Uses of Drones and Photogrammetry in Project Monitoring

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Abstract - *An unmanned aerial vehicle (UAVs), is also known as drone technology, is used for different types of application in the civil engineering.*

The drone previously has risen in military applications for spying and to get mapping area specifically to the construction project, the drone can be applied as a tool for visual inspections process such as area mapping, tracking work in progress, inspections of built up structure and locating and identifying construction defects.

Over the last 10 years, drone technology has developed to increase battery life for longer flight times, carry heavier payloads to hold more sensors, and create an easier system for the pilots to control. These improvements have made drone technology appealing enough to enter the sceptical world of construction.

Key Words: Drones, Time Saving, High Terrene, UAV, Civil Construction.

1.0- INTRODUCTION:

Construction industry now a days demanding a highly precise planning and work scheduling, effective management of project comes with good specification, requirements and inspections of the project which can enable the overall optimization in time, cost and resources.

However, many the projects still engaging traditional method to monitor progress and conducting inspection. It has caused many disadvantages in the decision making such as poor documentation.

From civil engineering areas, the drones could apply as a tools for visual inspections process either mapping area, working progress, inspections of high structure and to locate defects and cracks. Ageing infrastructures has become a major concern especially for elevated highway and bridges where roughly the life cost is due to repairing and maintenance.

Drones also can be used for ecological and environmental monitoring, urban traffic monitoring, building environment monitoring, species distribution modelling, population ecology, and ecological monitoring and conservation. Archaeology and cultural heritage, human and social understanding, personal and business drones for photography and videography, and even delivery services are other applications of drones. In addition, the unmanned aerial systems have been successfully used in different industries, such as agriculture, oil, and gas, construction, environmental protection, mining, etc.

For mining industry drone can be used as multiple purpose like routine operations on ground surface and in underground mines. To keep observation on ongoing activity. This study aims to conduct a review of the application of drone technology in the mining industry.

2.0- LITERATURE REVIEW:

UAVs are being used in various industries all over the world. In addition, they are used in construction projects development. They provide accurate performance information on the construction state or the current conditions of construction. UAVs are needed for the projects in order to collect visual data in form of images, videos, as well as the 3D Models from the most relevant locations and views of a project site. Recently, many researchers have concentrated on applications of UAVs in different areas of construction industry.

UAVs are innovation technologies that can help those in construction do their jobs better and faster over a number of applications. In construction and infrastructure inspection applications, UAVs can be used for real-time monitoring construction project sites. So, the project managers can monitor the construction site using UAVs with better visibility about the project progress without any need to access the site. Moreover, UAVs can also be utilized for high voltage inspection of the power transmission lines.

In the authors used the UAVs to perform an autonomous navigation for the power lines inspection. The UAVs was deployed to detect, inspect and diagnose the defects of the power line infrastructure. The authors designed and implemented a fully automated UAV-based system for the real-time power line inspection. More specifically, multiple images and data from UAVs were processed to identify the locations of trees and buildings near to the power lines, as well as to calculate the distance between trees, buildings and power lines. Furthermore, TIR camera was employed for bad conductivity detection in the power lines. UAVs can also be used to monitor the facilities and infrastructure, including gas, oil and water pipelines. The authors proposed the deployment of small-UAVs (UAV) equipped with a gas controller unit to detect air and gas content. The system provided a remote sensing to detect gas leaks in oil and gas pipelines. Table 1 summarizes some of the construction and infrastructure inspection applications using UAVs. More specifically this table presents several types of UAV used in

construction and infrastructure inspection applications, as well as the type of sensors deployed for each application and the corresponding UAV specifications in terms of payload, altitude and endurance.

