

Drones in Africa

Matthew N. O. Sadiku

Department of Electrical & Computer Engineering, Prairie View A&M University, Prairie View,
TX USA

Uwakwe C. Chukwu

Department of Engineering Technology, South Carolina State University, Orangeburg, SC, USA

Janet O. Sadiku

Juliana King University, Houston, TX, USA

Abstract:

Drones offer huge potential for Africa in terms of economic development and human security, such as monitoring weather patterns. The usage of drone technology is gaining attention in Africa. Africans are employing drones for commercial, humanitarian, and military purposes. Drone technology is providing the delivery solutions that can enable African nations distribute essential medical supplies to rural communities. This paper explores the adoption of drones in African nations.

Keywords: *Africa, drones, drones for Africa.*

INTRODUCTION

Africa is a continent that has 54 countries with an area of 30,370,000 square km and 1.4 billion individuals as of 2021, subdivided into five major regions, like Northern Africa (with countries like Libya, Egypt, North Sudan, Algeria, Morocco, and Tunisia as demonstrated) inhabiting the northerly region of Africa [1]. Due to its size and proximity to the equator, the climate of Africa ranges from the arid deserts in the north to dense rain forests in the south. Sub-Saharan Africa is perceived to be one of the world's most deprived regions with a history of civil unrest, corrupt governance, low educational enrolment levels, poor healthcare delivery, a wide digital divide, as well as lacking infrastructure to meet present day global socio-economic demands [2]. Africa is rising, and its tech scene is leading the way. It is closely watched as the next big growth market. It is the home to some of the youngest populations in the world.

Drones are autonomous or remotely controlled multipurpose aerial vehicles driven by aerodynamic forces. They are devices which are capable of sustained flight and do not need a human on board. Typically, a drone consists of an air frame, propulsion system, communication system, and navigation system [3]. Common drone configurations include fixed-wing, rotary-wing, multirotor, and hybrid designs. Their obvious usage areas are transportation and package delivery. As illustrated in Figure 1, compared with other transport modes, drones are the fastest and the least expensive [4]. Since a drone can fly over an inaccessible road, organizations have begun to use drones for healthcare delivery. While governments and regulators may be cautious about allowing drones to roam the skies, healthcare deliveries have a compelling reason to go for it.

Drones have the potential to play a transformative role globally. In recent times, the drone technology has gradually gained widespread adoption all over the world, including Africa. It has found diverse applications across various industries. Drones were used by the US to track down and kill Islamic militants in Somalia. The UN is using drones to support military peacekeeping operations and security services in the Democratic Republic of Congo, Mali, and the Central African Republic of Congo [5]. Amazon announced its plan to use drones to deliver packages to customers.

WHAT IS A DRONE?

Drones are autonomous robots that fly in the sky. They may also be regarded as pilotless aircrafts that were initially used by the military, but are now used for scientific and commercial purposes. The word “drone” was coined due to the similarity of its sound to a male bee. Drones are pilotless aircraft and are formally known as either unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UAS). Drones are also called “remotely piloted vehicle” or “unmanned aerial systems.” Drones were first used in the 1990s by military organizations. The notion of drones began around 1918 when the US Navy commissioned Charles Kettering built a militarized unmanned aerial vehicle (UAV). Their original use was to take strategic pictures for the military. From the beginning of the 21st Century, civil activities of drones started to get more attention.

Drones are classified in different ways: size, weight, flight time, commercial or military, and cost. The US Federal Aviation Administration (FAA) defines consumer and commercial drones as those that weigh less < 1.0 lb (0.45kg) with approximately a maximum 500 m altitude and 2km range from the base operator. A drone is a pilotless aircraft that operates through a combination of technologies, including computer vision, artificial intelligence, object avoidance tech, automation, robotics, and miniaturization.

