UAV REMOTE SENSING FOR MAPPING OF LAND ACQUISITION PROJECTS IN ANDHRA PRADESH: A CASE STUDY

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Abstract

Unmanned Aerial Vehicle (UAV) platforms are nowadays a valuable source of data for surveillance, inspection, mapping and 3D modelling. UAVs can be considered as a low cost, short & close range alternative to the classical manned aerial photogrammetry. At the current state low cost UAVs are being used mainly in mapping projects with low budgets. UAV based mapping provides not only the required accuracy at micro scale and also for the generation of elevation models in small scale areas. Rotary and fixed wing UAVs are capable of performing the photogrammetric data acquisition with amateur or single lens reflex digital cameras and it can fly in manual, semi-automated and autonomous modes. The outputs of the UAV technology includes 3D results like Digital Surface or Terrain Models (DSM/DTM),dense point clouds, textured 3D models, ortho-images, etc. In the present study, an attempt is made for mapping of different structures using UAV technology in Kovvada village, Ranastalam mandal, Srikakulam district, Andhra Pradesh for rehabilitation purpose. The abilities of UAV imageries in mapping of structure are assessed. The study reveals that the information generated on various types of structures with measurements in the village is very precise and serves the needs of the administration for disbursing compensation and rehabilitation measures in land acquisition sites, in a short duration.

Keywords: UAV Remote Sensing, Drones, DTM, DSM, 3D

Introduction

The applications of Unmanned Aerial Vehicles (UAVs) also known as drones have exponentially grown in the past few years. Now a day a large number of engineers, agriculture scientist, decision makers, facility management and relevant service providers are using these platforms for real time assessment and monitoring activities of various applications. With the progress of remote sensing technology including sensors and platforms together with image processing software, many new opportunities have developed in the areas of monitoring systems with the possible high frequency data collection. Unmanned aerial vehicles (UAV) offer a viable alternative option with a number of advantages over the other more traditional aerial platforms such as light aircraft and helicopters (Klemas, 2015). Such advantages include improved mission safety, flight repeatability, the potential for reduction in operational prices and fewer weather related flying limitations. These advantages are depending upon the type and size of airborne platform, sensor type, mission objectives, and the regulatory requirements imposed. GPS guided UAVs have the capacity to obtain very high spatial resolution (10 cm) imagery of specific landscape features with revisit times determined by the operator as opposed to fixed satellite revisit times (Lechner et al., 2012).

Unmanned Aerial Vehicle (UAV)

UVA hardware system includes a wireless remote control with active radio communication system, unmanned aerial vehicle (Rotary / Fixed Wing) with flight control, communication equipment, payloads, sensors and so on. The Rotary wing UAVs are more suitable for surveying small areas, whereas the fixed-wing’s design is based on that of an aircraft and is suited for surveying larger areas (Tahar & Anuar, 2012). Furthermore, the multiple rotor design of the rotary-wing gives it the ability to fly steadily, hover over an area and capture images (Eisenbeiss & Sauerbier, 2011). According to Tahar & Ahmad (2013), this gives the rotary-wing the ability to be more stable and thus capture images easily.

The DJI Matrice 100 Quadcopter UVA has been used which is having a rotary blade, or propeller-based system. These mini-copters are able to fly in every direction, horizontally and vertically, as well as hover in a fixed position. The relevant parameters for UVA flight platform presented in Table-1. Agisoft PhotoScan UVA data processing software is adopted for post processing of captured data. Agisoft PhotoScan is a stand-alone software product that performs photogrammetric processing of digital images and generates 3D spatial data based on the theory of full digital photogrammetry and remote sensing, using few control area network adjustment of remote sensing images, on account of the techniques including automatic matching of multi-baseline and multiple-matching high-precision digital elevation model, the production of high-precision image map and mosaic.

Table 1. The Parameters for UVA Flight Platform

Diagonal Wheelbase	*Weight with Battery*	*Payload*	*Max. Speed*	*Max. Wind Resistance*	*Operating Temperature*	*Rate of climb*
650 mm	2.43kg	3.6 kg	17 m/s (GPS mode, no payload, no wind)	10 m/s	-10°C to 40°C	15m/s
Operating radious	*Take off mode*	*Recovery mode*	*Endurance*	*Air range*	*Communication distance*	*Camera model*
2 km	Automatic	Manual	40 min. (Dual Battery)	2 km	5 km	Zenmuse X3 Gimbal with Camera Weight 247 g

Study Area

Kovvada is located 70 km from Visakhapatnam in Ranastanalam mandal of Srikakulam district in Northern Andhra Pradesh. It lies between the longitudes from 83°41’35" E to 83°43’10" E and the latitudes from 18°06‘40" N 18°07‘45" N and shown in figure-1. The village has almost flat terrain and adjacent to Bay of Bengal and having one hamlet named as Gudem. It is a proposed site to establish India’s biggest atomic power plant with six reactors with a capacity of 1000 MW each by Nuclear Power Corporation of India Limited (NPCIL), Govt. of India.

