

Natural Disaster Mapping in Real-Time Using Unmanned Aerial Vehicles (Drone)

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ABSTRACT

An unmanned aerial vehicle is used in this paper to demonstrate a disaster response scheme (UAV). Once the natural disasters like flooding or major quakes occur, rapid injury evaluation and continuous data collection are critical to develop a response plan for damage mitigation on behalf of disaster. This approach builds an onboard applications and prototype UAV with the use of navigation system termed GPS/IRNSS as a part of this research.

Keywords: *Rescue Robot, Geographic Information Systems, Unmanned Aerial Vehicle.*

1. INTRODUCTION

The communication networks are regarded as the initial infrastructure constituent for the damaged ones once the natural disasters like huge earthquakes and floods occurs. It is critical in case of dispatching rescue teams to have the efficient and the useful technique for the collection of information regarding the areas that are damaged. Furthermore, immediate damage assessment and continuous data collection for the development of disaster recovery plans are required. In general, aircraft and satellites collect data in the caused damage over a huge area disaster. Several kinds of robots for rescues are being developed to collect data on local damage. For example, for searching through rubbles, a robot that is snake-type [1] in addition a robot with crawler-type [2] were introduced.

The advancement of inertial sensors, microprocessors, and GPS enables small unmanned aerial vehicles (UAVs) to fly autonomously. Many universities and research institutes are developing various types of UAVs [3-4]. The use of small UAVs is one of the new methods of data collection that has received a lot of attention in recent years. Which have a number of advantages over aircraft. Small unmanned aerial vehicles could gather information by means of

Capturing the images in digital that are inaccessible to the peoples or the ground vehicles; which is also capable of flying at low altitudes in an extreme manner and in turn gathers data that are high-resolution. Various other advantages are their portability, low weight and

small size; include high mobility, safety, low operational cost and security [5-8].

Though the smaller UAVs are capable of collecting information, there was some intelligence on their applied disaster situations application. Because, size and weight of the sensors onboard were restricted because of the UAVs payload constraint, one such limitation of employing this small UAVs is that the data gathered is limited exclusively to the still or moving images [9-12].

In this approach, the issues are being addressed by creating the effective smaller UAVs system which in turn combines the inertial sensor, image sensor, and GPS. This method is presented for gathering critical information in the event of a disaster.

2. LITERATURE SURVEY

2.1 International Status

1. In the New Zealand, the local authorities should take risk management under the act of Local Government, 2002. It is necessary for Local authorities to handle the usage of lands for decreasing or evading the natural hazards as per (New Zealand's National Report, 2005). They are also responsible for handling the flood plains, fault line mapping, and the history of disaster in the document's property as per the New Zealand's National Report, 2005.

2. Local administrations of Japan are having the responsibility to cover desired range of preventing the disasters operations on site. They were also responsible

for preparing and implementing plans regarding disaster prevention as per the cabinet office, 2005. Actually, several results are delayed though to higher hierarchy stages beforehand taking the action as of (Britton, 2005).

3. The strategies for mitigating the disaster in United states like planning the land-use and code building enforcement at which the areas are delegated to the local governments on making the local responsibility for mitigation as a primary step (Cigler, 1988). In general, management of local disaster is held by a committee community that are tasked by the personnel coordination from fire, response units, and police (Henstra and Sancton, 2002).

4. In this, 3 countries, the U.S.A, New Zealand and Japan are chosen. The ins and outs for choosing these nations are that they were having efficient disaster handling strategies. Though the administrative structural outlines among the countries' activities might vary and they have dissimilar measures, they altogether endorse 'mitigation' to be the priority of national policy since last decade. Furthermore, they all have accepted strategies of risk management of disaster, reviewed their regulations and laws, and applied risk reduction of disaster schemes. Here the resolution is to witness how policies mitigation are built effectively in the of the local and central administrations association.

5. As a conclusion, there were many disaster countermeasures established as a reply to natural disasters in the meantime 1880s in Japan (Cabinet Office, 2005). Before 1961, Japan needed a sensitive method attentive on interpreting support and offering assistance to victims financially (Palm and Carroll, 1998). Though, the Typhoon Ise-wan was a revolving fact in the Japan's disaster management history (Cabinet Office, 2005) and the government provoked to make a complete system of disaster management that could be tracked by Disaster Countermeasures Basic Act, 1961 and Disaster Countermeasures Basic Plan (Britton, 2005). Together instruments are revised periodically following a foremost disaster (Britton, 2005).