USE OF DRONES IN AFRICA

In spite of its poverty and poor infrastructure, sub-Saharan Africa has led the way in the adoption of mobile banking and healthcare, and now medical drones [6]. Necessity is the mother of invention; the rapid adoption of drone technology in sub-Saharan Africa is exemplary. The drone technology caught on so quickly in developing nations such as Rwanda, Tanzania, and Ghana with poor roads and lack of accessibility. The United Nations has used drones to drop condoms over rural parts of Ghana, where a fraction of women have access to contraceptives to prevent the transmission of sexual transmitted diseases. Threats of criminality, security breaches, and loss of privacy make drones too risky in developed countries. The World Economic Forum in partnership with Zipline and the World Bank has been raising awareness for using drones in Africa and beyond [7]. Tanzania is planning to have the largest drone healthcare delivery operation in the world. In spite of the fast adoption of drones in the continent, drones are manufactured elsewhere, e.g. USA and China. Drones are used in the following ways in Africa [8].

- *Healthcare:* Drones have the transformative potential in revolutionizing healthcare delivery in Africa by addressing some of the continent’s most pressing challenges. Drone delivery in healthcare has the ability to decrease costs, protect supply chain integrity, get around geographic

restrictions, and speed up and improve delivery. Zipline is collaborating with governments of various countries to create a convenient delivery service to improve healthcare across the globe. The various applications of drones in healthcare delivery include delivering vaccines, medications, blood samples, diagnostic tools, and medical personnel to remote locations in a timely and cost-effective manner. Drones can also be used to spray larvicide in the swamps to fight against malaria. Delivering medical supplies to remote and underserved African areas poses significant challenges due to poor road infrastructure, long distances, difficult terrains, limited healthcare facilities, extreme weather conditions, and geopolitical factors that impact healthcare access. Drone technology presents a promising solution to overcome these challenges. Drone-enabled telemedicine services have emerged as a promising solution. Drones offer cost-effective solutions for transporting medical supplies and samples in Africa. Drone technology is capable of bridging the gap between remote areas and healthcare services, ensuring equitable access to medical care [9]. Figure 2 shows a typical delivery of medical supplies [10].

- *Agriculture:* Drones are essential for the modernization of African agriculture, as they bring more efficiency, precision, and reliability at a much lower cost. Farmers can use drones to monitor their fields more efficiently and determine much faster where and when they need to spray insecticide, water the fields, or any other necessary action. Drones are being adopted in Africa in crop agriculture due to the gradual transition from traditional farming to modern methods. All of this helps to save farmers money and time and enhance their crop quality, yields, and profits on those yields.
- *Warfare:* Most media focus has been on the use of military drones by conventional armies and their impact on international humanitarian law. Drones now constitute the new weapon in African warfare. Military drones are rapidly changing the face of warfare. As an indispensable tool in modern warfare, drones are proliferating in Africa, upsetting the balance of power on the battlefield. As shown in Figure 3, Ethiopian police officers take part in a drone piloting training program organized by China [11]. Across Africa, a flood of cheap imported drones is fueling conflicts. African armies and rebel militias see the drones as a highly useful and attractive weapon of warfare. They are turning to their affordable drones to fight insurgencies. The drones are often eagerly supplied by authoritarian states, including China, Iran or Turkey [12]. One of the countries at the forefront of this new arms race is Nigeria, which has been using drones for surveillance and reconnaissance operations against Boko Haram. Other African countries that have acquired military drones include South Africa, Kenya, Morocco, Tunisia, and Algeria. They are all using drones for military purposes.

ADAPTING DRONES IN AFRICAN NATIONS

Some countries, like Rwanda, have already developed innovative guides for governments to effectively regulate the use of drones, while other nations have created research and testing programs. Nearly every country on the continent uses drones in some form for military and nonmilitary purposes. We consider the following nations as typical African nations adopting the drone technology.