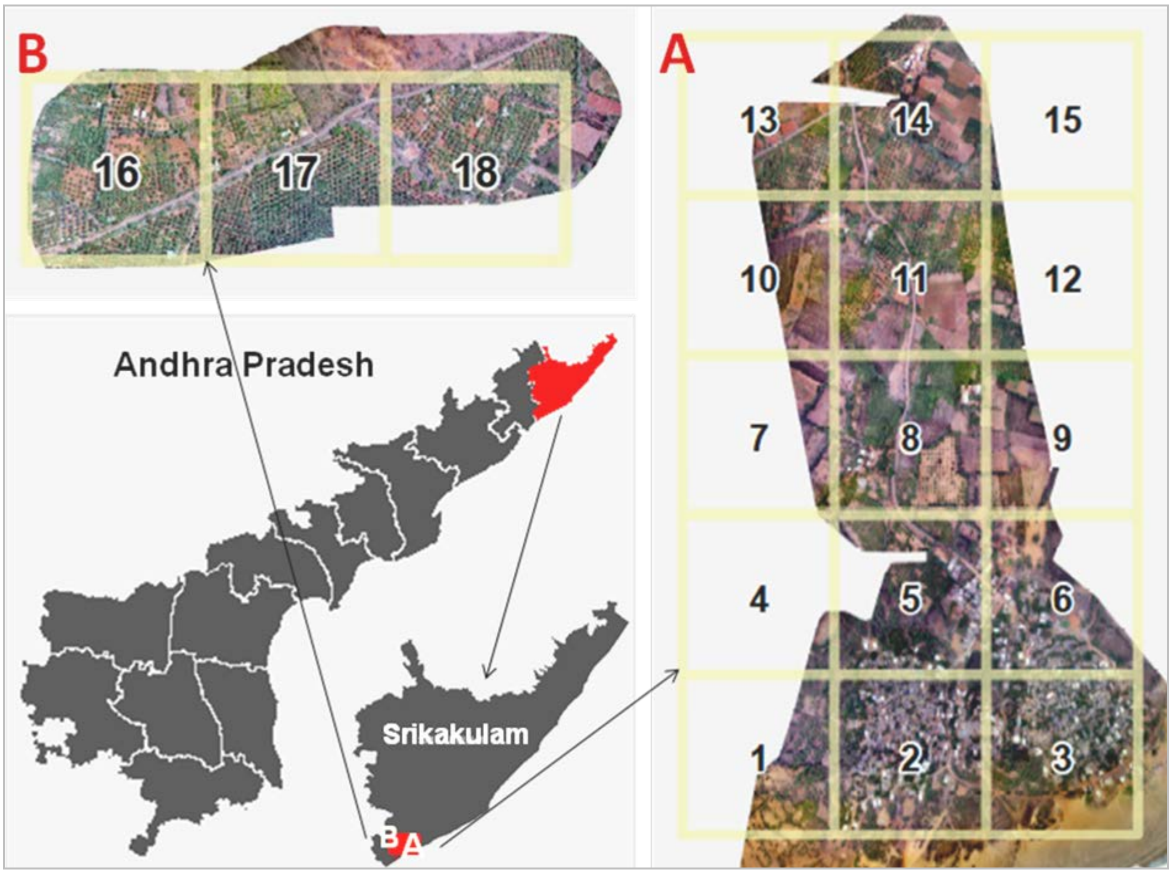

Figure 1: Location Map

Objectives

The main objective of the study is to map different structures/houses using UAV Remote Sensing technology with fine resolution images in Kovvada village, Ranastalam mandal, Srikakulam district, Andhra Pradesh for rehabilitation & resettlements (R&R) purpose and to demonstrate the use of UAV Remote Sensing (RS) capabilities in Land acquisition projects.

Methodology

The mapping of structures/houses of the study area went through several distinct stages. The first stage is data collection by using UAV; the second is data processing and final is feature extraction, geospatial database development and analysis. The comprehensive methodology used in the present study is shown in figure-2.

