A STUDY ON USE OF ROBOT DRONES FOR 3D PRINTING SHELTER

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ABSTRACT

A new research project aims to develop the world's first flying robots capable of autonomously assessing and manufacturing building structures to help areas suffering from natural disasters. The research team aims to develop drones that can use an Additive Building Manufacturing (ABM) system to reach remote and disaster areas, and 3D print structures such as shelters and buildings, providing much needed disaster relief. The drones being developed could fly to a disaster zone, scan and model the landscape using Building Information Management (BIM) systems, design temporary shelters, and print them on the spot. This could give those in need a place to live until emergency services personnel can reach them. ABM is a key technological building revolution currently transforming the construction industry by allowing the 3D printing of buildings and building components, resulting in quicker build times and reduced material and transport costs. However, due to their large size, ABM systems are inflexible making it difficult for them to undertake maintenance and repair work, especially in remote and rural areas. Whilst many drones are used for photography and surveillance, the drones in this project will utilize a revolutionary ABM system to remotely manufacture building structures such as shelters and bridges for those in need. In order to use this type of system for post-disaster reconstruction activities where the manufacturing speed of ABM would be hugely beneficial, the research team aims to develop the world's first ABM system consisting of a swarm of aerial robots that can autonomously assess and manufacture building structures. To do this, the team plans to miniaturize ABM and give it aerial capabilities so that it can be more mobile and able to manufacture complex high-rise structures. This would enable the robots to act as flying mini-factories, where they would land at to a construction site and work together to create buildings from scratch. When natural disasters strike, survivors need immediate access to temporary shelter. Since earthquakes, floods, and landslides often strike in remote areas, it can be a challenge to build strong and durable shelters quickly in affected locations. The researchers are working on developing 3D printing drones that can create high-quality structures on a large enough scale to serve as temporary housing. It is the only research project working on 3D printing using drones. According to the International Labor Organization, at least 60,000 people die every year on construction sites. The team is focusing their efforts on building in hard-to-reach areas. Natural disasters create physical obstacles for relief teams who need to build temporary structures. Drones could survey affected areas, and computer models could be created off-site. The drones could return later to 3D print buildings according to the plans. This would reduce the risk to emergency teams and help people get shelter faster. One challenge the researchers are facing is how to create adequate 3D *printer mounts for drones that can deliver payloads accurately and coordinate the activities of a fleet of drones. Drone 3D printers could also be used to construct tall buildings.*

Keywords: Additive building manufacturing (ABM), Building information management (BIM), Drones, Aerial robots, 3D print, Swarm, Shelter, and Surveillance.

I.INTRODUCTION

1.Drones :

A drone, in a technological context, is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAV). Essentially, a drone is a flying robot. The aircraft may be remotely controlled or can fly autonomously through software-controlled flight plans in their embedded systems working in conjunction with GPS. UAVs have most often been associated with the military but they are also used for search and rescue, surveillance, traffic monitoring, weather monitoring and firefighting, among other things. More recently, the unmanned aircraft have come into consideration for a number of commercial applications.

In late 2013, Amazon announced a plan to use drones for delivery in the not-too-distant future. Personal drones are also becoming increasingly popular, often for drone-based photography. Other applications include drone surveillance and drone journalism, because the unmanned flying vehicles can often access locations that would be impossible for a human to get to. In late 2012 Chris Anderson, Editor-In-Chief of Wired magazine, retired to dedicate himself to his personal drones company, 3D Robotics. Personal drones are currently a hobbyist's item most often used for aerial photography, but the market and potential applications are both expected to expand rapidly.

At the Cornell university the AR drones has been send for experiments in UAV visual autonomous navigation in structure environments.[1] moreover machine learning approaches were applied to predict the positions errors of the UAV following a desired flight path.[2]other research groups use the drones as an experimental platforms for autonomous surveillance task.[3]human machine interaction and even as a sport assistant[4] which add the athletic by providing them external imagery of their actions. [5]

In the United States, the Federal Aviation Administration (FAA) is developing regulations for the operation of unmanned aircraft. It bounces off a tree trunk, smashes into a highway tunnel, or careens into the side of a building. It runs out of battery and falls into a body of water. Your four-figure investment is typically only as good as your ability to handle it once it's aloft — which is why I'm a bit anxious when I first take the controller for the Solo, which 3D Robotics is billing as the smartest drone ever. A quad copter helicopter or quad copter is an aerial vehicle propelled by four rotors.

