка стоимости ущерба или же мобильные хот-споты для предоставления доступа к услугам интернета для больших территорий.

Ключевые слова: современные технологии, беспилотные летательные аппараты (дроны), спортивные мероприятия, олимпийские игры.

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