- *Rwanda:* This country was the first in the world to use drones to deliver blood and essential medicines to rural hospitals. Rwanda is among a group of early adopters of transport drones for healthcare systems in sub-Saharan Africa, with the first drone airport established in Rwanda. In 2016, the tech company Zipline, a company based in San Francisco, California, signed a deal with the Rwandan government for the delivery of logistical services in order to support the provision of healthcare in remote, infrastructurally disconnected areas of the country. The partnership between the Silicon Valley company Zipline and the Rwandan government gave birth to an innovative device whose impact on citizens' health is crucial. Figure 4 shows the

World Bank president, Jim Yong Kim, hailing Rwanda's use of drones in healthcare delivery [13]. The drone is operated by Zipline and is focused on lifesaving medical supplies. Zipline argues that minimizing waste in the medical system will help the drones pay for themselves. Zipline plans to expand its operations to more African nations. 83 percent of Rwandans live in rural areas and the country is mountainous. Traditionally, when remote hospitals needed blood, it came by road. The drones have shuttled blood to rural, mountainous areas for years. The drones have also reduced the quantity of blood that expired and went to waste [14].

- *Nigeria:* Many African countries such as Nigeria are adding drone technology to their arsenals. Nigeria deploys drones at border crossings to increase security along its porous frontier and to identify potential threats. The terrorists that Nigerian soldiers are looking for likely are watching them with drones of their own. Terrorist groups such as Boko Haram and its offshoot, the Islamic State West Africa Province, use drones for intelligence-gathering. The psychological impact of a weaponized drone in the hands of an insurgent is perhaps as important as its physical impact. Many of drones are made and marketed by China, and they have the potential to be weaponized by extremist groups. Nigeria also makes its own drones. Figure 5 shows Nigerian military leaders and officials deploying drones for border security [15]. Experts say Nigeria needs to lead the regional effort but that the nation itself lacks a coherent policy to combat armed groups' use of the drones.
- *South Africa:* South Africa has become another major actor in the drone industry. South Africa manufactures drones for sale to other countries and has considered deploying them along its 5,244-kilometer border. The flying of drones in the South African airspace had been unregulated and essentially illegal. South Africa is a member of the International Civil Aviation Organization (ICAO).

It has seen the recent founding of the Drone Council to facilitate the expansion of the drone industry, with one of its objectives to promote a more balanced involvement of women. South Africa was the first African country to legalize commercial drones [16]. There are also a multitude of examples of champions for 'drones for good' bringing the benefits of drone technology to farmers, town planners, conservationists, and disaster management – many of whom are women [17]. Fishing by drone has really taken off, and the US has become the biggest market for the equipment developed in South Africa. Drones are being used to enable people to go deep-sea fishing, while standing on the beach. The South African National Defence Force is investing in drone technology. There is no policy on how drones are to be used and integrated into the military. Drones in South Africa could impact the essence of the African value of Ubuntu. The South African Civil Aviation Authority (SACAA) has now collaborated with the drone industry and formulated regulations to deal with this rapidly expanding industry. The regulations on flying recreational drones in South Africa are [18]:

- ✓ Fly at or below 400 feet.
- ✓ Keep your drone within sight.
- ✓ Never fly near other aircrafts or near any airports.
- ✓ Never fly over groups of people.
- ✓ Never fly over stadiums or sports events.
- ✓ Never fly near emergency response efforts such as fires.
- ✓ Never fly under the influence.
- ✓ Be aware of airspace requirements.
- ✓ Fly/operate Remotely Piloted Aircraft (RPA) or toy aircraft in a safe manner, at all times.