It consist of hardware and software

1.1 Hardware :

The AR-Drone (see Fig. 1) is an electrically powered quad copter intended for augmented reality games. It consists of a carbon-fiber support structure, plastic body, four high-efficiency brushless motors, sensor and control board, two cameras and indoor and outdoor removable hulls. The control board not only ensures safety by instantly locking the propellers in case of a foreign body contact, but also assists the user with difficult maneuvers such as takeoff and landing. The drone operator can set directly its yaw, pitch, roll, and vertical speed and the control board adjusts the motor speeds to stabilize the drone at the required pose. The drone can achieve speeds over 5 $m.s^{-1}$ and its battery provides enough energy up to 13 minutes of continuous flight. Drone control computer is based on the ARM9 processor running at 468MHzwith 128 MB of DDR RAM running at 200MHz. The manufacturer provides a software interface, which allows communicating with the drone via an ad-hoc Wi-Fi network. The API not only allows setting drone required state, but also provides access to preprocessed sensory measurements and images from onboard cameras.

Figure. 1: The AR-Drone quad copter

The drone sensory equipment consists of a 6-degree-of-freedom inertial measurement unit, sonar-based altimeter, and two cameras. The first camera with approximately $75^{\circ} \times 60^{\circ}$field of view is aimed forward and provides 640 × 480 pixel color image. The second one is mounted on the bottom, provides color image with 176 × 144 pixels and its field of view is approximately $45^{\circ} \times 35^{\circ}$. While data from the IDG-400 2-axis gyro and 3-axis accelerometer is fused to provide accurate pitch and roll, the yaw is measured by the XB-3500CV high precision gyro.[6]

1.2 Software

The control board of the AR-Drone runs the Busy Box based GNU/Linux distribution with the 2.6.27 kernel. Internal software of the drone not only provides communication, but also takes care of the drone stabilization, and provides so called assisted maneuvers. The bottom camera image is processed to estimate the drone speed relative to the ground, and therefore, the drone is more stable than other quad copters .After being switched on, an ad-hoc Wi-Fi appears, and an external computer might connect to it using a fetched IP address from the drone DHCP server. The external computer then can start to communicate with the drone using the interface provided by the manufacturer. The interface communicates via three channels, each with a different UDP port. Over the command channel, a user controls the drone, i.e., requests it to Take off and land, change configuration of controllers, calibrate sensors, set PWM on individual motors etc. However, the most used command sets the required pitch, roll, vertical speed, and yaw rate of the internal controller. The channel receives commands at 30 Hz.

The new data channel provides the drone status and preprocessed sensory data. The status indicates, whether the drone is flying, calibrating its sensors, the current type of altitude controller, which algorithms are activated etc. The sensor data contain current yaw, pitch, roll, altitude, battery state and 3D speed estimates. Both status and sensory data are updated at 30 Hz rate. Moreover, the drone can run a simple analysis of the images from the frontal camera and search for a specially designed tags in the images. In the case the tags are detected, the new data contains estimates of their positions The stream channel provides images from the frontal and/or bottom cameras. The frontal camera image is not provided in actual camera resolution, but it is scaled down and compressed to reduce its size and speed up its transfer over Wi-Fi. As a result, the external computer obtains a 320×240 pixel bitmap with16bit color depth. A slight disadvantage of the camera system is that a user cannot obtain both camera images at a time.

Rather than that, the user has to choose between bottom and forward camera or go for two picture in picture modes, Switching the modes is not instant (takes _ 300 ms) and during the transition time, the provided image contains invalid data. Since the control board is accessible by telnet, the drone user can log in and change settings of the onboard operating system and adjust configuration files of the drone internal controllers. Moreover, it is possible to cross-compile an application for the ARM processor and run it directly on the AR-Drone control board. In this case, one can access the drone cameras and onboard sensors directly without a delay caused by the wireless data transfer. Thus, one can achieve faster control loops and experiment with a low level control of the drone. Even when a custom application is running on the platform control board, the internal controllers, which take care of the drone stability, can be active. However, the memory and computational limits of the control board have to be taken into account when developing an application, which should run onboard the drone.[6]