According to the survey results, 34 respondents said that their companies use subcontracted UAV services. Reviewing the raw data for these 34 respondents reveals that 18 of them were among those that also use in-house UAV operators. This means that 16 respondents totally rely on subcontracted UAV services out of the 69 that use UAVs on their construction sites (28%). Survey participants were asked to select their uses of UAVs from numerous options within the construction industry. As seen in Figures-5, the most popular uses of UAVs on construction sites are capturing progress photos, then followed by taking promotional videos, conducting visual inspections, and enhancing site management.
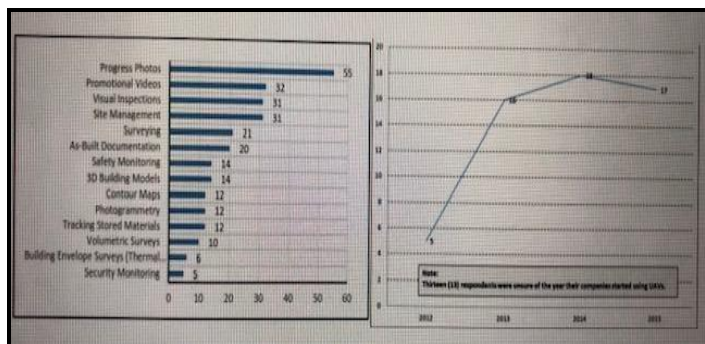

Figure.1: UAV Uses across all Sectors of the Construction Industry & Distribution of Year of UAV-Adoption

Above figure presents the distribution of responses related to the year in which respondents' companies first used UAVs on their construction sites. The earliest known uses among survey participants occurred in the year 2012, when five respondents indicated that their companies started using UAVs. The next year, 16 respondents' companies started using UAVs. Little change was seen in the number of companies starting to use UAVs in the years 2014 and 2015, as the numbers were 18 and 17 respectively. As companies become more familiar with the exemption process and the FAA rules, the trend of UAV utilization will likely see an increase.

3.0- ABOUT DRONE TECHNOLOGY:

Drone is a physical flying machine which does the certain tasks for which it is trained to do so operation like product delivery, Aerial photography, Arial surveys of area etc. the advantage of this is it takes less time and give the best results out of it. Drones are of different types like Tricopter, Quadcopter, Hex copter, AI drone, AR drone etc. Drones are the future of many industry and it changes all the aspects of the market in coming 5-10 years.

3.1- Types of Drone:

1. Single-Rotor Drones

2. Multi-Rotor Drones

3. Fixed-Wing Drones

4. Fixed-Wing Hybrid Drones

5. Small Drones

6. Micro Drones

7. Tactical Drones

8. Reconnaissance Drones

9. Large Combat Drones

10. Non-Combat Large Drones

11. Target and Decoy Drones

12. GPS Drones

13. Photography Drones

14. Racing Drones

3.2- Components Parts of Drone:

1. Standard Propellers

2. Pusher Propellers

3. Brushless Motors

4. Landing Gear

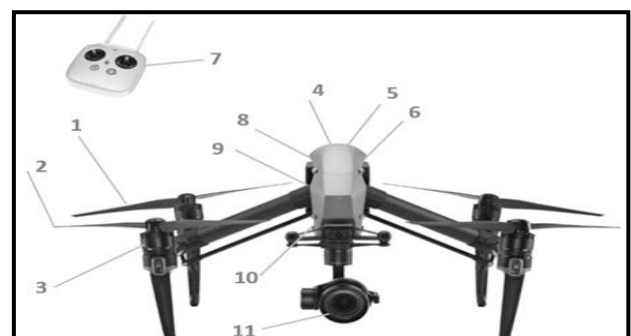5. Electronic Speed Controllers

6. Flight Controller

7. The Receiver

Figure.2: Components parts of drone

8. The Transmitter

9. GPS Module

10. Battery

11. Camera

4.0- APPLICATION OF DRONES IN CONSTRUCTION:

With development of real-time monitoring technologies, UAVs provide many positive applications in civil engineering to control the construction process of the building, bridge, and any infrastructure system through capturing videos and images from parts of views of a project site as more as possible. Some studies have considered UAVs for checking the structures during maintenance. Moreover, they have been used in various transportation areas, such as traffic controlling and monitoring on roads during and after emergency incidents or severe weather conditions, road surface distress, repair and maintenance of streets activities and management of the work site to enhance the safety of workers. Compared to traditional control traffic systems, UAVs can fly over the work environment and they are able to cover a large area.