- ✓ Remotely Piloted Aircraft or toy aircraft should remain within the visual line of sight at all times.
- ✓ Fly/operate RPA in daylight and clear weather conditions.
- ✓ Inspect the aircraft before each flight.
- *Ghana:* The Ghana government and Zipline deployed the COVID-19 vaccine to hard-to-reach areas within Ghana. To facilitate the delivery, Ghana's Zipline branch has four distribution centers hosting a fleet of 30 fixed-wing drones that are serving as a drone airport and a medical supply warehouse. The drones can deliver the vaccines as far as destinations that are 22,500 km away from the distribution center. So far, the Zipline has distributed over 1 million vaccine doses in Ghana in over 50 thousand deliveries.
- *Kenya:* Swarms of millions of locusts have decimated crops in many parts of Africa. In Western Kenya, drones have been used to spray and kill the swarms, as typically shown in Figure 6 [19]. Each drone has the capacity to cover 22 acres per hour, operate for up to 10 hours a day, and carry up to 16 litres of spray solution for every spray run. The drones can target otherwise inaccessible areas like roosting locusts atop trees. Drones not only have the potential for surveillance but for control operations targeting small swarms. Kenya is also engaged in spirited attempts to digitize its land records. In addition to digitization of existing records, Kenya is increasingly using drone technology in support of land mapping, particularly in remote areas, in order to enhance the accuracy of the data in the registries. The data obtained through the use of drones could facilitate more accurate delineation of boundaries among land holdings [20].
- *Niger:* In 2013, the US expanded its drone operations in the middle of the Sahel from a base in Niamey in Niger. A number of drones and 100 military personnel were stationed in Niger “to promote regional stability in support of US diplomacy and national security and to strengthen relationships with regional leaders committed to security and prosperity.” The drones fly in Niger, Mali and Libya, and share broad patterns of human activity with French forces and other US partners who are fighting ‘terrorism’. The US and the Nigerien government were worried that the foreign deployment of drones would trigger a backlash among civil society, as foreign military interventions are a sensitive issue. Therefore, both the US and Niger have remained vague about why, when, where, and how drones would be deployed exactly. The President of Niger, Issoufou Mahadou, welcomed the drones because he was “worried that the country might not be able to defend its borders from Islamist fighters based in Mali, Libya or Nigeria” [21].

BENEFITS

Drones were previously restricted to military operations, inspections, surveys, and deliveries. Today, drones are being used to solve some socio-economic and environmental problems. The drone technology is bringing innovation into people’s daily lives. In many African countries with poor road infrastructure, drones are becoming an efficient way of providing logistical services for the delivery of supplies in rural areas. Several African companies are currently using geographic information systems (GIS) drones to collect aerial photos that are clearer than satellite photos. Drones are reshaping the way militaries from Morocco to South Africa protect their citizens, monitor their coastlines, combat wildlife, and more.

Drones cost a fraction of what it takes to purchase and maintain manned aircraft and they provide a superior aerial advantage to any manned aircraft. Drone technology can potentially solve some of the biggest challenges facing the region and be a major catalyst towards a future of prosperity, peace, and independence. Perhaps the most exciting development for humanitarian aid workers in Africa is the use of drone technology in emergency medical situations. In agriculture, drones can help enhance and optimize crop yields via aerial monitoring of fields.

CHALLENGES

The difference between a radio controlled aircraft (used as a toy) and a drone has not been defined by the International Civil Aviation Organization (ICAO). Aerial data must be regulated because it is related to the protection of privacy. Security must be reliable in all possible ways. Due to the proliferation of easy-to-obtain drones, thousands of African civilians have been killed by drones in recent times. Markets, schools, markets, hospitals, weddings, funerals, and civilian vehicles have all been hit by poorly targeted drone strikes.

Drones are becoming part of the tool kit for violent actors across Africa. Security experts in Africa are raising concerns about the growing use of drones by terrorist groups and the readiness of government forces to match their sophistication. As African nations continue to sort out the regulations and systems needed to support drone activities, drone technology promises to advance in Africa at an astounding pace. Another area of major concern is privacy. Flying drones with cameras, scanners, and sensors could allow unscrupulous individuals to anonymously collect and record sensitive or damaging information on civilians, businesses, and other organizations [22].

