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Research Article

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Utilization Of Drones as A Tool For Monitoring Progress In Civil Engineering Construction Using Enugu State As A Case Study

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Abstract

The hazardous nature of the Nigerian building construction sector is alarming due to the dearth of construction data and records of incidents that have led to the loss of life, property damage, injuries, and loss of materials on construction sites This study aims to assess the effectiveness of drone monitoring of security and safety at Nigerian building sites in reducing hazardous site conditions. The following hypotheses were made to meet the study's goal and objective to assess the level of drones using Enugu State in Nigeria as a case study. The Methodology includes a literature survey and questionnaires at various sites. 242 people responded to the survey. To assess the constraints of employing quadcopters and other drones/UAVs (unmanned aerial vehicles) for safety and security surveillance on construction sites in Enugu State, Nigeria. Inventive drones and the DJI Phantom 3 Standard Both types of drones were used in this experiment. The targeted experts and stakeholders included architects, builders, engineers, quantity surveyors, land surveyors, estate surveyors, and clients. The data were analyzed using the SPSS computer program for Windows, version 23.0. Only 65 per cent of respondents were aware of the drone idea, although 51 per cent of respondents used drones in various construction monitoring sectors. The adoption rate of 17.6% for safety and security monitoring, however, was deemed low by participants in the Enugu State building construction sector. Drones have been successfully used in developed countries such as America, Europe, China, Australia, and India, to monitor safety and security as well as the progress of both large-scale and high-rise construction projects. As a tool for monitoring the security and safety of all building phases, drones are still in their infancy from the Nigerian perspective. The successful use of drones in Nigeria is encouraged since realistic imagery generated from drones may be used for analysis and evaluation of ongoing construction work, including planning movement on site and monitoring materials on site and may be archived for future purposes.

Keywords: Building Construction, Unmanned Aerial Vehicles, Drones, Enugu State, Security Surveillance

1. Introduction

The industry is risky since there are insufficient construction statistics and records of incidents that have led to fatalities, property damage, injuries, and material losses on typical building construction sites in Nigeria. UAVs were initially largely utilized for military operations, and military research has played a significant role in the development of UAV technology. Additionally, satellite navigation has been made possible for the military as well as civilian Drones because of the advancement of GPS technology. The term "quadcopters" refers to small multi-rotor helicopters that can be fitted with virtually any type of sensor technology. Humans are unable to reach certain heights, but drones can. You can use a

drone to capture pictures and identify the damaged area of a roof while inspecting it for leaks. High-rise buildings can be inspected by drone without interfering with activity. In a matter of minutes, an unmanned aerial vehicle can take a large number of pictures at various angles and zoom levels. The entire procedure is carried out with very minimal safety risk, at significant cost savings over alternative inspection techniques, and without closing any roads. The Nigerian construction sector is well renowned for adopting technologies later than other industries. Currently, the construction industries are undergoing a digital revolution that represents a paradigm shift in the way technologies are used. This revolution aims to boost productivity, efficiency, value, quality, sustainability, and lower lifecycle costs. The usual task force and qualified workers needed for the safety monitoring of construction sites are severely understaffed. Many safety and security events, though, go unreported. An ordinary Nigerian construction site is dangerous and accident-prone because local contractors and clients pay little to no attention to safety and security. The recent deterioration of the situation is attributable to government policy and a lack of enforcement.

The aim of this study is to the utilization of helicopters and drones as a tool for monitoring progress in civil engineering construction work. Drones can also be used for population ecology, ecological monitoring and conservation, species distribution modelling, urban traffic monitoring, building environment monitoring, ecological monitoring, and ecological and environmental monitoring. Other uses for drones include delivery services, human and societal understanding, personal and commercial photography and videography, and archaeology and cultural heritage. Additionally, unmanned aerial systems have been employed successfully in a variety of fields, including mining, oil and gas, construction, environmental protection, and agriculture. A significant portion of the structural engineering industry's assistance comes from drones. They are frequently employed during construction to complete a project or inspection in difficult-to-reach regions. To accurately assess the current state of the roof, skylights, culverts, and bridges, structural engineers take advantage of the UAV's ability to collect high-resolution photos.