For our purposes, we have created a simple application, which uses all three aforementioned channels to acquire data, allows drone control by a wireless joystick and performs a simple image analysis. This piece of freely available software serves as a base for more complex applications, which provide the drone with various degrees of autonomy. The software does not require any nonstandard libraries and works both under GNU/Linux and Windows environments.[7]

1.3 Dynamic model of the drone

In order to design controllers for the drone, it is desirable to know its dynamic model parameters. Instead of modeling the drone like a standard quad copter helicopter, i.e., considering its propeller speeds as inputs and angles as outputs, we model the drone including its internal controller. Since the internal controller is able to set and keep the desired angles and vertical speed, we do not have to deal with complexity of the drone model [8]. Instead of it, we model the drone as a system, which has the desired pitch, roll, yaw rate, and vertical speed as its input, and its actual angles, speed, and position as its states, see Fig. 2. Since the position of the drone is a pure integration of its speeds, we can further simplify the model, and consider only the yaw and speeds as its state variables. Moreover, we can consider that the forward speed is given by the drone pitch, and ignore the influence of other inputs. The same can be done for the drone side speed and roll, yaw and yaw rate, and altitude and vertical velocity.

Therefore, we can decompose the drone dynamic model in four first- or second order dynamic systems and identify their parameters separately. This decoupled model allows to design separate controllers for each such aforementioned tuple of state and input variables.

