Leveraging on Unmanned Ariel Vehicle (UAV) for Effective Emergency Response and Disaster Management

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ABSTRACT

Over the past two decades, the impact of disasters has been devastating, affecting 4.4 billion people, resulted in 1.3 million causalities and $2 trillion in economic losses. Global climate change and worldwide instabilities have affected urban areas. In spite of all the technological advances, the impacts of natural and manmade disasters in urban areas represent an increasing challenge – therefore effective mitigation and emergency response strategies are pivotal. Concerning post-disaster reconstruction scenario, the most significant factor is accessibility to the disaster affected area and timely response based on best possible information available. Effective emergency response and sustainable post-disaster reconstruction are crucial and lie at the heart of disaster management agencies in almost every cautious country around the globe. The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years. The success of the reconstruction phases, i.e., rescue, relief, and rehabilitation, is mainly dependent on the accessibility to the site, availability of efficient project teams and timely information to make informed decision. Using UAV to access the affected areas and to monitor and capture data to make well-informed decisions, combined with the efficiency of a project team and strong coordination, project success should increase. This paper presents potential application of UAV for accessibility to affected areas, monitoring, and capturing timely and useful information for enhancing prompt and effective sustainable disaster management. The UAV with mounted imaging device will access to disaster struck areas and capture timely and useful information for making more informed decisions for effective, timely and sustainable response in post-disaster scenarios.

The potential application of UAV would be helpful for emergency response management teams to access areas that are otherwise not accessible, take timely measures by learning from captured information, making informed decisions related to effective emergency response and disaster management processes undertaken by emergency management agencies. Professionals need to have access to disaster struck areas to respond to emergency and provide urgent and critical life saving aids. Timely access and information will support a better and more efficient system for sustainable disaster management. Hence, the study is valuable for all professionals involved with research and development of emergency response and sustainable disaster management strategies.

INTRODUCTION

The recent sudden increase of natural and manmade disasters has taught many valuable lessons (Iglesias, 2007). Unfortunately, the need for preparedness is greater than ever before, given the increasing frequency and worsening intensity of weather-related storms and the escalation of technological threats (Moeini et al., 2013). No geographical area is immune or protected from the threat of emergencies and disasters. The importance of a proactive approach in responding to a disaster scenario in term of learning from past projects cannot be overstated (Arain, 2008). Pre-planning with local public safety and emergency response agencies can decrease confusion when a jobsite incident occurs (Ahmed, 2008). A quick response due to proper pre-planning and preparedness can expedite saving lives and rehabilitation process (Moeini et al., 2013).

Post-disaster reconstruction and rehabilitation is a complex issue with several dimensions (Arain, 2015). Many professionals in both fields tend to focus on planning and immediate response and have only recently begun to consider the requirements and opportunities inherent in long-term mitigation and reconstruction (Vale and Campanella, 2005). The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years (Pelling, 2003). Government, non-government, and international organizations have their own stakes in disaster recovery programs, and links must be established among them, as well as with the community. In other words, a post-disaster rehabilitation and recovery programs should be seen as an opportunity to work with communities and serve local needs. Relief and development often leads to burdens on the recipient government, and also often fails to serve the actual purpose and to reach the people in need (Shaw et al., 2003).

Environmental management professionals are now concentrating on the sustainability of environmental quality and environmental improvement; emergency managers and planners are re-focusing their efforts on the survivability of systems, organizations, and communities (Vale and Campanella, 2005). Sustainability and survivability are, in truth, two aspects of the same concept, namely: how to encourage and achieve continual improvement in ecosystems, the built environment, and human society (Pellow and Brulle, 2005). Both environmental management and emergency management have much to contribute to, and to gain from, the planning and implementation of post-disaster reconstruction.

Development is a dynamic process, and disasters provide the opportunities to vitalize and/or revitalize this process, especially to generate local economies, and to upgrade livelihood and living condition. Shaw and Sinha (2003) suggested the ideal level of involvement of different stakeholders after the disaster, as shown in Figure 2. The standard time frame of rescue, relief, and rehabilitation are defined as short term, long term, and longer term respectively.