2. Literature Review

UAVs are used in a variety of different businesses all around the world. They work on the creation of construction projects as well. They provide exact performance information regarding the state of the building or the current construction conditions. UAVs are needed for projects to collect visual data in the form of images, videos, and 3D models from the key places and angles on a project site. Recently, a lot of study has been done on deploying UAVs in several areas of the construction business. The current digital revolution affecting the construction industry is a change in how technologies are used, to boost productivity, efficiency, value, quality, sustainability, and lowering lifetime costs. The timely and effective delivery of construction projects is one of the challenges facing Nigerian building construction in the 21st century [1]. Buildings are constantly collapsing as a result, and there is inadequate safety oversight and material management on building construction sites [2]. As the population grows, land values increase, natural resources decrease, and human activity continues to strain the quality of the land, water, and air, it is more crucial than ever to measure and monitor the environment. As a result, topographical information systems, which are advanced over topographical surveying, are required [3]. High-resolution digital elevation models (DEMs) created by UAV photogrammetry are among the most crucial spatial information tools for studying hydrology and geomorphology [4].

Governments, security personnel, and civil society in Nigeria are extremely concerned about the rise of insecurity, terrorism, kidnapping, killing, and shooting of innocent individuals as well as environmental degradation brought on by terrorism [5]. Automated site management solutions are essential for lowering accident risks. Unmanned aerial vehicle (UAV) remote sensing has recently been used for a variety of purposes in the civil sector, including tracking climate change [6,7,8] assisting in search and rescue operations [9,10], and maintenance in the construction industry [11,12], helping with search and rescue operations, as well as maintenance work in the construction sector [9, 10, 11, 12].

An aircraft without a human pilot on board is simply referred to as a drone or an unmanned aerial vehicle (UAV). Drones or unmanned aerial vehicles (UAVs) are machines that function to varying degrees of autonomy; they are flown by a human operator using a remote control through radio frequency or satellite and are entirely controlled by onboard computers (Holton et al., 2015) [13]. Unmanned aerial vehicles (UAVs), commonly referred to as drones, are pilotless aircraft that were originally employed only by the military but are currently used for a variety of scientific purposes and both for the general good and in the business world [14,15]. It is currently essential for a variety of corporations, organizations, and companies in Nigeria's logistics sector to secure and carefully monitor their infrastructure to maintain efficiency, effectiveness, and survival [16].

UAVs are cutting-edge technology that can be used in the construction business for a variety of purposes and can speed up and improve worker productivity. UAVs can be utilized for real-time surveillance of construction project sites in infrastructure inspection and construction applications. Therefore, without having to physically reach the site, project managers may monitor the construction site using UAVs to have a better understanding of how the project is progressing. Additionally, UAVs can be used to inspect electricity transmission cables at high voltage. Unit to detect air and gas content. To inspect electricity lines, the authors deployed UAVs to conduct autonomous navigation. The UAVs were used to find, examine, and identify power line infrastructure flaws. A fully automated UAV-based system was created and put into use by the authors for real-time power line inspection. More specifically, a variety of UAV photos and data were analyzed to locate trees and buildings close to power lines and to determine the separation between the trees, buildings, and power lines. TIR

cameras were also used to identify poor conductivity in the power cables. UAVs can be used to monitor infrastructure and facilities, including pipelines for water, oil, and gas. The authors suggested using small unmanned aerial vehicles (UAVs) with a gas controller. The device offered remote sensing to find gas leaks in pipes carrying gas and oil. Some UAV uses for infrastructure and construction inspection are included in Table 1. This chart details the various UAV types that have been employed in uses in construction and infrastructure inspection, the kinds of sensors used in each, and the accompanying UAV specifications for payload, altitude, and endurance. The construction sector is undergoing a revolution and embracing technology to increase efficiency, improve quality, and reduce risk. The construction sector is now embracing the advancements instead of being resistive and unresponsive. The current construction sector is embracing technology and starting to deliver differently.