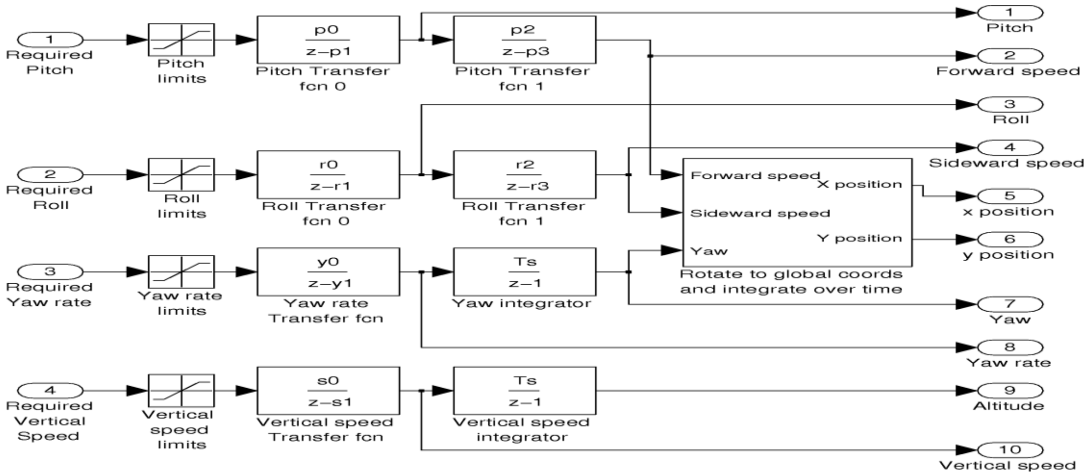

Figure 2 structure of the drone model

II. 3D PRINT TEMPORARY SHELTERS

When natural disasters strike, survivors need immediate access to temporary shelter. Since earthquakes, floods, and landslides often strike in remote areas, it can be a challenge to build strong and durable shelters quickly in affected locations. Dr. Mirko Kovac of Imperial College London believes he has found the solution. He has created the world's first drone 3D printer that can 3D print material onto waste and makes it transportable. He recently received about $5 million to work on his invention to print emergency shelters. Kovac is the leader of a team of researchers at Imperial College London's Department of Aeronautics. He acts as the Principal Investigator and works with other researchers from Imperial's Dyson Robotics Lab and other universities. They are receiving support from the Engineering and Physical Sciences Research Council and are working with several construction, robotics, and 3D printing specialists. Their goal is to develop aerial construction robots equipped with 3D printers. The researchers are working on developing 3D printing drones that can create high-quality structures on a large enough scale to serve as temporary housing. It is the only research project working on 3D printing using drones .Kovac and his team believes using drones to 3D print buildings can improve safety. According to the International Labor Organization, at least 60,000 people die every year on construction sites. The team is focusing their efforts on building in hard-to-reach areas. Natural disasters create physical obstacles for relief teams who need to build temporary structures. Drones could survey affected areas, and computer models could be created off-site. The drones could return later to 3D print buildings according to the plans. This would reduce the risk to emergency teams and help people get shelter faster. The work is coordinated by a Building Information Management system that is fed by sensor data from drones. One challenge the researchers are facing is how to create adequate 3D printer mounts for drones that can deliver payloads accurately and coordinate the activities of a fleet of drones. Drone 3D printers could also be used to construct tall buildings. Kovac predicts that drone 3D printers will be part of "smart cities" in the future. He expects that they will eliminate some jobs and create others because they will need to be manufactured, operated, and maintained. earch project aims to develop the world's first flying robots capable of autonomously assessing and manufacturing building structures to help areas suffering from natural disasters. The four year collaborative research project entitled 'Aerial Additive Building Manufacturing: Distributed Unmanned Aerial Systems for in-situ manufacturing of the built environment' involves researchers from the University of Bath, Imperial College and University College London. The research team aims to develop drones that can use an Additive Building Manufacturing (ABM) system to reach remote and disaster areas, and 3D print structures such as shelters and buildings, providing much needed disaster relief. The drones being developed could fly to a disaster zone, scan and model the landscape using Building Information Management (BIM) systems, design temporary shelters, and print them on the spot. This could give those in need a place to live until emergency services personnel can reach them.[9]

III. REVOLUTIONIZING REMOTE CONSTRUCTION

ABM is a pivotal technological building series now transforming a construction attention by permitting a 3D copy of buildings and building components, ensuing in quicker build times and reduced element and ride costs However, due to their vast size, ABM systems are resistant creation it formidable for them to commence upkeep and correct work, generally in remote and farming areas. World's initial mobile factories In sequence to use this form of complement for post-disaster reformation activities where a production speed of ABM would be hugely beneficial, a investigate group aims to rise a world's initial ABM complement consisting of a overflow of aerial robots that can autonomously consider and make building structures. To do this, a group skeleton to miniaturize ABM and give it aerial capabilities so that it can be some-more mobile and means to make formidable high-rise structures. This would capacitate a robots to act as drifting mini-factories, where they would land during to a construction site and work together to emanate buildings from scratch. Co-investigator and Senior Lecturer in a Department of Architecture Civil Engineering, Dr Richard Ball said: "We are gay to be partial of this desirous and sparkling plan that will pull a forefront of construction technologies into a future." Co-investigator and Senior Lecturer in a Department of Architecture Civil Engineering, Dr Chris Williams added: "It is sparkling to be operative on a plan where a structure has to be so light and fit that it can be built by tiny drifting drones." The University's Department of Architecture Civil Engineering was ranked equal initial in a UK in Architecture a Built Environment for a high peculiarity and general impact of a investigate (2014 Research Excellence Framework). In a assessment, 85 per cent of a investigate outlay was judged to be internationally glorious while 90 per cent of a investigate impact was judged outstanding. Building printing refers to various technology that use 3D printing as a way to construct buildings. Potential advantages of this process include quicker construction, lower labor costs, and less waste produced. 3D printing at a large scale may be well suited for construction of extraterrestrial structures on the Moon or other planets where environmental conditions are less conducive to human labor-intensive building practices. Developments in additive manufacturing technologies have included attempts to make 3D printers capable of producing structural buildings.[9]

IV. 3D PRINTED RESIDENTIAL BUILDINGS

In the Netherlands, DUS Architects is 3D printing a 3D Printed Canal House, together with an international team of partners. The 3D Print Canal House links science, design, construction and community at an open building site in the heart of Amsterdam. Their aim is to demonstrate how 3D printing could revolutionize construction by increasing efficiency and reducing pollution and waste, and offer new tailor made housing solutions worldwide. 3D printing could also play a significant role in the quick build of low-cost housing in impoverished areas and those affected by disasters. The 3D Print Canal House is currently under construction at a canal-side plot in Amsterdam – an open 'expo-site' that it is proving to be a popular visitor attraction for the public. At the heart of the site, is the Kamermaker, or Room Builder – which is essentially a scaled-up version of a table-top 3D printer. The Kamer maker prints building blocks from molten bio-plastic. This is currently a mix of 80% plant oil reinforced with microfibers, although this formula is still under development with the project's materials partner Henkel. For reinforcement, the blocks have an internal honeycombed centre that can be back-filled with Eco concrete. It also provides space for pipes, wiring and data cables to be installed internally.[citation needed] The building blocks are then used to form component parts that can be slotted together like Lego to create a 4-storey, 13-room structure model on a traditional Dutch canal house. One of the most distinct design features of the Canal House is its geometrically-faceted plastic façade. 3D Print House Building Blocks. This gives a contemporary 3D print twist to the traditional canal house silhouette. The ability to print ornamental detailing on demand is a key design benefit of 3D modeling and printing in the building industry. [9]