CONCLUSION

The age of drones has arrived and drones are here to stay. Autonomous flying is being applied in several industries ranging from transportation to law enforcement and defense. The drone industry in Africa is taking off and it is evolving into a massive enterprise. The drone technology can enable African countries to flourish and prosper. The addition of thousands of new technology and drone-related jobs to the global economy presents a unique growth opportunity for African youths. The Drone & Data Academy will prepare young Africans with the skills that will be needed to join the new technology workforce [23]. The capacity for drone warfare in a continent experiencing various armed conflicts is certain to become relevant. For more information about the use of drones in Africa, one should consult the books in [24-27] and the following related journals devoted to drones:

- ✓ *Journal of Unmanned Vehicle Systems*
- ✓ *Journal of Intelligent Robot System*

REFERENCES

1. W. Shafik, "Chapter 7 Navigating Emerging Challenges in Robotics and Artificial Intelligence in Africa,"
<https://www.irma-international.org/viewtitle/339985/?isxn=9781668499627>
2. K. Haula and E. Agbozo, A systematic review on unmanned aerial vehicles in Sub Saharan Africa: A socio-technical perspective," *Technology in Society*, vol. 63, November 2020.
3. P. Kardasz et al., "Drones and possibilities of their using," *Journal of Civil & Environmental Engineering*, vol. 6, no.3, 2016.
4. "Drones and blood transportation: Will drone impact society?"
<https://mbamci.com/drones-and-blood-transportation/>
5. P. Tilsley, "Drones increasingly used in Africa to save people's lives, deliver blood samples to labs," August 2019,
<https://www.foxnews.com/world/drones-africa-save-lives-blood-samples-labs>
6. B. McCall, "Sub-Saharan Africa leads the way in medical drones," *World Report*, vol 393, January 2019, pp. 17-18.
7. R. Sengupta, "Drones deliver medicines in Africa," June 2019,

- <https://www.downtoearth.org.in/news/health-in-africa/drones-deliver-medicines-in-africa-64832>
8. “The drone industry in Africa,”
<https://www.do4africa.org/en/the-drone-industry-in-africa/>
 9. G. Olatunji et al., “Exploring the transformative role of drone technology in advancing healthcare delivery in Africa; a perspective,” *Annals of Medicine & Surgery* (London), vol. 85, no. 10, October 2023, pp. 5279-5284.
 10. J. Orisakwe, “Rise of drone delivery service for medical supplies in Africa,” August 2023,
<https://insights.omnia-health.com/management/rise-drone-delivery-service-medical-supplies-africa>
 11. N. Hochet-Bodin, “Drones: A weapon system coveted by all African armies,” December 2023,
https://www.lemonde.fr/en/international/article/2023/12/30/drones-a-weapon-system-coveted-by-all-african-armies_6388927_4.html
 12. “Drones in Africa: Cheap UAV proliferation changes warfare and fuels surge in deaths,” May 2024,
<https://northafricapost.com/77187-drones-in-africa-cheap-uav-proliferation-changes-warfare-and-fuels-surge-in-deaths.html#:~:text=Across%20Africa%2C%20a%20flood%20of,indiscriminate%2C%20thus%20increasing%20civilian%20casualties.>
 13. “World Bank president hails Rwanda's use of drones in healthcare delivery,”
http://www.xinhuanet.com/english/2017-03/22/c_136148796.htm
 14. “Drones have transformed blood delivery in Rwanda,” April 2022,
<https://www.wired.com/story/drones-have-transformed-blood-delivery-in-rwanda/>
 15. “The dizzying possibilities of drones,”
<https://adf-magazine.com/2023/09/the-dizzying-possibilities-of-drones/>
 16. “South Africa: First African country to legalise commercial drones,”
<https://trends.directindustry.com/project-19318.html>
 17. “Trailblazing women in the African drone industry,”
<https://womenanddrones.com/wd-africa/>
 18. “Drone regulations - Southern Africa,”
<https://akdmc.com/media/6684/ak-southern-africa-drone-laws.pdf>
 19. “Pilot project using drones to control desert locust launches in Kenya,” October 2020,
<https://blog.invasive-species.org/2020/10/26/pilot-project-using-drones-to-control-desert-locust-launches-in-kenya/>
 20. P. Kamari-Mbote and M. Muriungi, “Potential contribution of drones to reliability of Kenya's land information system,” *The African Journal of Information and Communication*, vol. 20, 2017, pp. 159-169.
 21. “Remote Horizons: Expanding use and proliferation of military drones in Africa,”
https://paxforpeace.nl/wp-content/uploads/sites/2/import/2021-05/PAX_remote_horizons_FIN_lowres.pdf

