OPEN ACCESS
Global Journal of Research in Engineering & Computer Sciences
ISSN: 2583-2727 (Online)
Volume 05| Issue 04 | July-Aug. | 2025
Journal homepage: https://gjrpublication.com/gjrecs/
Research Article

The Principal Development in Robotic Systems and their uses

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DOI: 10.5281/zenodo.15852103 **Submission Date:** 05 June 2025 | **Published Date:** 10 July 2025

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Abstract
Robots are employed for wireless environmental monitoring, especially flying or spider robots. Since the spider robot has legs for mobility, it can readily adapt to novel circumstances or obstacles, unlike standard wheels or two-legged robots. Interfaces are not necessary for it to function. This review effort will help address the problems that typical contemporary robots face, especially ones that are wheeled or legged. Apart from operating in environments that are inaccessible to standard robots, such scaling walls or trees and traversing uneven terrain, which are activities that neither wheeled nor walking robots can accomplish, spider robots are usually used to help monitor nuclear or dangerous regions. Furthermore, the spider robots help find and track down lost objects. The invention of the spider robotic system solves the problems that ordinary robots faced. Spider robots help provide information on the state of environments or places that are off-limits to humans or standard robots because of environmental toxicity or the need for careful observation or monitoring. Many industries and aspects of daily life are rapidly altering as a result of robotics advancements. Significant progress has been made in developing more mobile and adaptive robots and using artificial intelligence (AI) to enhance learning, perception, and decision-making. These advancements are enabling robots to perform challenging tasks, collaborate with humans, and operate in a range of environments, including as manufacturing, healthcare, agriculture, and exploration. The challenges and future directions of the robotic system are examined.

Keywords: *Artificial Intelligence (AI), Toxic Environments, Spider Robots, Sensors, Arduino, Challenges.*

I. Introduction
In the subsequent half of the 20th century, humankind obtained the rewards of numerous comprehensive scientific findings that normally took place in the first half, among which was the control of the nuclear chain reaction for producing electricity [1]. Due to its high energy density and the therefore minor requirement for gasoline, nuclear power has been misused. Also, it has authorized enhancements in the toughness of resources that were used in the nuclear laboratories, and this has led to prolonged achievements and improved safety restrictions. As a result of this, improvements in engineering and resource science have been enforced to an extensive range of nuclear-connected projects, which stretch from the framework of a reactor and additional structures through to the processes by which they are disbanded [2]. For instance, static and monorail-type teleoperated engines have been in use since the beginning of nuclear energy to handle activities carefully in zones of life-threatening radioactivity disclosure and to accomplish polluted constituents. Martin and Hamel, 1983; Wehe et al., 1989, though several mobile samples were existing during the 1960s Clark, 1961; Huffman, 1962 [3]. With the help of microchip technology booming in the mid-70s, scientists proposed different but possible robotic designs that might replace human beings in a wider range of work jobs in radioactive surroundings; this may include inspection, maintenance, and repair in such environments [4]. Also at the same phase, civil nuclear power plants were established in North America and Europe on a scale never repeated since, and hence it made sense to design and build acceptance robotic technology for these purposes [5]. In 1979, the necessity for progressive robotic proficiency became vital because of the reactor disintegration that took place in Unit 2 at Three Mile Island. It was inescapable that several jobs had to be commenced tenuously, accompanied by the use of long-