5.0- USES OF DRONES IN PROJECT MONITORING:

The application of drones to construction industry has increasing day by day. The new technique and ability to fly on high elevation is the main contribution factor. This technology allows construction companies to use the collected data for the processes of the work and improve aspects of construction management related to following factors.

5.1- Volumetric Estimation:

It is difficult to calculate quantity of earthwork and take survey on high elevated terrene land so by utilizing drones with laser scanner combined with standard topography survey 3D model of large area can me created on computer with different software's like Pix4D and we can be calculate what type earthwork and their quantities present at site and we can also take observation on past progress and plan data to identifying what earthwork has been removed and how much work done on particular site on duration. This collected data is more accurate to human workmanship. This helps to project in charge better understanding of the work progress. And also this will helpful for to save the project cost & duration and Human Workmanship.

5.2- Progress Reporting:

Mostly contractor depends on their supervisor and engineering team. But they have to handle more sites from office so in now days they are using drone's technology to get update of the ongoing projects.

The project in-charge & manager is using drones on their sites to get real time work progress at site. Drones can provide a clear view of sites this is help them to identify what is done which work is still pending on site and they can also take decision what changes required to the particular work and. The contractor can handle many sites with drones and keep eyes on each and every activity and contractor can also monitor their staff attendance working ability and their dedication towards the work.

5.3- Structural Integrity Maintenance:

The all completed projects are required periodical maintaince. The project like high rise building, skyscraper, bridges and dams are difficult to inspect and need more time and manpower to complete the inspection task. With the help of drones, we can get clear images of work. This methodology saves time as well as manpower and also reduce the risk of any mishap at site. Sometimes client wants to see what action taken on their observed points so we can show them taken action on work from site to directly on their computer screen at office.

5.4- Safety:

The construction industry is the one of the dangerous occupation. Especially for the working labor on site. The statement given by OSHA is construction has been ranked as the most dangerous industry in the last decade (DeYoung, 2018, p. 24). The main reason of the accident is fast working nature of construction and lack of awareness of construction safety at construction site.at some site there is no safety officer available at site to instruct labors. And this main reason accident at site. Accident can be reducing by generating safety awareness among the labor and by utilizing drones to inspect areas that are difficult to reach and taking strict action on workers who does not following safety rules at site.

UAVs enable organizations to inspect hard-to-reach

Areas and to deliver supplies without exposing employees to the potential risks. For example, engineers used UAVs to inspect the 343-meter-high rise building Viaduct, controlling them from the ground and thereby reducing personal risk.

5.5- Inventory Management:

To keeping eye on site material, equipment's is most challenging task. Using live images, videos that captured by drone data can help to contractor keep eye on assets as per convenience without presenting on project.

5.6- Quality assurance:

Advanced drones are equipped with infrared thermography sensors have been increase the quality assurance of the contractor to the client. In this technology drones scan the whole structure and create 3D image of the structure and

helps to identify defects that may be present. This defects would most likely go unnoticed without the uses of this technology.

5.7- Taking fast decision:

Real-time information is a key challenge for engineering

And construction companies. UAVs can assist project

Managers by providing a picture of the entire project

And keeping them informed about day-to-day progress.

They are then able to take informed decisions quickly and

Anticipate planning delays.

5.8- Advertisement & Marketing:

If you want to attract people to purchase your product for that you have to perform some unique marketing ideas an e.g. with using of drone you can click different photos & and videos from different angle to show your client how your imagination is transferring into reality to give assurity to your clients about your product.

5.9- Team Communication:

This is where the project team and its employees can address different aspects of site operations with a software glance of its live data from drones. This type of transparency can lead to, simplification and coherence in decision making and production control, increased work coordination, easier identification of problems and deviation, stimulation of contacts among work units and broadened employee engagement and autonomy.