22. “Flying drones in Africa: The challenges and the opportunities,”
<https://www.shearwater.ai/post/flying-drones-in-africa-the-challenges>
23. “The African Drone and Data Academy,”
<https://adda.cired.vt.edu/>
24. C. S. Rinehart, *Drones and Targeted Killing in the Middle East and Africa: An Appraisal of American Counterterrorism Policies*. Lexington Books, 2018.
25. D. Soesilo and G. Rambaldi, *Drones in Agriculture in Africa and Other ACP Countries: A Survey On Perceptions and Applications*. CTA, 2018.
26. A. Stokenberga and M. C. Ochoa, *Unlocking the Lower Skies: The Costs and Benefits of Deploying Drones Across Use Cases in East Africa*. World Bank Publications, 2021.
27. F. E. Mbuya, G. Rambaldi, and H. R. Chaham, *Getting Drones Off the Ground in Africa*. CTA: 2017.

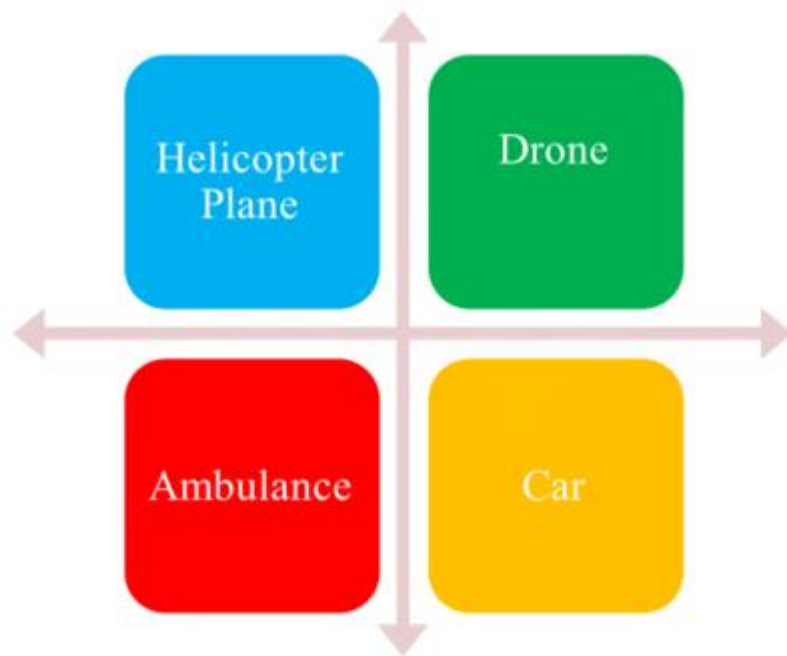


Figure 13.1 Drone is compared with other means of transportation [4].



Figure 2. A typical delivery of medical supplies [10].



Figure 3. Ethiopian police officers take part in a drone piloting training program [11].



Figure 4. World Bank president hails Rwanda's use of drones in healthcare delivery [13].



Figure 5. Nigerian military leaders and officials deploy drones for border security [15].



Figure 6. Drones used to spray and kill swarms [19].