

Environmental Applications of Unmanned Aerial Vehicles

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Introduction

Unmanned Aerial Vehicles (UAV) also referred to as “drones” have emerged as a sophisticated technology central to both commercial and governmental organizations. From on-demand deliveries to scanning an unreachable man-made hazard, drones possess the capability of reaching the most remote areas with little to no manpower needed and require the least amount of effort, time, and energy. (Joshi 2019) The scientific community has embraced drone technology to observe, measure, and monitor the natural environment. Work to date has included environmental monitoring, renewable resource sustainability, disaster relief, ecological studies, and agricultural sustainability. Drone usage has proven to be extremely beneficial to investors and regulators assess risk associated with recognized environmental events.

Throughout the years, Environmental Risk Analysis (ERA), or just "Risk Analysis," has risen as an investigative measure for activities or events that can represent imminent dangers to human wellbeing and the environment. The examination of hazard incorporates risk assessment,

site characterization, risk communication, risk management, and policy relating to risk. Risk analysis has a wide range of applications, from simple studies to hazard environment, to complex risk assessment on human health and the environment over a large scale. (Gurjar et al., 2002)

UAV technology allows scientific and regulatory institutions the ability to assess the environmental risks at different levels, with the goals of mitigating or eliminating the risks. This paper will examine some of the applications that UAV technology is being used to assess environmental risks at different scales.

Environmental Monitoring

Environmental monitoring or management is the process of establishing the current status of an environment or to establish trends in environmental parameters. Environmental monitoring is paramount to the protection of human health and the environment. As the global population continues to increase, the energy demands continue to escalate and industrial production continues to proliferate, the need for environmental monitoring is going to extremely important. (Aritola et al, 2019)

Aerial photography is one area where drones can play a vital role in environmental monitoring. A smaller sized drone can fly for a few hours recording pictures with a pixel resolution of 1m which is extremely suitable for aerial mapping and nature monitoring. Hovering at around 200m above ground level (AGL), drones possess the ability to take high-resolution imagery of any environment, unrestricted by cloud cover. Drones can also be armed with meteorological apparatus such as wind gauges, thermometers, and humidity or pressure sensors for the capture of pertinent climate data. Drones can also reach areas not accessible to humans

such as a site associated with environmental hazards such as pyroclastic explosions, mudslides/landslides among others. Drones can also be outfitted with photoionization detectors (PID) to detect the concentrations of petroleum hydrocarbon contamination in real-time in such situations of a catastrophic release or spill. Perhaps the greatest impact drones may have on environmental monitoring is the ability to reveal how an area changes over time. Drones equipped with remote sensing LIDAR can detect changes of the finest detail which can be used to model glacial retreat, monitor coastal erosion, terrain modeling, forestry, and in fluvial and flooding basin assessments among others. (Smith 2018)

Renewable energy

“Renewable energy is energy derived from natural resources that replenish themselves in less than one lifetime without exhausting the planet’s finite physical resources. These resources – such as solar, wind, rain, waves/tidal, biomass, and thermal energy stored in or near the earth’s crust – are present in one form or another nearly everywhere. These resources are virtually inexhaustible, and they cause virtually little climate or environmental damage”. (REN21 2019)

Renewable energy has a huge impact on the environment, lessening polluting fossil fuel use, however, maintaining the massive infrastructure associated with renewable energy fields can be challenging.

UAV technology can have a vital role in the management of renewable energy infrastructure. For example, small UAVs are employed to inspect wind turbines which can be advanced several hundred feet in the air. The drones can relay real-time footage of power cables and 3D imagery of turbine blades to technicians on the ground level. Drones have also been used

to record high definition videos of hydroelectric dam walls and even could aid the installation of solar panels and their inspection using drone-based thermal imaging. Drones employed in this fashion can be used quickly and efficiently with very low monetary investments. (Smith 2018)

Disaster relief

Disaster areas can be too dangerous for first responders and relief workers to reach safely expeditiously. Drones possess the ability to access locations that humans cannot, therefore providing a new method of search and rescue that was otherwise unattainable in the past. Specifically, drones were extensively used during Hurricane Dorian which were among the first attempts at using drones in a life-saving capacity. The Volans-I drone was equipped to deliver necessities such as insulin and anesthetics to people who were trapped by the storm's damage. Drones can travel more safely and efficiently than helicopters in certain extreme circumstances. Drones can make small shipments to hospitals and can continue to operate independently of cell and electrical power outages.

In addition, drone technology has proven effective for fighting wildfires which have plagued the western United States over the last decade. Drones were able to augment emergency aircraft operators without the introduction of additional risks. Unmanned drones can disperse fire retardants in areas that are impossible for emergency aircraft to reach. Drones can be outfitted with communication and management software which can maintain contact between firefighters on the ground and headquarters. Other drones collect data to show where fires are migrating,

which cuts down on emergency response time and can be used to correctly allocate resources in the future. (Zeng 2020)

Agricultural Sustainability and Productivity

Agriculture provides humanity with food, alternative fuels, and raw materials that are necessary for human livelihood. By 2100, the estimated human population will approach 11 billion people which will greatly impact food production and water resources. Drones outfitted with Remote Sensing imagery can assist the increased productivity of agricultural practices to face growing demands. Drones equipped with high-resolution image cameras can provide repetitive information on crop status throughout the year at different scales. The information or analysis of remote sensing imagery could be more routinely overlaid with other information such as soil data, moisture content, environmental/weather data, nutrient yields, and pest management practices. Also, UAVs have become a precision instrument to disperse fertilizers and nutrients to crops in such a way to reduce conventional fertilizer use thus conserving the resource and protecting the environment from pollution. (Smith 2018)

Conclusion

Unmanned aerial vehicle technology, which is providing data and support from the ground, air, and waterway monitoring to infrastructure inspection, agricultural applications, environmental mapping, is reshaping virtually every environmental sector by modernizing how natural resources and environmental data is obtained, analyzed, and incorporated. Drone technology has allowed the advancement in ventures not obtainable or possible in the past by augmenting conventional resources with the help of sophisticated technology. With the growing demands on the global food supply, water, and natural resources, the potential for environmental risk will increase in a magnitude of proportion. Drone usage and reliance will only continue to grow, providing solutions and answers to new problems and disasters faced in the future.

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