6.0- DISADVANTAGE:

1. Skill person required for operations.
2. Initial investment is high.
3. Legislative uncertainty
4. Spying
5. Climatic conditions

7.0- PRACTICAL USE:

a. Drones are recently use by disaster management team in Kolhapur during flooding to locating the victims of flooding.

b. Indian railway using this technology for inspection and 3D mapping dedicated freight corridor with length 3360 KM the entire project is mapped using this technology.

c. At NOV-2019 COAL INDIA used drones to identify illegal mining a system which had already tested in a pilot project.

d. An autonomous body of India uses drone's methodology for 3D digital mapping for DPR. Project Name- Raebareli – Allahabad Highway.

8.0- CASE STUDY:

8.1 Hospital building Progress monitoring using 3D Image:

During the construction process of the single storey hospital apartment, the drone was flown minimum five times to captured different photos with different angle. First photo was taken at 0' degree camera angle with altitude of 8 meter & second image was taken at 90' degree camera angle with altitude of 16 Mtr and the third image was taken at 35' degree and height is 25 Mtr. and fourth one is taken at 65' Degree camera angle and altitude of 35 Mtr after collecting all images, all the data is transferred to the computer and with the help of software (3DF Zephyr) data is converted into 3D Model then it is exported into REVIT (software that supports BIM models).
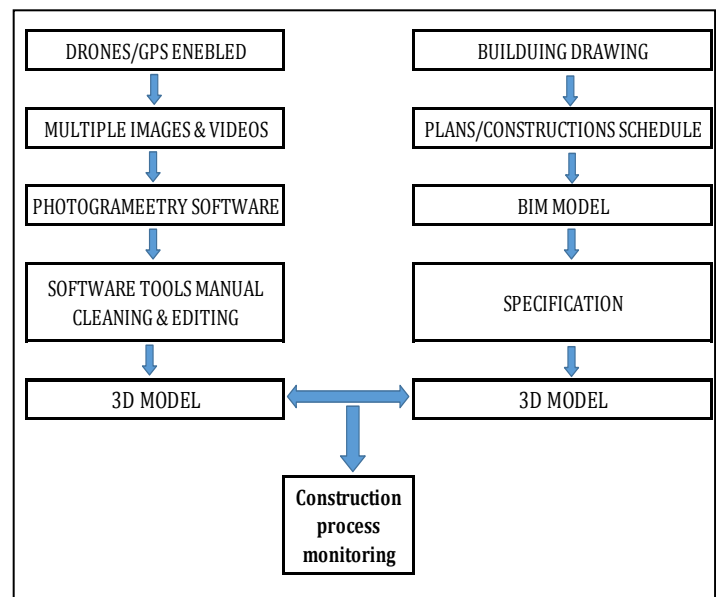

Figure.3: Overall Process using drone to monitor project.

Then both REVIT models, the original one & the one which is created using drone is compared with each other and is shows difference in dimension an e.g., Comparison shows that door were installed on schedule and the placement of the windows was delayed. This indicates that a lag was building up between doors and windows installation. The lag detected with windows installation could be recovered by the time door were being installed.
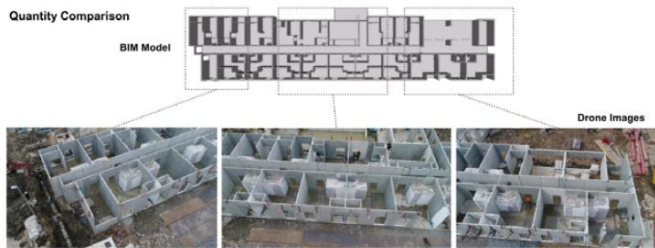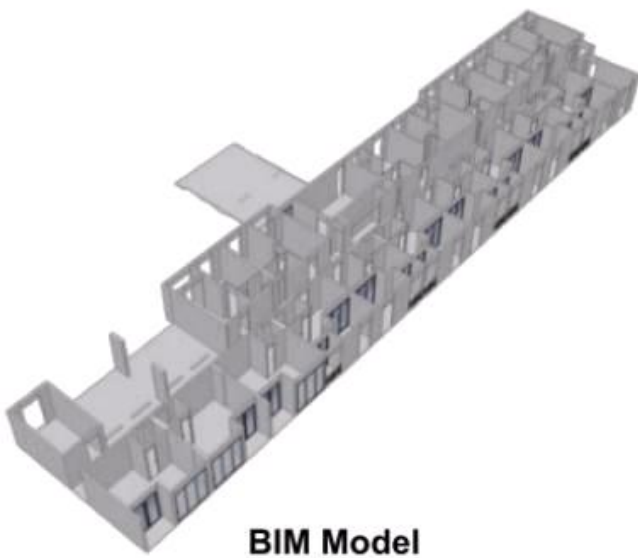
Figure.4: Quantity comparison for the placement of Door