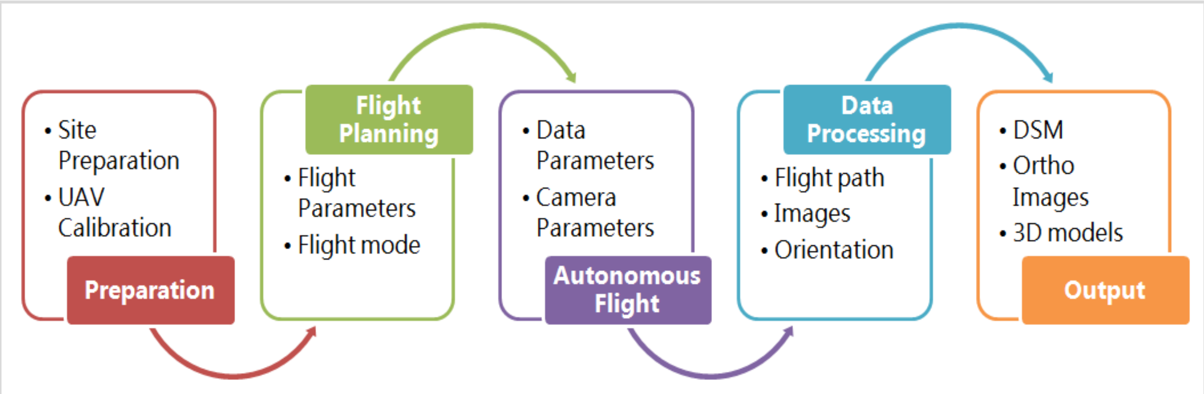

Figure 2: Methodology

The data acquisition same as traditional aerial photography, such as route design, aerial flight, flight planning, quality inspection and measurement on images control should be implemented for UVA digital aerial photography. The quality inspection for aerial photography can be completed in the aerial site without prints by select the height of photography. The lateral overlap of 70% and a longitudinal overlap of 65% have been set for overlapping the images. UAV driven data collection in practice still relies on experienced pilots navigating the UAVs on and around project sites. Recent commercial systems provide autonomous navigation and data collection capabilities using GPS waypoints and pre-determined flight path (Fernandez Galarreta et al. 2015; Zollmann et al. 2014). These methods are beneficial in land surveying and monitoring with large footprint. The accuracy of the images collected from this mission is found to be 10cm horizontal and 20cm vertical. The geolocation RMS error for Omega, Phi and Kappa is also observed less than 2 degree.

Results & Discussions

The purpose of UAV based Remote Sensing (RS) data collection is to map and measure the building surface area and type for compensation to the individual household, thus each centimetre of measurement was very important. After the image processing and quality checks were completed, a grid (18 No.s, Figure-1) was generated for mapping of the structure. The affective grid were identified and considered for mapping. The details of the type of housing structure, number and affected grids are presented in Table-2. The grid number 10&11 was merged because of very less structure (3 No.s) in grid-10. A total 1151 number of structures (1149 houses & 2 water tanks) were extracted from the UAV ortho-images of the Kovvada village by using ArcGIS software and assigned unique id for each structure, which is helpful for district administration during socio-economic survey.

The derived maps of different structures/houses are through visual interpretation techniques. Out of which, 365 nos. of Reinforced Cement Concrete (RCC) House, 105 nos. of Asbestos house, 379 nos. of Thatched house, 238 nos. of Huts and 62 nos. of Under Construction houses were segregated on the basis of their surface structure and built-up materials. The extracted constructions of grid number 2&3 maps are presented in Figure 2&3. The detailed household survey by the concerned department was carried out for each of the above mentioned housing structures and the results delivered by UAV RS Images are of immense help. The accuracy of the measured surface areas of all the buildings were validated by physical survey carried out by the district administration by using field measurement instruments.

Table 2. Grid wise structure/houses

House Type	Grid-2	Grid-3	Grid-5	Grid-6	Grid-8	Grid - 10&11	Grid - 14	Grid - 16	Grid - 17	Grid - 18	Total
Asbestos Roof	37	30	3	18	3	3	3	2	4	2	105
Huts	75	99	13	30		1		19		1	238
RCC Houses	86	120	45	61	10	14	14	8	2	5	365
Thatched House	161	94	26	65	9	7	7	4	2	4	379
Under Construction	19	20	9	11	1	1	1				62
Water Tank			1	1							2
Total	**378**	**363**	**97**	**186**	**23**	**26**	**25**	**33**	**8**	**12**	**1151**

