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Department of Electrical & Computer Engineering (ECE)

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Section: 11
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Project Title: Precise Control Drone
Sustainability and Environmental Effects of Precise-Controlled Drone

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Sustainability and Environmental Effects of Precise-Controlled Drone

In the era of modern science and technology, the development and use of precise-controlled drones are increasing exponentially across various industries because they offer unparalleled accuracy, diverse functionality, and enhanced efficiency. Advanced controller design using different sensors enhances the functionality and efficiency of the drone. Parallelly, it also raises concerns about environmental impact and sustainability. This section will describe the environmental effects and sustainability of precise-controlled drones.

The Environmental Benefits of Precise-controlled Drones:

Precise-controlled drones, when used appropriately, can bring about many environmental benefits because of their ability to collect data, monitor ecosystems, and perform given tasks with high accuracy and minimal ecological impact.

a) **Agriculture Sector:** In precision farming, these drones can significantly reduce excessive fertilizer use, lowering production costs and soil pollution. Moreover, their application in farming and livestock monitoring can boost accuracy by up to 99%, conserve 90% of water, and reduce pesticide use by 30%-40%.[1]

b) **Wildlife Conservation:** The use of precise-controlled drones for wildlife conservation provides numerous advantages over traditional methods. The main advantage of using precise controlled drones is their versatility. They can perform any survey in any remote area without hampering the natural habitat of wild animals, inspiring us with their potential to revolutionize wildlife conservation. Additionally, this type of drone provides a bird's eye view, which is unparalleled in traditional field research. This enables more accurate species counting and is the fastest method of collecting data. Moreover, they can fly autonomously and execute pre-programmed missions across diverse environments.

c) **Habitat Restoration:** Habitat restoration is an intentional process of rehabilitating an ecosystem damaged, degraded, or destroyed due to natural disturbance or human activities. Drones are capable of dispersing seeds over a large area of land in a minimum amount of time. If nutrition-enriched seeds are dispersed in that area, then the chances of seedling survival increase. This reforestation method is efficient and less labor-intensive than the traditional methods.

d) **Ecosystem Monitoring:** Precise-controlled drones are equipped with advanced imaging sensors. We need to integrate additional specialized sensors for ecosystem monitoring to collect various environmental data such as humidity,

temperature, etc. We can also monitor air quality and water quality, detect pollution sources, and collect ecological health data in areas that are difficult to access and dangerous for humans. This ecological data can help us to detect pollution hotspots and develop strategies to minimize environmental damage.

e) **Forestry:** In the field of forest management, the use of precise-controlled drones provides efficiency and ecological sustainability. They can also perform accurate tree counting, species identification, and forest health monitoring tasks. Drones, if used in this field, facilitate surveying large tracts of land, which is beneficial for mapping forests, collecting information on damage caused by pests or diseases, and monitoring reforestation efforts. They also contribute to fire detection caused by wildfire and reduce the extent of damage through quick response. Traditional ground-based in-person surveys conducted in this field are time-consuming and have some potential risks. If drones are used in place of the conventional method, it will save time and ensure the safety of ground workers by avoiding hazardous environments.

f) **Disaster response:** In any natural disaster such as wildfire, flood, cyclone, etc. precise-controlled drones can locate survivors, access damage, and deliver emergency supplies to the affected areas. The use of drones in this field is much more efficient than the traditional method. It minimizes human risk, reduces response time, and enhances disaster management efforts.

g) **Minimize Resource Consumption:** Using drones reduces the resources required for agriculture, surveys, mapping, and monitoring tasks. For example, precise controlled drones used in agriculture lessen the amount of pesticides, fertilizers, and water. This reduces the environmental impact by preventing over-application and runoff and reduces the operational cost by ensuring efficient resource use. Furthermore, drones reduce the need for manual labor and heavy machinery, conserve resources, and enhance human and environmental safety.

h) **Reduced Carbon Footprint:** Drones have very low carbon emissions compared to traditional methods of data collection using manned aircraft or ground-based surveys and surveillance because they require less fuel power and infrastructure. It has also reduced the demand for conventional autos and equipment, resulting in decreased fuel consumption and greenhouse gas emissions. This makes them more environmentally friendly.

i) **Nature preservation:** Drones play an essential role in environmental protection. They are used for aerial surveys, animal population monitoring, and endangered species monitoring, all while assisting in conservation.

j) **Efficient assistance control**: Drones can provide precise data on crop fitness, soil conditions, and irrigation supply in agriculture. This information may assist farmers in making the most use of their resources, reducing waste, and limiting their usage of water and pesticides.

k) **Rapid catastrophe:** Drones provide quick and ecologically friendly catastrophe and search and rescue missions, reducing the need for human intervention.

Negative environmental effect:

There are many advantages of using precise-controlled drones in different sectors. However, there are some potential challenges and considerations regarding sustainability.

a) **Noise pollution:** Noise generated by drones, mainly in highly populated urban areas, can increase noise pollutants.

b) **Energy consumption:** One of the main concerns is energy consumption associated with drone operations. Drones themselves produce much fewer emissions than traditional vehicles during their operation. However, the energy required for charging and powering flight operations contributes to carbon emissions. Renewable sources of energy, such as solar panels, seem to be a good option, but in real life, they cannot produce sufficient power to run the motors used in drones.

c) **Impact on Wildlife:** While drones can help with wildlife conservation, they can also disturb flora and fauna if they are no longer used responsibly. This can strain animals, disrupt reproductive styles, and cause unwanted damage to the environment.

d) **Battery generation and waste:** Drone batteries are usually lithium-ion batteries, which have an environmental effect in terms of aid recovery, manufacturing, and disposal. Sustainable battery technologies and responsible recycling practices are needed to solve this hassle.

e) **Manufacturing and disposal:** For manufacturing drones on a large scale, huge amounts of plastic and other non-biodegradable materials are used. At the end of the lifecycle, they contribute to producing electronic waste, which is typically not recycled. To minimize this impact, manufacturers should focus on recycling

the usable parts after the end of the life cycle. Different materials, such as plastic, copper, and batteries, can be reused or recycled. So, manufacturers should focus on using reusable materials during production and conduct a take-back program to encourage recycling.

Strategies for Sustainable Drone Operations:

To maximize the environmental sustainability of precise-controlled drones, engineers, designers, and manufacturers should focus on using environmentally friendly, energy-efficient, and recyclable components for the production of drones. Some of the strategies are mentioned below.

a) **Energy Efficiency:** Engineers should adopt energy-efficient methods during the design and production of drones. They should focus on designing the controller of drones that run on low power, and the production unit should also focus on using the minimum amount of energy for the production of drones.

b) **Renewable Energy:** Drones cannot operate using solar energy. However, renewable energy sources such as solar energy or wind energy can be used to charge the batteries used in drones and for the production of drones.

c) **Sustainable Manufacturing:** Manufacturers should focus on a sustainable design approach for drone manufacturing. They should design using eco-friendly and recyclable materials. The production unit should also focus on reducing carbon and other greenhouse gas emissions in the environment.

d) **Encourage Recycling:** Manufacturers should encourage the recycling of drones after the end of their lifecycles. They can arrange take-back programs or exchange programs to promote the recycling of drones.

By implementing these strategies, the potential of precise-controlled drones to contribute to sustainability and environmental benefits can be maximized.