Globally, there is an aerial revolution taking place. Drones have become technologically advanced instruments with multiple applications, most notably in the construction industry. Their advantages range from improved project monitoring capabilities to increased on-site safety. Drones are helping the construction sector restructure itself by enabling quality control, project management, increased safety, real-time reporting, and simple access to expansive or challenging sites.

3. Research Methodology

This study used accurate images and video streams captured by DJI Phantom 3 and a genius-Idea drone to examine the use of quadcopter drones (unmanned aerial vehicles) as a tool for monitoring worker safety cultures on building construction sites. The researcher selected these drones because of their excellent photo quality and accessibility in the study area. Drones with characteristics that allow data collecting in building sites easier are made by DJI Enterprise, though. A recreational drone was employed in the survey as a backup to the real Idea drone.

In this study, drones with the following characteristics, including DJI Phantom 3 standard drones and genius-idea drones, were used: Drone with innovative concept takes off, weighing 275 grams and capable of 3000 meters of flight. For mobile equipment systems, versions of iOS 8.0 and above or Android 4.3 are needed. The DJI Phantom 3 has a maximum tested altitude of 500 meters, an endurance time of 25 minutes, an inbuilt 3-axis gimbals stabilization, a photo resolution of 12 megapixels, a shutter speed of 8 to 1/8000 s, a video resolution of FHD (1920 x 1080), high density (1280 x 720), and a package weight of 0.65 kilograms, recording media of micro SD 64GB, and an operating temperature of 32 to 40°F/0 to 40°C. Moreover, the remote control is included. Figure 1 presented the top view of a typical drone.

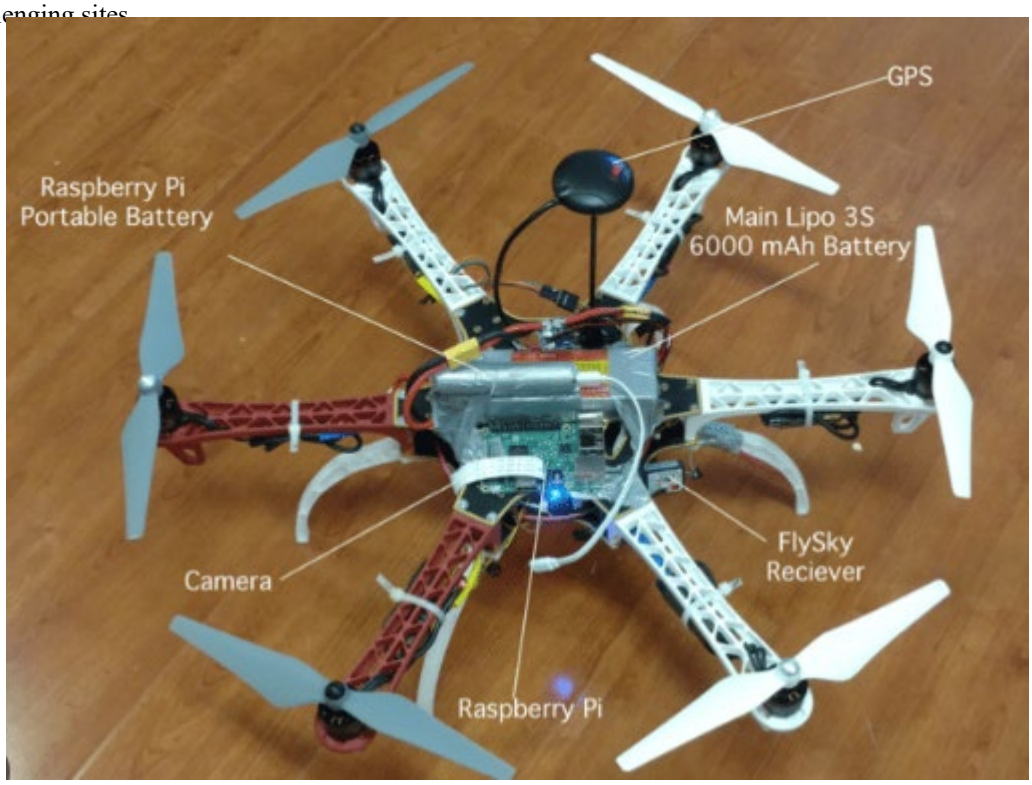

Figure 1: Top views of a typical drone.