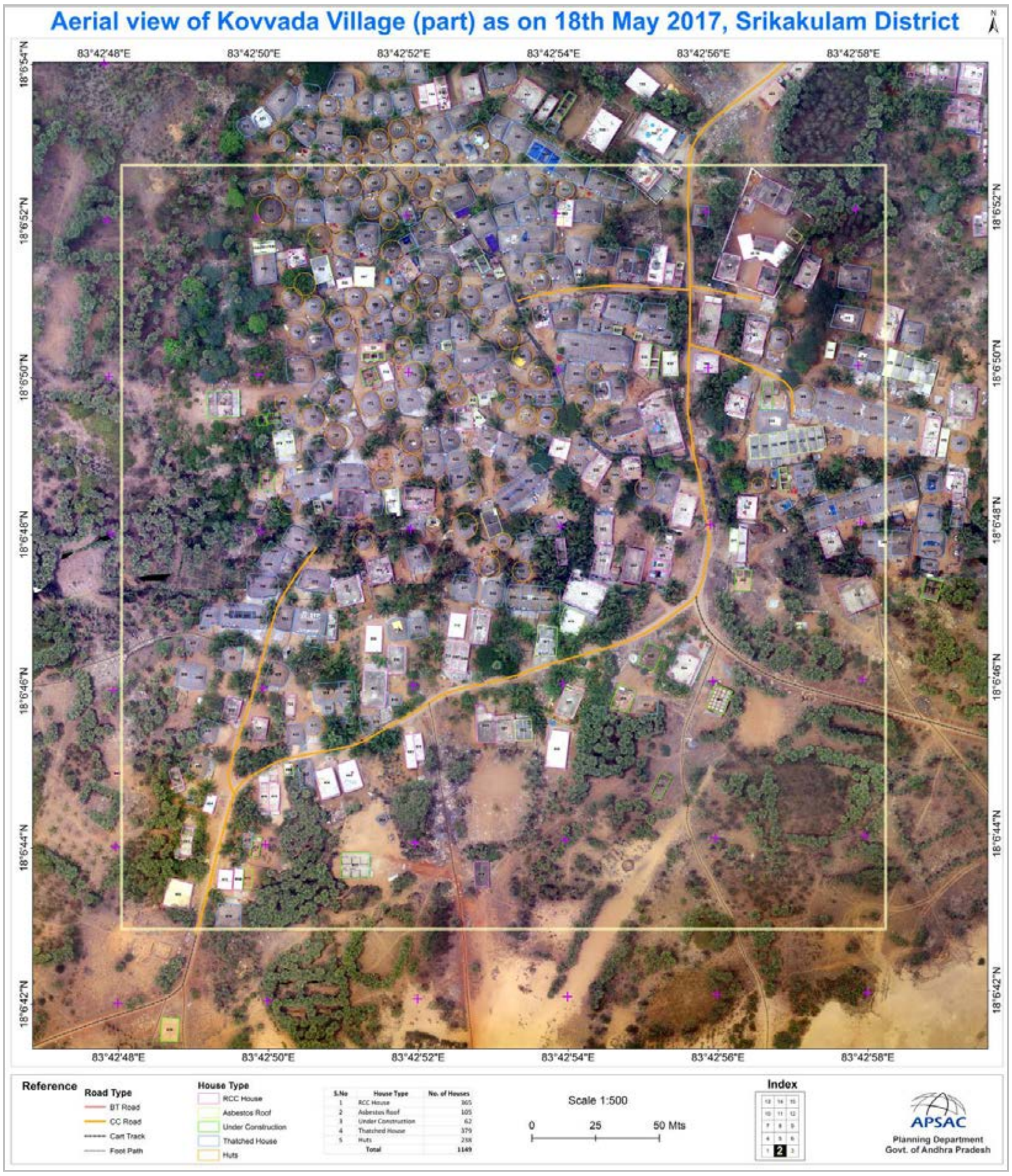

Figure 1: Different structures (Grid-2)