2.2 National Status

Some studies on the landforms coastal nature along the delta front too specified an augmented rate of sedimentation over the river all through the nineteenth century and also through a huge portion of 20th century. The study by Padma kumari *et al.*, aimed at the remote sensing application and the techniques of GIS on Geomorphology (2012), studies on Land Cover/Land Use (2012), Shoreline Erosion and Deposition (2013), respective changes (2015) of East Godavari district, Andhra Pradesh, India. Sarma *et al.*, (2010) and K. Nageswara Rao (2006), and the Shoreline Morph metric Analysis (2013) reviewed on Asymmetric development and Coastal Morpho dynamics of the Subsidence of Holocene sediments in the Godavari delta, Godavari

Delta, habitat loss and Coastal erosion over the Godavari delta. Nageswara Rao (2010) shows the sediment retention impacts on dams on the delta shorelines recession: the evidence from Godavari and Krishna deltas India. The national management of disaster guidelines (2007) prepared by the authority of national disaster management, Government Authority of India. The marine and coastal conservation of nature in the region of EGREE was studied by Tulasirao (2015). The conservation of Mangrove wetlands was and examined managed in Andhra Pradesh was reviewed by Ramasubramanian (2015). Likewise, Murthy (2015) suggested a change in coastal environment in recent times along with the east coast of India that impacts the events of climates at which the works are limited. Hence, there was a scope for new development in this area further.

3. SYSTEM PROPOSED

Figure 1 depicts the proposed scheme layout. Following natural disaster, it is critical for gathering data on the areas affected and the victims located. Man-powered aircraft were used typically for collecting the data that are disaster-related. Though, due to the low mobility of these aircrafts, this method of data collection is impractical. As a result, we created a one-of-a-kind disaster mitigation system that takes full advantage of the smaller UAV's for the generation of hazard map in real time all through the flight.

The sensor and images information captured through the UAV are transmitted in real time to the GCS. Image processing is used in GCS to analyse sensor and images data. The analysed data, such as the important locations coordinates, is united with database GIS for distribution, and a mapping hazard was being generated. This map could be employed for locating the victim's disaster and rescue teams dispatch. Also, there is a possibility to send messages to UAV for gathering excess data. The small UAV system is capable of collecting data even after the occurrence of disaster so as to develop the plans regarding disaster recovery. The system of small UAV assists in quickly and accurately evaluating the situation of disaster [13-14].

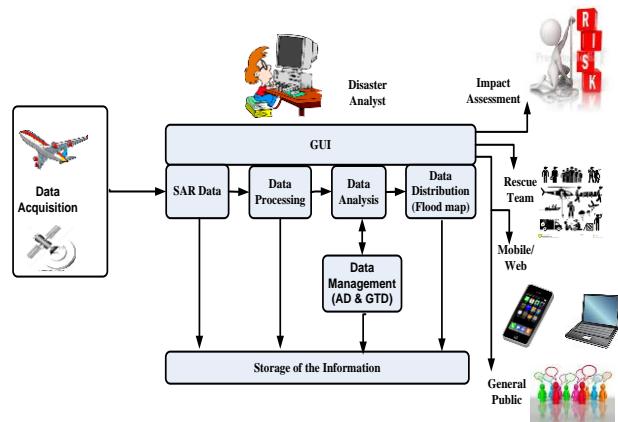


Figure 1 Conceptualization of the proposed Disaster Mitigation system

4. REAL TIME HAZARD MAP GENERATION

Although, small UAV can capture moving or still aerial images, it will be difficult for capturing the images of huge disaster areas clearly and easily. Due to their lower-altitude flight, the images of UAV's were restricted to small areas and is complex for finding the significant location coordinates of significant moving images locations by UAV transmission. From this review, the hazard map is generated in real time for analyzing the information of disaster thereby incorporating the attitude and position assessed over the sensors onboard and the images that are transmitted from UAV. Figure 2 depicts the flow diagram for creating a real-time hazard map. Two methods were suggested for analysing data of disaster by the pictures captured by UAV. An initial technique covers the creation of image mosaic from images that are moving and is conveyed by UAV. The images on the map are updated in the second method. The images are projected and transformed onto the map automatically. Lastly, the critical locations coordinates, like the disaster victim's location, and of hazardous areas images are united by means of GIS database. "Google Earth" is employed in this study as the GIS for updation and the integration of data collected by small UAV. It can be used to analyse and share disaster information as a hazard map [15-17].