Increasing worldwide impact of climate change, environmental degradation from human exploitation, urbanization and economic and social instabilities, unknown patterns and consequences of recent type of natural and manmade disasters, social and cultural complexity of urban residences and the aging urban infrastructures has increased the level of vulnerability to any type and different level of disaster (Pelling, 2003). Due to the increasing urbanization and population growth, the impact of any type of disaster (natural or manmade) in an urban area can be devastating with longer recovery period.

Increasing discussions and debates within disaster mitigation interest groups have raised questions regarding the practicality of adopting developmental approaches to disaster reconstruction (Ahmed, 2008). The chaos surrounding the disaster period following a disaster could easily lead to short-term and hasty decisions adversely affecting the community’s ability to achieve sustainable, long term reconstruction goals (Arain, 2015). To minimize the occurrence of these unwise decisions, it is important to plan proactively for post-disaster restoration in order to provide general guidance for decision-makers and a framework for the professionals involved in reconstruction processes (Iglesias, 2007). For proactive plans and decisions, an integrated approach is required that may empower to implement the developed reconstruction strategy and monitor its results and progress.

The recent sudden increase of natural disasters has taught many valuable lessons (Iglesias, 2007). Unfortunately, the need for preparedness is greater than ever before, given the increasing frequency and worsening intensity of weather-related storms and the escalation of technological threats. No geographical area is immune or protected from the threat of emergencies and disasters. The importance of a proactive approach in responding to a disaster scenario in term of learning from past projects cannot be overstated. Pre-planning with local public safety and emergency response agencies can decrease confusion when a jobsite incident occurs (Arain, 2015). A quick response due to proper pre-planning and preparedness can expedite saving lives and rehabilitation process.

It is suggested that a timely access to relevant information and disaster site will assist in improving rescuing and reconstruction project processes, coordination and team building process because the most likely areas on which to focus to reduce unwise decision can be identified during the early stage of the post-disaster scenario (Arain and Low, 2006). Tapping on the live feed of information of post-disaster scenarios, the UAV system provides direct access to a wealth of pertinent and useful information for decision makers and eventually enhance collaborative venture. By having the access to timely information via UAV and a systematic way to make well-informed decisions, the efficiency of project team and the likelihood of strong coordination and eventually project success should increase (Arain, 2015).

The potential application of UAV would be helpful for emergency response management teams to access areas that are otherwise not accessible, take timely measures by learning from captured information, making informed decisions related to effective emergency response and disaster management processes undertaken by emergency management agencies. Professionals need to have access to disaster struck areas to respond to emergency and provide urgent and critical life saving aids. Timely access and information will support a better and more efficient system for sustainable disaster management.

UNMANNED AERIAL VEHICLE AND ITS APPLICATION

The UAV application supporting forest fire management is surely the most developed and practically demonstrated activity among all disasters (Restas, 2012). UAV can be used before fire for hot spot detection, during the intervention helping fire management with real time information and after suppression for post fire monitoring. The method of prescribed fire can be also in the focus of UAV use as a special application for fire prevention (Restas, 2015).

Detecting hot spots by aerials earlier than reporting it by civilians is obviously helps fire managers limiting the damages fires cause (Restas et al., 2014). Unfortunately the main reason why this method is not always used is the huge costs of aerials. If this procedure made by UAV is cheaper solution than the traditional one (manned aircraft) means option of drone use is the better solution. Naturally this case assumes the similar professional efficiency of different methods (Restas et al., 2014).

As pre-disaster activity, UAV following the stream of rivers can control the state of dams. In case of any unusual recognition the responsible authority can react in time for the problem. This activity is very flexible; the flight patrol can be optimized depending on time or other workload. Since affected areas are usually oversized, managing floods by aerials is always suffered from limited sources. It means drone can support disaster management at local level. This task requires tactical or operational UAV (Restas, 2015).

The stability of dams hangs on many conditions like the time it suffer from water press, how structure of dams built, what materials made of it. There is yet not enough information about it, however it can be supposed, with a procedure what is able to analyze the state of dam as airborne is help for managers. Knowing the state of dam managers can optimize the sources making the critic parts of dam stronger or in case of escalated problem can order the evacuation in time (Restas, 2015).

Since floods are a slowly developing disaster UAV can help for the management in many ways. With UAV observation can predict how flooded the area, what buildings are in risk, where from and where to evacuate the citizens, etc. The essence of this application is the gap of aerials what means the missing of manned aerials but UAV can offer as a satisfied solution (Restas, 2015).