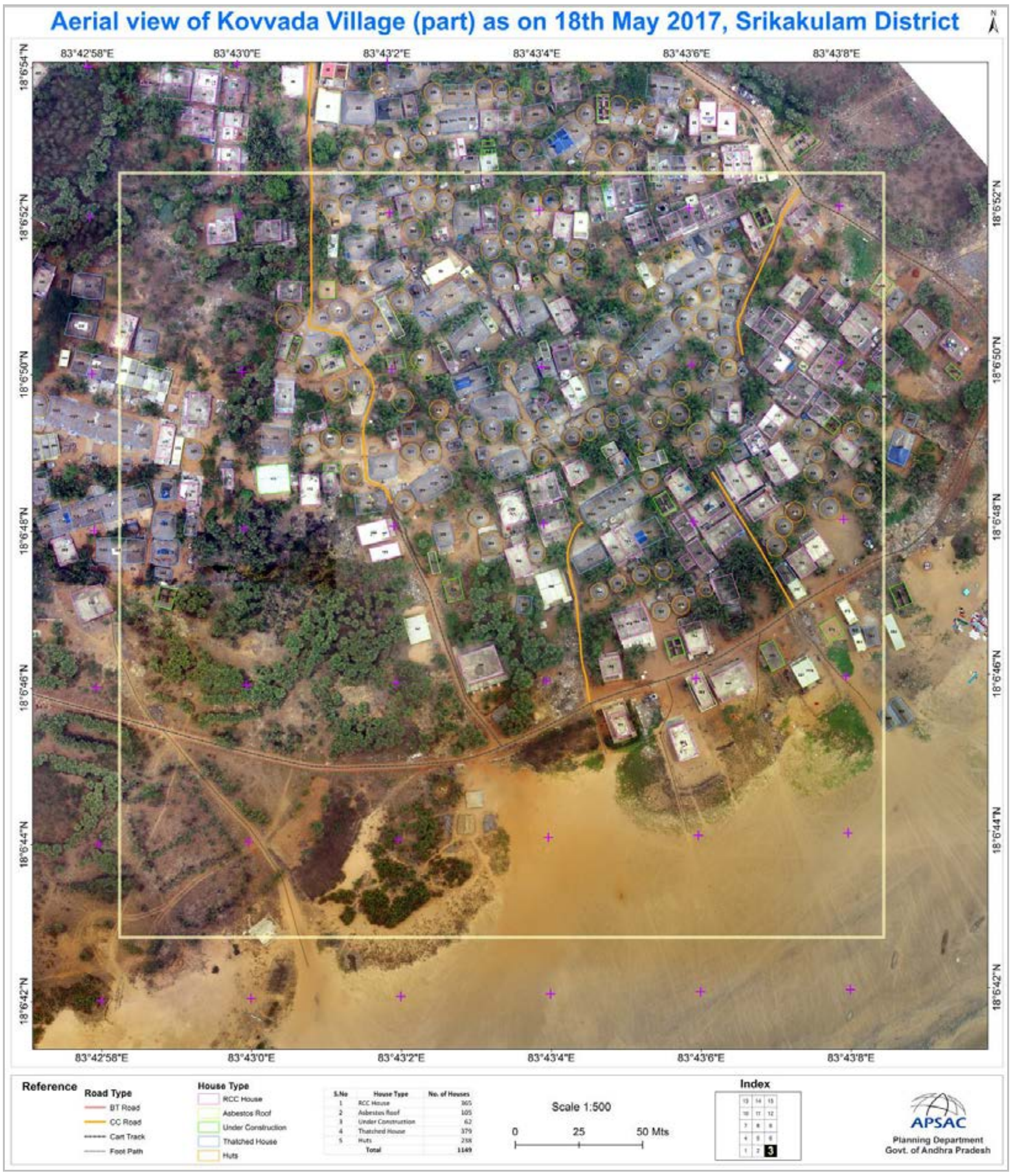

Figure 1: Different structures (Grid-3)

Conclusions:

This study concludes that the UAV enabled mapping approach facilitates to capture high resolution images with good quality and generates ortho-images easily. Due to the high resolution nature and timeliness, such images can easily used for mapping. This exercise also proved that the visual quality of the images is adequate for structures mapping as the guiding features such as fences and hedges were clearly visible. This study further revealed that the mapping of individual houses from grouped houses, UAV derived ortho-images are good enough to fit the purpose of mapping the structures/houses.

In present scenario, there are number of remote sensing satellite constellations are available by many agencies in the world but when the requirement specific applications comes into the picture, it becomes more important for a remote sensing scientists to find out a proper satellite data which can provide justice scientifically as well as technically to address the right solution in time. In the present study which was a real time application, it was really a challenge for the concerned scientists to identify the suitable remote sensing images which can deliver the exact solutions for measuring settlement surface areas in a stipulated time frame. After a marathon exercise and evaluation of resources, the team of scientists found that UAV based RS images can only deliver the results in a very precise and time bound manner. It can be concluded that UAV Remote Sensing based data acquisition have a lots of potentiality by its own and needs to be explored by scientific and research community.

Acknowledgements

The authors are grateful to the Collector and Joint Collector of Srikakulam district, Govt. of Andhra Pradesh for their support and encouragement during the work. Thanks to the district survey department and their staff for their extensive help during the data acquisition. The authors wish to extend sincere appreciation and encouragement given by the management and the concerned staffs of APSAC, Planning Dept., Govt. of Andhra Pradesh during the course of the study.

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