

Robotics in Africa

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Abstract:

Robots are no longer something you see in the movies and TV shows. They are currently in homes and businesses. They are becoming more and more common in our society and more integrated into our lives. Some pioneering innovators in Africa are making significant strides in the development of robotic and mechanical systems designed to revolutionize the harvesting of diverse crops. AU Member States are encouraged to invest in R&D to enhance the affordability and accessibility of these robots for African farmers. Several African nations have been investing in building their own capabilities in robotics R&D. Universities and research centers are conducting groundbreaking research in areas like autonomous systems, artificial intelligence, and human-robot interaction. This paper examines the adoption of robotics in African nations.

Keywords: *Africa, robotics, robotics 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]. The continent is not just catching up with the world; it is propelling itself to the forefront of innovation. Africa is rising, and its tech scene is leading the way. Africa is closely watched as the next big growth market. It is the home to some of the youngest populations in the world.

Robotics constitutes one of the most exciting fields of technology today. It is the discipline of designing and constructing intelligent machines, called robots. A robot is an autonomous mechanical device that is designed to sense its environment, carry out computations to make decisions, and perform actions like humans in the real world. Popular interest in robotics has increased in recent years. Robots are becoming more and more common in our society and more integrated into our lives. This is due to the fact that they are becoming smarter, smaller, cheaper, faster, more flexible, and more autonomous than ever before. The robot revolution is going to change us as humans [2,3]. In recent years, the robotics and artificial intelligence fields have grown and changed uniquely and impacted many industries and sectors worldwide. Although Africa is quickly adopting new technologies, significant problems still make it hard for robots and AI to be widely used and integrated.

WHAT IS ROBOTICS?

Robotics is a relatively new field that is dedicated to the design, construction, and use of robots. It is a technology field that uses electronic or mechanical technology to replace human labor. Robots are machines with enhanced sensing, control, and intelligence used to automate, augment, or assist human activities. They are currently used in manufacturing and production firms. They are expanding to other business industries.

The word “robot” was coined by Czechriter Karel Čapek in his play in 1920. Isaac Asimov coined the term “robotics” in 1942 and came up with three rules to guide the behavior of robots [4]:

- (1) Robots must never harm human beings,
- (2) Robots must follow instructions from humans without violating rule 1,
- (3) Robots must protect themselves without violating the other rules.

Robotics has advanced and taken many forms including fixed robots, collaborative robots, mobile robots, industrial robots, medical robots, police robots, military robots, officer robots, service robots, space robots, social robots, personal robots, and rehabilitation robots [5,6]. Robots are becoming increasingly prevalent in almost every industry, from healthcare to manufacturing. They are regarded as intelligent agents that can perform actions similar to what humans can do.

Robotics is an interdisciplinary discipline embracing mechanical engineering, electrical engineering, computer science, and others. The goal of robotics is to create intelligent machines (called robots) that behave and think like humans. Robots were originally intended for use in industrial environments to replace humans in tedious and repetitive tasks. Today, robots help human beings in everyday life. Depending on applications, there are many types of robots. Robotics technology has been implemented in a variety of fields including manufacturing, medicine, elderly care, rehabilitation, education, agriculture, home appliances, search and rescue, car industry, defense, and more.

USE OF ROBOTICS IN AFRICA

In recent years, several organizations in Africa have launched initiatives to advance participation in robotics. In some parts of Africa, robots are used in agricultural harvesting, mining, controlling traffic, and even fighting deadly diseases. As technology and robotic automation spread across Africa, young children have been attracted to creative designs. These students have developed remarkable robots that address real-world challenges. They have been meticulously designed to solve daily problems faced by individuals, showcasing how technological advancements can enhance our lives.

Carnegie Mellon University - Africa aims to use AI and robotic systems to address important problems in areas such as transportation, building systems, manufacturing, energy, agriculture, security, health, and climate. (It is believed that Pittsburgh, Pennsylvania is the birthplace of AI and

a global leader in the growing robotics industry, with Carnegie Mellon University as a trailblazer since the 1950s.) The goal is to improve our understanding of real-world systems and address specific challenges that can have a positive impact on both society and the environment. A culturally sensitive social robot for Africa is shown in Figure 1 [7].

The African Robotics Network (AFRON) is a community of institutions, organizations, and individuals engaged in robotics in Africa. It was established in April 2012 to promote communication and collaborations that will enhance robotics-related education, research, and industry on the continent. In order to achieve this, AFRON organizes projects, meetings, and events in Africa and at robotics and automation conferences abroad.