An earthquake is a rapid escalating disaster, where, many times, there is no other way for a rapid damage assessment than aerial reconnaissance (Restas, 2015). For special rescue teams, the drone application can help much in a rapid location selection, where enough place remained to survive for victims. Floods are typical for a slow onset disaster. In contrast, managing floods is a very complex and difficult task. It requires continuous monitoring of dykes, flooded and threatened areas. UAV can help managers largely keeping an area under observation. Forest fires are disasters, where the tactical application of UAV is already well developed. UAV can be used for fire detection, intervention monitoring and also for post-fire monitoring. In case of nuclear accident or hazardous material leakage UAV is also a very effective or can be the only one tool for supporting disaster management (Restas, 2015).

Types of Unmanned Aerial Vehicles

The UAV classification is based on the military standards which have been partially adopted for civilian UAVs. Civilian UAVs are classified into two main classes: a) fixed wing, and b) multirotor or multicopter. Each UAV class has its unique design, operability and advantages and disadvantages which are briefly presented below.

Fixed Wing UAV

Fixed wing UAVs have a simple and aerodynamics structure consisting of a pair of rigid wings connected to the main fuselage. They a long flight time capacity(maximum 90 - 120 min) within both visual and beyond visual line-of-sight (VLOS & BVLOS) to cover long distances and large operational areas in a single flight.

This type of UAV is suitable for the rapid creation of aerial orthomosaic of disaster affected areas. Fixed wing UAVs offer a perfect platform for real-time accurate visual assessments of areas affected by disaster and enable the emergency responders to plan for response and recovery in large areas in a timely manner. The fixed wing UAVs are also effective platforms for immediate visual inspection of some critical infrastructure such as roads, railways, water, oil and gas pipe lines as well as power transmission lines.

Modified long range Skywalker X8

Modified long range Talon system

Modified long range Talon system

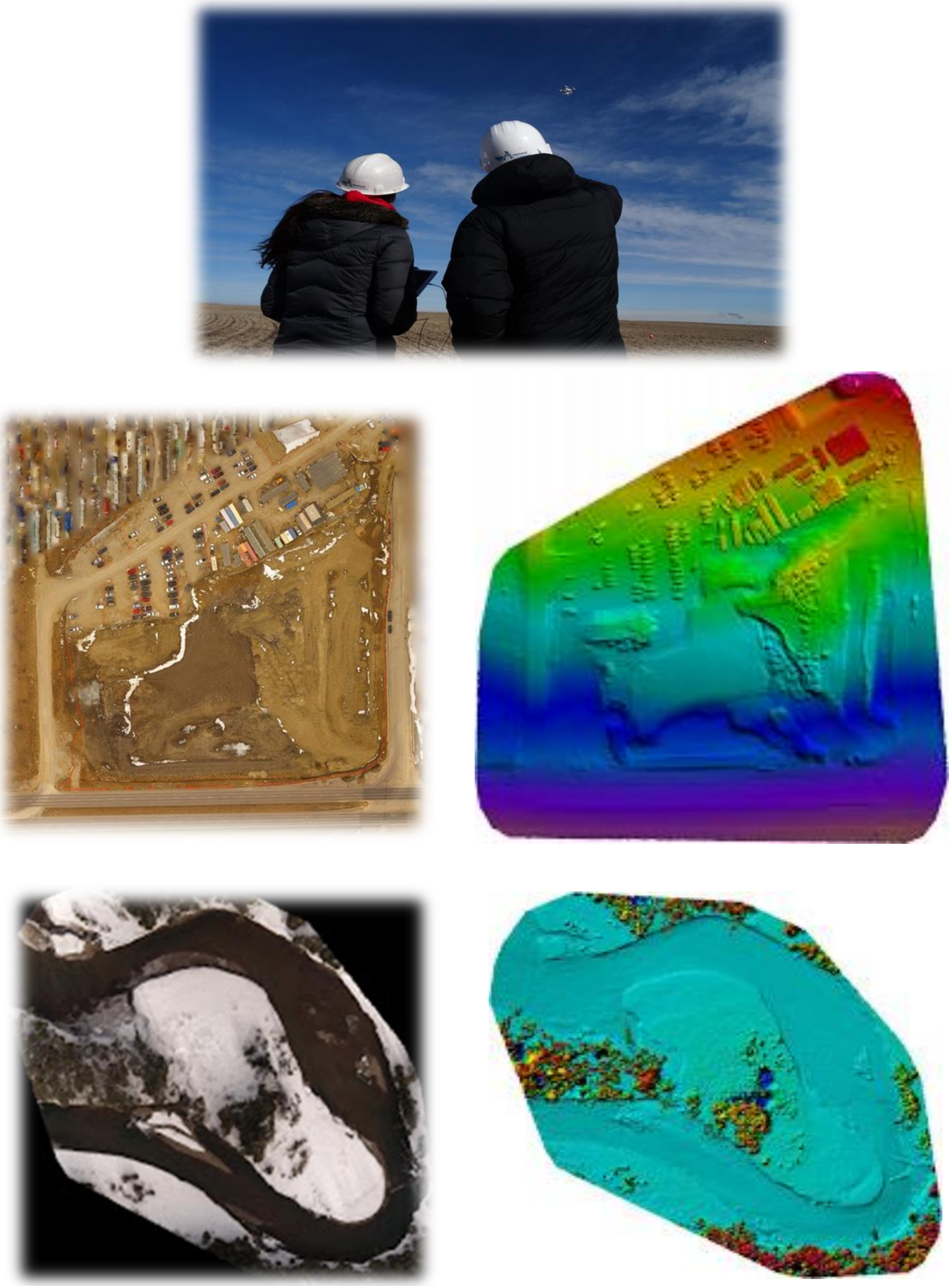
Modified Fixed Wing UAVs for aerial photogrammetry and surveying, equipped with Infrared and Sonar