V. CURRENT TECHNOLOGY

Modern development and research have been under way since 2004 to flexibly construct buildings for commercial and private habitation. With built-in plumbing and electrical facilities, in one continuous build the process uses large 3D printers that would notionally complete the building in approximately 20 hours of "printer" time. By January 2013, working versions of 3D-printing building technology were printing 2 meters (6 ft 7 in) of building material per hour, with a follow-on generation of printers proposed to be capable of 3.5 meters (11 ft) per hour, sufficient to complete a building in a week. Behrokh Khoshnevis founded the Contour Crafting project which demonstrated the basic capability, based on two parallel rails, an XY-controlled printing gantry and pressurized concrete tank. Dutch architect Janjaap Ruijssenaars's performative architecture 3D-printed building was planned to be built by a partnership of Dutch companies. The house was planned to be built in the end of 2014, but this deadline wasn't met. The companies said that they are still 100% sure the house will be printed. Various approaches to building printing are being researched. Two of these are Contour crafting and D-Shape. Other approaches involve direct sintering of inorganic raw materials to build composite ceramic building structures, similar to the approach used with metals in direct metal laser sintering.

VI. USE OF DRONES FOR 3D PRINTING

Drone swarms that can print emergency shelters for survivors of natural disasters are just around the corner, says Mirko Kovac in an interview. Colin Smith visited Imperial College London's flight arena, buried deep in the bowels of the Department of Aeronautics, to speak to Dr Kovac. In between carrying out tests on a prototype aerial robot for repairing oil pipelines, Dr Kovac spoke about his research and the future benefits aerial robotics could bring in construction. Dr Kovac and his team have received more than £3.4 million in funding from the Engineering and Physical Sciences Research Council and industrial partners. His project will push forward the development of aerial construction-bots, equipped with 3D printing technology, which excrete materials that can be used to repair or build structures. One potential application is in disaster relief, says Dr Kovac. These types of emergencies can throw up all types of physical obstacles such as landslides and floods, which prevents teams from reaching those in need in a timely way. Dr Kovac says the aerial drones he is developing could fly to a disaster zone, scan and model the landscape using Building Information Management (BIM) systems, design temporary shelters, and print them on the spot. This could give those in need a place to live until emergency services personnel can reach them. This process, called Additive Building Manufacturing (ABM), is already being trialled in many parts of the world by the construction industry. It involves the use of large robots on a building site that extrude building materials to construct buildings, similar to a 3D printer. This process has the advantage of reducing construction times, material and transport costs and easing traffic and environmental impacts. These technologies also have the potential to improve safety in the building industry. According to the International Labor Organization, at least 60,000 people are killed every year on construction sites - around one death every 10 minutes. However, the current approaches are all ground-based, on lying operating in easily accessible locations, and they can only build small structures. Dr Kovac will lead a team of researchers who are aiming to advance ABM technology so that construction could be carried out for the first time from the air. The team plan to miniaturize ABM and give it aerial capabilities so that it can be more mobile and able to manufacture complex high-rise structures. This would enable the robots to be flying mini-factories, where they would land at to a construction site work together to create buildings from scratch.[9]