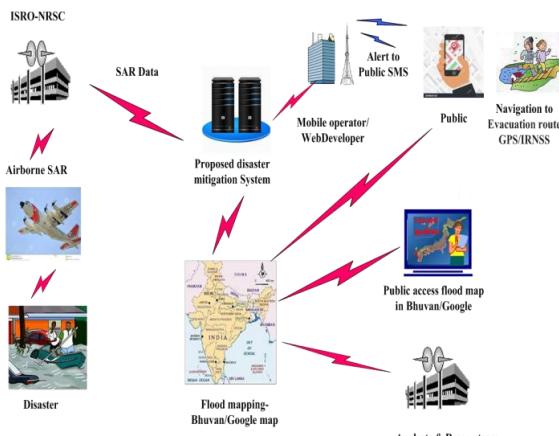


Figure 2 Architecture for generation of hazard map

4.1 Area of Study

The district of East Godavari is located on north-east coast of AP, India, and was bordered by Visakhapatnam district on the north and the Orissa state. The Bay of Bengal in turn covers the in the study area's coastline south-eastern corner. The districts of Krishna and West Godavari are located to the west. Kakinada is the district headquarters. 10.807 square kilometers are covered by the spatial coordinates 17.3213° N, 82.0407° E. (Figure

2). The use of Agriculture land for grassland, farming, and other factors that dominates the area of study. The annual rainfall in an average seems to be 115 cm. The district prospers because of their abundant rainfall and abundant soils. The weather is mostly hot and humid. Late May to early June is the hottest time of year, with maximum temperatures ranging between 38 and 42 degrees Celsius? Pampa, Yeluru, Godavari, and Thandava rivers are among the most important. The east Godavari's elevation ranges from insufficient meters nearby the shoreline to around 300 meters up hills in agency. 1280 mm of rain falls on average each year. A trivial island called 'Hope island' situated at 5 Km from the coast of Kakinada make that as a natural harbor.

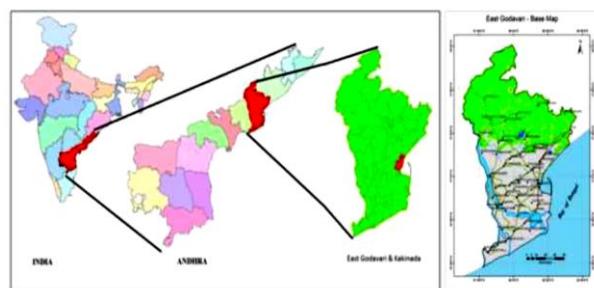


Figure 3 Study area (East Godavari)

Table 1. Disasters that have occurred in the study area in the past (1860-2015)

Occurrence Date	Type of disaster	Detailed description
19/12/1869	Earthquake	Magnitude: 3.7
12/06/1893	Cyclone	
04/09/1895	Cyclone	
28/10/1903	Cyclone	
25/05/1904	Cyclone	
30/09/1915	Cyclone	
21/10/1916	Cyclone	
13/10/1933	Cyclone	
05/05/1955	Cyclone	
04/11/1969	Cyclone	
31/03/1980	Earthquake	Magnitude: 3.8
02/10/1980	Earthquake	Magnitude: 4
15/10/1982	Cyclone	
30/07/1990	Earthquake	Magnitude: 3.6
04/11/1996	Cyclone	
26.12.2004	Tsunami	
12.10.2014	Cyclone	

The area of study is vulnerable to depressions and cyclones due to its location on the coast. East Godavari district, with a coastline 177-kilometer straddling three divisions of revenue, is susceptible to storms and cyclones that occur frequently in Bay of Bengal. Thirteen coastal Mandals in the district of East Godavari have been recognized as catastrophe prone due to their high vulnerability to cyclones and storms. [18-21]

4.2 Methodology

(a). Data Collection

RISAT-1 data for the region of interest prior disaster is required for reference, study and analysis purposes.