Multirotor or multicopter

These types of UAVs have a more complex structure and better control systems operations compared to the fixed wing UVAs. In contrast to fixed wings UAVs multirotors have a lower speed and much shorter flight time (maximum 30- 40 minutes) due to their non-aerodynamics structure.

The main advantages, of multirotor UAVs are the Vertical Takeoff and Landing (VTOL) and capability to hover and perform agile maneuvering in small spaces. Multirotor UAVs are suitable platforms to inspect urban facilities such as bridges, power plants (fossil or nuclear fuel based), municipal buildings, hospitals and emergency centers. These types of UAVs are also able to carry different types of emergency packages such as CPR and emergency first aid kits to area with limited access. Multirotor UAVs enable the building inspectors to assess the building situation and define the possible damages with high level of accuracy and in a timely manner.

Modified Multirotor UAVs for aerial photogrammetry and surveying, equipped with Infrared and Sonar



Arial and infrared images of the flooded areas to inspect the possible equipment damage in the construction site during the flood

CONCLUSION

Concerning post-disaster reconstruction scenario, the most significant factor is accessibility to the disaster affected area and timely response based on best possible information available. Effective emergency response and sustainable post-disaster reconstruction are crucial and lie at the heart of disaster management agencies in almost every cautious country around the globe. The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years. The success of the reconstruction phases, i.e., rescue, relief, and rehabilitation, is mainly dependent on the accessibility to the site, availability of efficient project teams and timely information to make informed decision. Using UAV to access the affected areas and to monitor and capture data to make well-informed decisions, combined with the efficiency of a project team and strong coordination, project success should increase. This paper presents potential application of UAV for accessibility to affected areas, monitoring, and capturing timely and useful information for enhancing prompt and effective sustainable disaster management. The UAV with mounted imaging device will access to disaster struck areas and capture timely and useful information for making more informed decisions for effective, timely and sustainable response in post-disaster scenarios.

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The paper sets the foundation for future research into application of UAV for disaster management. UAV can help managers largely keeping an area under observation. UAV can be used for fire detection, intervention monitoring and also for post-fire monitoring. In case of nuclear accident or hazardous material leakage UAV is also a very effective or can be the only one tool for supporting disaster management. UAV can also assist in transporting medical help to disaster struck areas and also airlifting critically injured human beings to near by medical support venues. Timely access and information will support a better and more efficient system for sustainable disaster management. Hence, the study is valuable for all professionals involved with research and development of emergency response and sustainable disaster management strategies.

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