VII. NEED OF ROBOTIC DRONES TO 'PRINT' EMERGENCY SHELTER

Researchers from the University of Bath, Imperial College, and University College London have developed robotic drones designed to "print" emergency shelters. The flying robots will autonomously assess and manufacture building structures to help areas suffering from natural disasters. Using Building Information Management (BIM) systems, the drones in production could fly to a disaster zone, scan and model the landscape, design temporary shelters, and construct them on the spot. The team plans to miniaturize the Aerial Additive Building Manufacturing, or ABM, process. The robots will act as flying mini-factories, landing at to a construction site and working together to create buildings from scratch.. According to statistics from the International Labour Organization, at least least 60,000 are killed annually on construction sites – that's about one death every ten minutes. Automating some of the most hazardous parts of construction would definitely make sites far safer. Admittedly, this usually won't require flying 3D printers – a robotic concrete 3D printer would do just fine. However, Dr. Kovac is especially thinking about disaster areas that are hard to reach. Landslides, earthquakes, mudslides and flash floods somehow frequently happen in far-off locations, such as the earthquake that struck Nepal in 2015 and killed more than 8,000 people and heavily damaged numerous cities and villages throughout the Himalayas. These types of disasters create all sorts of physical obstacles for relief teams and construction workers who need to build temporary living conditions. "Drones would fly to the [emergency] site and just observe what is happening. Once the site has been identified, and where shelters would be needed, then we could create the virtual model on the computer offsite, in a safe zone away from the site," explains Kovac. The drones could then return to do the necessary 3D printing. This would greatly reduce the risk for emergency personnel while also helping the people in need as quickly as possible. Their whole work is to be coordinated by a so-called Building Information Management system (BIM), which is fed by the sensor data from scouting drones. The real challenge, however, will be in creating adequate 3D printer mounts for the drones, capable of delivering sufficient payload accurately. Coordinating a fleet of drones might also pose a challenge. The idea, however, is revolutionary. What's more, these drone 3D printers can also be used during the construction of tall buildings, simply to work on hard-to-reach places. It's all part of what Kovac foresees as being 'smart cities'. Drones will take over a lot of jobs, and simultaneously create more jobs, as they will need to be manufactured, operated, and maintained. While it all sounds very futuristic – and it remains to be seen if 3D printing can be reliably and accurately achieved by drones – it's a concept that could truly change the construction and disaster relief industries if it works.[9]

VIII. ADVANTAGES

1. It could save lives of human beings from construction accidents.
2. It could help and provides shelter in disaster regions.
3. It could help our soldiers, stationed at the territory of country by providing shelters during war period.
4. It could save life as well as time.

Applications:

1. French researchers develop extremely thin 3D printable acoustic met surface to perfect sound absorption
2. 3D printed 'O Phone' goes back to basics to cure Smartphone addiction
3. Belgian design agency treats clients to chocolate made with 3D printing
4. 3D printers find their way into the metal spring industry for prototyping
5. Metal 3D printing soaring in Singapore's blooming aviation industry three ASFOUR unveils two spectacular 3D printed dresses at New York Fashion Week Renishaw and BioHorizons collaborate to produce tailor-made 3D printed dental abutments.

IX. CONCLUSIONS

This study shows the importance and use of '3D Printing Drones' in today's scenario. It also focused that by using such modern technology we can save the precious human life being slayed at construction sites of disaster region. And we can also these drones by commercial way for example its use in chocolate industry.it can also get used for surveillance purpose.

REFERENCES

[1]. Bills, C., Chen, J., Saxena, A.: Autonomous MAV flight in indoor environments
[2]. using single image perspective cues. In: IEEE Int. Conf. on Robotics and Automation.
[3]. (2011)

[4]. Bills, C., Yosinski, J.: MAV stabilization using machine learning and onboard
[5]. sensors. Technical Report CS6780, Cornell University (2010)
[6]. Faigl, J., Krajn´ık, T., Von´asek, V., Pˇreuˇcil, L.: Surveillance planning with localization
[7]. uncertainty for mobile robots. In: 3rd Israeli Conference on Robotics.(2010)
[8]. Ng, W.S., Sharlin, E.: Collocated interaction with flying robots. Technical Report
[9]. 2011-998-10, Dept. of Computer Science, University of Calgary, Canada (2011)
[10]. Higuchi, K., Shimada, T., Rekimoto, J.: Flying sports assistant: external visual imagery
[11]. representation for sports training. In: 2nd Augmented Human International
[12]. Conference, New York, NY, USA, ACM (2011) 7:1–7:4
[13]. Tomas Krajnik et.al. AR-Drones as a platform for robotic research and education (2012)
[14]. Krajn´ık, T.: Simple 'getting started' applications for AR-drone (2011) http://
[15]. labe.felk.cvut.cz/~tkrajnik/ardrone.
[16]. ˇSolc, F.: Modelling and control of a quadrocopter. Advanced in Military Technology
[17]. 1 (2007) 29–38
[18]. 9.www.bbc.com/news/technology-27311292