UAV Images from UAV

(b). Procedure including Algorithm/ model

Algorithm and the procedure in implementing the system is shown in figure 2 and also listed below:

1. A central disaster analysis/processing system will be located at Krishna District headquarters.
2. The geological, rainfall, landslide, elevation model and ground data will be made available to the central processing system from NRSC/RISAT SAR data as reference for disaster analysis.
3. On the event of disaster, the image of flood prone areas will be gathered from images from UAV and fed to the processing system for its analysis.
4. GeoTIFF image acts as a tool for deriving environmental information from remotely sensed images, including satellite images and aerial photographs.
5. The image received from GeoTIFF (Tag Image File Format) is one of the most versatile and widely used raster file formats.
6. GeoTIFF files can store colour, gray scale, and bi-level (binary) images at various bit depths.
7. Pre-processing of GeoTIFF image is carried out using image processing software applying various suitable algorithms, for extraction of information about refined damaged / high risk areas affected due to disaster.
8. The processed GeoTIFF image is converted /exported into a suitable file format, which is compatible to view it on Bhuvan/Google earth maps with information of damaged area including its latitude and longitude.
9. The flood map is obtained from Bhuvan/Google earth using GPS/IRNSS navigation solution.
10. The flood map provides basic flood hazard map information allowing one to view flood hazard zones.
11. The central processing system alerts by sending public service bulk SMS to general public/rescue team/analysts about disaster information, evacuation area and route information including a web portal link to view the flood map in real time (view in Bhuvan/Google earth).
12. GPS/IRNSS navigation system is used to display the nearest evacuation area route

4.3 Integration of Information Using GIS Database

We can easily and correctly assess the disaster situation by the generation of hazard map and mosaic image by the images projected. In this step, the disaster data was combined by database GIS for creating the hazard map. The incorporation with GIS procedure is as follows. First, using a pointing device, important locations like the landslides and disaster victim's location are chosen on the screen. The important locations coordinates can then be considered with the use of seized pictures and the location and elevation of UAV's. Following that, recognition tags like "disaster victim," "fire," besides "landslide" were chosen. On-screen selection of location and identification tag following that, the GIS updates the image of the selected location, as well as its ID, timestamp, and coordinates. The procedure is recurring till the whole hazard mapping was generated. This procedure could be conceded out after flight or at the time of flight by means of the data kept. The experiments on field were conducted in Japan, Kanagawa, and unified data of disaster attained with the small UAV using database GIS. The small UAV was employed for detecting the vehicles and people on ground, thereby proving the effectiveness of system. Figure 4 depicts an instance of data incorporation with a GIS database. During the flight, the coordinates of important locations and image were updated on GIS. It can be seen that retrieving information from the GIS is easier than retrieving information from the original moving image conveyed by UAV. This system of UAV is beneficial for analysing and gathering disaster-related information. The information of disaster united with the database GIS could be employed as a hazard map; it is too beneficial intended for disaster information sharing and evolving plans regarding disaster recovery [22-26].



Figure 4 Data integration with the Google Earth database.

5. CONCLUSION

In this study, a novel system for mitigating disaster based on small UAV is proposed. The smaller UAV can

seize the images related to natural disaster areas that are affected, and the information gathered, like collapsed buildings digital images, united with GIS database so as to share the maximum conversant information with saving squads. This method is proposed for the generation of hazard map with the small UAV fortified with an inertial sensor, an image sensor, and a GPS. We carried out field experimentations. We conclude that the system is effective in disaster mitigation based on the results of our experiments.

AUTHORS' CONTRIBUTIONS

Aim to design and develop a model for societal application in the area of Disaster Monitoring Natural Disaster Mapping in Real-Time Using Unmanned Aerial Vehicles (Drone). The drone captures the image which is processed and the effected are is identified and it is embedded into Google map for the public move from effected are to safe location.

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