Figure.5: BIM Model

Figure.6: Drone Image

8.2 Drones can Deliver Construction Prefabricated Unit:

Drones deliver prefabricated construction unit research result shown that UAV can also use for to transfer object from one place to another place while hovering. Where difficult to approaches for human, at such scenario the object is attached to special UAV by human or magnet had delivered by UAV. The architectural installation work was done by UAV in FRAC Centre Orleans, Prefabricated module size was 30 cm × 15 cm × 10 cm. For this work four UAV were guided by intercommunicating program based on real time camera system to pick up and drop object on desired location. The glued modules is placed by human to the pickup location after that drones pick up the light weight module and place it to the decided location after placing 1500 lightweight module the tower has a height of 6 mtr. It's a scaled tower from this we can conclude that the drones can be used for delivering tool to build prefabricated structure.

8.3 Drones Used in Placing Pilot Lines of Suspension Bridges:

In construction process of cable suspension bridge a pilot line must be placed first from first anchorage to the other side end anchorage before the catwalk is constructed then cable is connected to anchorage. There is different method has been used to position the pilot line. And there is a one story a young man flying kite to carry pilot line with kite to build the Niagara River railway suspension bridge. At present helicopter and boats were used to carry pilot line but this not method could be difficult in hilly terrene & mountain and climatic conditions and for both helicopter & boats need skilled person to done this job and this method is time consuming and costly. Research study gives solution on this that drones are capable for placing pilot lines. This method also use in newly built suspension bridge. The 2470-meter-long bridge, Longjiang Suspension Bridge (Fig. 10), is located in a mountainous area in China. Chishuihe Bridge (Fig. 7), with a main span of 1,200 meters, connects two provinces in China. Xingkang Bridge (Fig. 8) has a main span of 1,100 meters. Yangsigang Bridge (Fig. 9) was under construction and is completed in 2019. All these project used drones for pilot lines.

Figure.7: Chishui River Bridge

Figure.8: Xingkang Bridge

Figure.9: Yangsigang Bridge

Figure.10: Longjiang Bridge

9. CHALLENGES:

Due to the small battery drones have limited flying time and commanding range is also less. In some work may not complete with one time flying. The payload capacity is very limited. For operating drones professional training required. And drones cannot be used in weather conditions like heavy raining heavy snowfall high wind velocity. While monitoring real time traffic there is chances that flying drones can be distract some degree and undermine traffic safety. Large amount of data is a great challenge even though many advanced algorithms are available. The image sharpness or clarity is another critical challenge that hinders drones from further application in infrastructures. Well understanding of input and output relationship is of great importance before widespread applications of drones in infrastructures. However, this relationship is not easy to understand or evaluate. Furthermore, searching the balance between public concerns of safety and privacy and drone benefit is a challenging issue.

10. CONCLUSIONS:

The construction industry is one of the fastest growing industry & also playing major role in economy of India. The construction industry is experiencing a digital transformation that has been highlighted by the emergence of computer programs used to increase communication and expedite construction. The construction industry upgrading itself day by day and drone technology is one of them. We can conclude that

•During planning phase UAV can be used for accurate survey and mapping purpose to collect necessary information to make good plans. Good plans improve productivity by reducing cost without sacrificing serving quantity

•At the time of construction phase drones can be used for both monitor the construction activity and deliver materials.it saves time and cost effective to use drone during the infra work

•This method can be used for reporting and for documentation of project.

•Drones also useful for inspecting such area and part of infrastructures were difficult to reach human such as underneath of bridge, high tower, windmill, dams, and skyscraper. For maintenance purpose and for inspection.

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