Pan-African Robotics Competition (PARC) is an annual youth robotics competition that brings together middle school, high school, university, and young professional robotics team across Africa and its diaspora. PARC recently launched a Virtual Learning Platform allowing youth around the world to engage with coding, programming, and robot design with online and offline capabilities.

Collaborative robots are designed to work seamlessly with workers in all fields; they facilitate improvements in workers efficiency. Cobots are being integrated into a wide range of disruptive digital manufacturing innovations that allow a factory to perform smarter, and produce better quality material. Cobots can also provide logistic solutions and their possibilities for manufacturing are limitless. Figure 2 show a typical cobot [8]. Besides manufacturing, a great number of other industries across Africa have already adopted collaborative robots.

ADAPTING ROBOTICS IN AFRICAN NATION

There are several African countries that are beginning to have a dedicated strategy for adopting robots. We present the following African nations as typical examples [9].

- *Nigeria*: In Nigeria, the National Center for Artificial Intelligence and Robotics has significantly pushed the country to propel in machine learning, the Internet of things, blockchain technology, intelligent robotics, and digital manufacturing and prototyping. Uniccon Group unveiled Africa's first humanoid robot in Abuja, Nigeria. Omeife, the 6-foot-tall female battery-powered human-like robot, is African by design and has Igbo-like physical attributes. It can speak different languages like Igbo, Yoruba, English, French, Swahili, Wazobia, Pidgin, Afrikaans, and Arabic [10]. In Nigeria, there is a growing interest in agricultural robotics, with large-scale farms utilizing harvesting robots to boost productivity.
- *Ghana*: The Kwame Nkrumah University of Science and Technology (KNUST) has introduced the TEK mechanical harvester. This groundbreaking technology has the remarkable capability to harvest one cassava plant in just one second, with the potential to significantly streamline the cassava harvesting process across the continent.
- *Uganda*: In early 2016, a pair of sprawling posture robots were designed, one designed to mimic a crocodile and another designed to mimic a monitor lizard, along the banks of the Nile River in Uganda, Africa. These robots fell at the intersection of our interests in developing robots to study animals and robots for disaster response. The robots needed to be designed on the basis of a systematic study of data on the model specimens, be fabricated rapidly, and be reliable and robust enough to handle what the wild would throw at them [11].
- *South Africa*: Robots are used in the gold mining to eliminate the associated risk involved in these jobs. Robots now replace humans to assess the depth of some of the country's gold mines. South African engineers at the Council for Scientific and Industrial Research (CSIR) in Pretoria are currently testing robots that will be able to assess the safety of mines after they have been blasted. Spot is a mobile ground robotics tool which is helpful in the South African market in that their legacy mining methodologies do not easily facilitate the use of autonomous drones.

- *Congo*: The Democratic Republic of Congo has introduced robotic machines into the public sector. In the capital city of Kinshasa, authorities have installed two eight-foot tall solar-powered robots (“robocops”) to help direct traffic and prevent road accidents. These robots have eliminated the need for human traffic wardens as they can detect pedestrians and are designed to withstand all weather conditions.
- *Botswana*: An African nation known for gorgeous diamonds, has introduced robots into its mining sector. These robots are designed to perform tasks and go into depths that human miners cannot simply reach, bringing up stones.

BENEFITS

By embracing robotics, African nations have the potential of addressing critical issues of poor harvesting practices and food wastage, bolster agricultural efficiency. This will ultimately contribute to ensuring a sustainable and abundant food supply for its growing population. Having a national policy guiding AI and robotics adoptions is essential. Robots do the heavy lifting while humans leave or make their way to the working face after or before a shift. Robots are the ideal solution for “no go areas.” The overriding benefits are those that involve efficiencies and precision while achieving zero harm [12]. In Africa, robotics is being applied in various sectors such as agriculture, healthcare, education, manufacturing, and logistics. For example, robotic devices can assist healthcare workers in performing surgeries or providing care to patients in remote areas.

Other benefits of robotics in Africa include the following:

- *Cost*: On a continent where money for expensive robots is limited, some think that there is real potential for Africa to build a reputation for coming up with more affordable, accessible robots. Low cost educational robots have made robotics more accessible to young people.
- *Automation*: Automation is technology that assists humans, with limited guidance, in the production, maintenance, or delivery of products or services. An era characterized by a rise of autonomous robots and self-learning software is upon us. Many industrialized economies are being transformed by the increasing automation of work. Self-driving cars upending the taxi and trucking industries will be one of the most visible signs of these changes in the near future. The potential for job displacements due to automation are important concerns. Yet, Sub-Saharan Africa does have areas of economic activity where the economic calculus favors automation.
- *Education*: A side benefit of the spread of robots is its use in education. There are initiatives aimed at promoting robotics education and entrepreneurship across Africa. Many institutions ranging from local high schools to Universities around the continent are integrating program like robotics and AI into their curriculum. For example, RoboCupJunior is an educational robotics initiative that aims to enhance learning through educational robotics activities around the world. RoboCupJunior has three distinguished leagues - Soccer, Rescue and Dance - that attract students from all the continents. Robotics can also be used as a tool for teaching STEM (Science, Technology, Engineering, and Mathematics) subjects, helping to inspire and educate the next generation of African innovators. However, Africa has not taken significant advantage of this initiative, with a rather low participation of a few African countries.
- *Agriculture*: Agriculture is one of the key areas where robotics is making an impact in Africa. The agricultural sector stands as a cornerstone of African economies, serving as a multifaceted generator of income through foreign trade, employment opportunities, and sustenance. Since a significant portion of Africa's population relies on agriculture for their livelihoods, there is great potential for robotics to improve efficiency and productivity in farming practices. In spite of the enormous potential of Africa as a breadbasket, the agricultural sector of the continent is faced with constraints that hinder its progress and the welfare of its populations. African countries are confronted with alarming levels of food loss. The quest for a promising and transformative

frontier in African agriculture could be enhanced by the adoption and integration of robotics in agriculture through modern farming practices such as mechanization. Robotics-based mechanization holds significant promise, especially in the realm of harvesting, as shown in Figure 3 [13]. African farmers can use robotic harvesting to enhance food security in the region. Several AU Member States are adopting agricultural robotics to modernize their farming practices.

- *Globalization*: The world is becoming one. Globalization is slowly causing the interaction and integration of companies, governments, and people of different nations. In this process, technology, products, and information are all spread at a faster pace. There are new developments which are transforming the way people live, work and relate to one another in South Africa. This is shaped by the disruptive technologies such as AI and robotics [14].

CHALLENGES

There are certainly challenges to overcome, such as limited access to resources and infrastructure, the growing interest and investment in robotics in Africa bode well for the continent's future development. African countries are importing robots and people feel that their jobs are at risk. Fear of losing jobs to computers is common, but robotics can allow many jobs to evolve besides ensuring safer, efficient, and better work results. In fact, robots will create more jobs that did not exist before. The robotic automation of manufacturing will also give rise to new job opportunities in the design, construction, vending, installation, management, and continued maintenance of robots. The continent may not be maximizing its labor force to do the jobs currently being taken over by robots. With continued support and collaboration, Africa has the potential to become a significant player in the global robotics industry.

African nations face significant challenges in accomplishing food security due to factors such as a growing population, urbanization, and limited agricultural and food production capacity. The AU High-Level Panel on Emerging Technologies (APET) recommends that AU Member States develop supportive and enabling regulations aimed at reducing bureaucratic burdens, and providing tax incentives to farmers who invest in robotics technology.

CONCLUSION

Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots. Robotics can take on a number of forms, with the end objective being that of assisting humans with intelligent machines. Today, there are robots that can autonomously sense, reason, plan, act, move, communicate, and collaborate with other robots. The robot revolution is going to change us as humans.

Robotics in Africa is an exciting and rapidly growing field with a lot of potential for innovation and development. While Africa may not be as commonly associated with robotics as some other regions of the world, there are numerous initiatives, projects, and startups emerging across the continent that are driving progress in the region. For more information about robotics in Africa, one should consult the books in [15,16] and the following related journals devoted to robotics:

- ✓ *Robotica*
- ✓ *Robotics and Autonomous*
- ✓ *Robotics and Computer-Integrated Manufacturing,*
- ✓ *Advanced Robotics*
- ✓ *Autonomous Robots*
- ✓ *Journal of Robotics*
- ✓ *Journal of Robotic Systems*

- ✓ *Journal of Robotic Surgery*
- ✓ *Journal of Robotics and Mechatronics*
- ✓ *Journal of Intelligent & Robotic Systems*
- ✓ *Journal of Mechanisms and Robotics-Transactions of the ASME*
- ✓ *Journal of Automation, Mobile Robotics and Intelligent Systems*
- ✓ *Journal of Future Robot Life*
- ✓ *IEEE Robotics and Automation Letters*
- ✓ *IEEE Transactions on Robotics*
- ✓ *International Journal of Medical Robotics and Computer Assisted Surgery*
- ✓ *International Journal of Robotics Research*
- ✓ *International Journal of Social Robotics*
- ✓ *International Journal of Humanoid Robotics*
- ✓ *International Journal of Advanced Robotic Systems*

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Figure 1. A culturally sensitive social robot for Africa [7].



Figure 2. A typical cobot [8].



Figure 3. Robotics-based mechanization for harvesting [9].