3.1 About Drone Technology

A drone is a real flying machine that performs specific tasks for which it has been trained, such as product delivery, aerial photography, area surveys, etc. This has the benefit of taking less time and producing the greatest results. There are numerous types of drones, including quadcopters, hexacopters, AI drones, and augmented reality drones. Drones are the future of many industries, and in the next 5 to 10 years, they will completely transform the market.

Types of Drones

1. Drones with a single rotor
2. Dual-Rotor Drones
3. Drones with Fixed Wings
4. Fix-Wing Hybrid Drones
5. Tiny Drones
6. Miniature Drones
7. Tactical Drones

1. Drones for reconnaissance
2. Huge Battle Drones
3. Large, Non-Combat Drones
4. Decoy and Target Drones
5. GPS Drones
6. Drones for photography
7. Drones for racing.

Component of Drones

1. Common Propellers
2. Pusher Propellers
3. Brushless Motors s
4. Landing Equipment
5. Speed controllers, electronic
6. Flight Director
7. The Recipient
8. The Transmitter
9. A GPS unit
10. A battery

11 Camer

Figure 2 presented labelling of parts of drones

Figure 2: Parts of drones

3.2 Application of Drones in Construction

As real-time monitoring technology advances, UAVs have several advantageous uses in civil engineering to supervise the building, bridge, or other structure's construction and any infrastructure system by taking pictures of photos of a project site taken from various angles as well as possible. UAVs have been considered in certain research for checking the buildings when performing upkeep. Additionally, they have been utilized in a variety of transportation contexts, including traffic management and observing traffic on roadways both before and after emergencies, extreme weather, road surface deterioration, roadway upkeep, and repair tasks Constant oversight of the job site to improve worker safety workers. Compared to conventional traffic control systems, UAVs can fly above the workplace and perform a variety of tasks spanning a wide area. Drones are being used by the project manager and in-charge to monitor work progress on the job site in real-time. Drones may give users a good perspective of construction sites, making it easier for them to see what has been completed and what work is still outstanding. They can also decide whether any adjustments to the current project are necessary. With drones, the contractor can manage multiple sites and keep an eye on every action. They can also monitor staff members' attendance, productivity, and commitment to the job.

3.3 Uses of Drones in Project Monitoring

Drones are being used in the construction business more and more frequently. The primary contributing factor is the use of a novel technique and the capacity to fly at high altitudes. This technology enables construction organizations to use the data gathered for work operations and enhance construction management features connected to the following issues.

4. Site Location

One of the states in southeast Nigeria is Enugu State. Enugu serves

as its capital. The former Anambra State was transformed into the state in 1991. The state of Enugu is situated between latitudes 06°00'N and 07°00'N and between longitudes 07°00'E and 07°45'E. Due to the commercial-scale discovery of coal in Enugu Urban in 1909, the state is known as the Coal City State. At that time, Enugu served as Eastern Nigeria's capital. However, the Devine Hectares and WTC estates were the two estates employed in this research project for observational purposes. In Centenary City, Enugu State Golf and Lifestyle City, in latitude 6°25'39" N and longitude 7°31'13", is the brand-new Devine Hectares Estate. The Enugu, Port-Harcourt Expressway's Enugu-South KM 7 is where Centenary City is situated. The prototype residential structures on the Devine Hectare Estate are duplexes and a few bungalows. Engineers and an estate manager work for the estate exclusively. Phases 1, 2, 3, and 4 make up the estate. While phases 3 and 4 have not yet been created at the time of this research, phases 1 and 2 have some built-up area and roughly 160 plots. While WTC Estate is situated next to the Uba Bus Stop in the middle of Enugu State, Nigeria. In this study, a semidetached bungalow at latitudes 6°25'36N and 7°30'14"E was observed. Figure 3 presented a typical map of Enugu State.

Figure 3: Map of Enugu State

5. Discussion

The modalities provided were accepted and concurred with in this investigation for the effective functioning of drones. Before starting site activities, the UAV must be inspected. On-site work should be done to monitor the ecosystems or find safe areas for flight. Environmental safety criteria, such as those relating to nearby persons, neighbouring buildings, trees, wind and humidity, etc., as well as the status of the UAV (GPS reception, component condition, battery and motor status), should receive special attention. According to our pilot studies, it's crucial to create a flight plan based on the data gathered during the site visit so that the pilot and camera operator are familiar with the predefined flight path, camera sequence, and locations for image capturing, all of which are essential for the successful completion of the work [18, 19]. for the effective functioning of drones. Before starting site activities, the UAV must be inspected. On-site work should be done to monitor the ecosystems or find safe areas for flight. Environmental safety criteria, such as those relating to nearby persons, neighbouring buildings, trees, wind and humidity, etc., as well as the status of the UAV (GPS reception, component condition, battery and motor status), should receive special attention. According to our pilot studies, it's crucial to create a flight plan based on the data gathered during the site visit so that the pilot and camera operator are familiar with the predefined flight path, camera sequence, and locations for image capturing, all of which are essential for the successful completion of the work. agreed that before using a drone on a job site, compliance with the Federal Civil Aviation Administration's regulations must be ensured. Additionally, as no two construction sites are exactly alike, there is a need to plan jobs ahead of time. Knowing what you plan to do with the information before you gather it can help you determine the level of detail that is necessary to complete the task. The modalities provided were accepted and concurred within this investigation. It is challenging to estimate the amount of earthwork and conduct surveys on highly elevated terrain, but by using drones with laser scanners in addition to traditional topography surveys,

we can create a 3D model of a sizable area using programs like Pix4D. We can also observe past progress and gather information to determine what earthwork has been removed and how much of it has been removed. The data that was gathered is more accurate than human labour. This aids in improving the comprehension of the job progress by those in charge. Additionally, this will help to reduce project costs, length, and human labour. Figure 4 presented a building construction being monitored by a drone.

Figure 4: Building construction monitoring by a drone

6. Conclusion

Whether construction businesses employ drones for remote monitoring, building surveys, land surveys, topographic terrain mapping, or any other purpose. Whether used for status updates, thermal imaging recording, or integration with laser scanners, drones have shown to be a priceless asset throughout the whole life cycle of a construction project. When working on building projects, engineers, contractors, investors, and potential clients naturally feel more confident since they can cut costs, time, risk, and labour thanks to drone technology.

High-resolution satellite images become more useful and convenient for mapping than using aerial images. The use of drones will reduce the rate of building collapse, wastage of materials, inadequate monitoring, and unsafe working environment. Job satisfaction will improve because the client will be carried along in the decision-making from any location during the project lifespan. Trained pilots or personnel should handle the flight and take instructions from the site engineer/builder in collaboration with the architect and quantity surveyor on the precautions and areas to capture (the flight mapped out path) for harmonization and delivery. Photography/videography captured on site will be analyzed and communicated to stakeholders for further analysis and corrective measures if necessary. However, the communication could be done through the following media: WhatsApp, E-mail, Skype, and other application software agreed upon by the stakeholders. The format of the reports should be in MS-word format, pdf, MS-project, or in CAD format if need be. Surveying is the cornerstone of all physical progress. This suggests that without the direct and indirect use of surveying knowledge, no significant physical growth can take place. As geospatial professionals throughout the world are tasked with the duty of supplying the accurate geospatial information required in urban and rural development, this knowledge of drones is essential for nation-building and engineering.

7. Recommendations

There is a need to deploy ways of applying effective project smart reporting and monitoring of civil engineering projects. In the construction sector, professional cooperation and labour division are required. The use of drones will reduce the rate of building collapse, wastage of materials, inadequate monitoring, and unsafe working environment. Job satisfaction will improve because the client will be carried along in the decision-making from any location during the project lifespan. Without suitable research and the deployment of modern equipment, sustained physical growth in underdeveloped countries would not be possible.

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