handled tools and what were then original vision systems [6]. At this time, the first-ever radiation inspection robot for this objective, used in the basement of the unit four years later, was considered a landmark in the nuclear industry [7]. About seven years after the Three Mile Island accident, the tragic accident that took place in Chernobyl caused a policy to entomb the damaged plant in clay and sand to restrain the magnitude of the ongoing dangerous secretions and reformed the interest in the idea of using mobile robots in place of individuals for nuclear accident response applications [8]. These technological enhancements over the next two eras have driven the design and execution of highly refined systems, with robotics gaining more and more popularity in the majority of marketable fields, such as entertainment, transport, and medicine [9]. Most of the robots that we are acquainted with make use of wheels for their movement [10]. They can accomplish high speed and comparatively small control complication, but even with multifaceted suspension systems, they present many boundaries in irregular and rough environments (e.g., hazardous surroundings and uneven ground) with the aid of legged spider robotics, and most of this difficulty is overcome due to its litheness and ground adaptation [11]. The chance to choose between different existing solutions and to control and adapt the location of the center of mass of the system allows dodging downturns and slippage due to environmental abnormalities [12]. The charges that have to be paid are the lesser speed of movement and greater intricacy of the controller with veneration to wheeled systems. Also, due to the datum that the legs are self-reliant controlled, legged robots have a large number of degrees of freedom (DOF) to be harmonized to control the location, balance the forces (e.g., load and external forces), and ingest as little energy as possible [13]. Meanwhile, the task of finding an optimum force allocation was made in real-time; fast processes and control functions have to be used, as likewise when a body force command solution is not reachable and a new plan has to be conveyed [15]. The spider-legged robots have a body and several enunciated legs that start from it. Each of these kinematic chains can also be viewed as a manipulator that acts like a limb and adds to the overall position and equilibrium of the spider robot structure. To estimate and produce an operative legged spider robot, the awareness is to draw motivation from nature [16]. In nature, different-legged systems can be able to walk and climb different surfaces with low energetic consumption, and high autonomy has been found. Indeed, safe attachment to and easy detachment from smooth substrates is a major feature of a diverse range of animal species. Attachment without using fluids, so-called dry adhesion, was exploited by geckos and Evarcha arcuata spiders using fibrillar elements [17]. The adhesion force seems to be related to the approaching angle between the attaching elements and the surface: the maximum adhesion condition is reached when the angle is around 30°; a sliding condition occurs when the angle is smaller, and detachment occurs when the angle is bigger [18, 19]. Currently, there are some certain conditions in which humans are incapable of completing a certain mission in real life. Such missions include locating a lost object or item or finding a missing individual in a jungle for more than a day and also discovering a pothole with a lack of oxygen and also working in a toxic environment [20]. To achieve such problematic tasks, the human will have to depend on mobile robots [21]. Scientists nowadays show emphasis on the new design of self-adaptive robots, which includes path tracing [22]. In the year 2011, Pratihar, Roy, and Singh estimated the optimal base forces and joint torques in the real-time process for the monitoring of the eight-legged robot [23]. This researcher concentrated on finding the best point in the circulations of the basis's forces and values of the joint torques of the six-legged robot online [24]. The minimization of the standard of the joint torques and the base forces was simulated in their study. Roy conducted another study in the same year with Pratihar and discovered that unlike duty features, it will lead to many energy intakes. These duty factors can also differ among 1/3 and 2/3, whereas energy intake will change in the range of 3% and 36% [25]. In the subsequent year, both Pratihar and Roy conduct another research on the legged robot and simulate the technique of attaining extreme steadiness with the minimum energy intake steps. Henry, Menon, and Boscariol, in the year 2013, examined resolving the unsuitable relocation of forces in the reloading of the legs in the hiking robots, which may likely lead to the irreversible dispassion of the spider robots from their upright facades [26]. This researcher finally concluded that it is likely to save 36% of the whole charges of this spider robot if the designed step is well-organized. In this study work, the National Instrument (NI) protocol was nominated to relate to the suggested well-designed robotic supervisor for interfacing and processing [27]. The suggested smart system gathers data about the environments, particularly in available areas, and aids the robot in choosing the finest route course to be taken. The National Instrument implanted field-programmable gate array board has been selected to merge with the spider robot for the tenacity of great enactment adeptness as well as being user-friendly and compatible. The categorization of leg actions is predefined in this study for persistent walking. With the help and combination of several sensors on its frame construction, this suggested eight-legged flexible smart spider robot is fit to be employed in ambiguous environments [27].

II. Materials and Methods

2.1 The method used in producing the spider robotic system

The recommended spider robot is divided into three parts, which may likely comprise the body structure of the spider robot, its sensor, and the control algorithm. The configuration of the spider robot is made of aluminum; this is because of the strength of aluminum in resisting the tensile and pressure stress on its exterior. Stalemate bolts were used to protect the position of the National Instrument board on the framework. Several sensors are applied in the spider robotic body [19-22]. The body of this spider robot must be tough enough to adequately support the heaviness of the National Instrument board in vigorous circumstances. Henceforward, the consideration that has been taken during the blueprint stage of the spider robot of the main body of the robot includes compression and tensile stress alongside the axis of the movement of these moving parts of the spider robot caused by the burden carried. The eight-leg pairs of the spider robot will be attached to a frame of the spider at certain angles that will enable it to maintain stability, and the whole spider robot will be controlled remotely. To help keep this spider design steady, avoid it. From losing balance or sloping over, you will need to assemble the leg pairs and the structure at an angle from the conservative straight ahead. Because the pairs of legs will be pointing at different angles than straight ahead, their directional vectors do not point in the direction of movement; rather, at the exact angle from the 90-degree line down the middle of the design signifies straight ahead from an outside perspective. This results in two vector quantities chained together and gives magnitude and force in precisely the same path. A servo bracket is fixed to the joint of the legs; each of these different legs of the spider robot has three degrees of freedom (DOF). Among the degrees of freedom (DOF), one of these degrees of freedom is alongside the z-axis and also functions as the shoulder, and the turning of this shoulder will serve as a controller to the other two joints. This shoulder will be master, and the location of it will invigorate the other two to take their spot. The National Instrument board helps in the control of the movement of these joints. Each of these joints uses a servo bracket to join to each other. The whole project of the spider robot is carried out using a feedback loop graphic national instrument LabVIEW interfacing with an insolent controller and with the help of the company of smoke device, temperature sensor, and ultrasonic sensor. This GH311 ultrasonic sensor produces an exact and non-contact space dimension. When there is a difficulty as far as, like, 31cm away from this spider robot, with the help of the GH311 sensor, it will transfer a high indication to the National Instrument board to specify the position of the problem and implement the suitable moving algorithm to dodge such a hitch. The GH-312 sensor was applied in the spider robot construction to identify hydrogen, smoke, alcohol, liquefied gas, butane, and propane.

2.2 The principal operation of the spider robotic system

With the help of the Arduino receiver or microcontroller, it takes the signal from the transmitter and aids in sending it to both the servo and the speed controller. It is this device that synchronizes to the controller and is what allows the spider robot to receive radio signals as a result of the built-in aerial in the robot. The speed of this controller is the central piece of the research and is what helps in controlling both the servo and the electric motors by regulating their rotation proportional to the amount forced upon it by the transmitter. It is connected to the battery; all of the four motors are in parallel to the Arduino receiver and a switch. All four electric motors are wired in parallel, with two being reversed. This is because there will be two electric motors at either end of the research, and when one pair of legs is walking forward, then the other leg needs to be walking backward. By wiring the motor so current flows in the opposite direction, this effect is achieved. With the objective of the spider robot moving forward or backward and dodging the problems in the way of the robot's path. The Arduino or microcontroller board is preprogrammed and waits for you, the user, to input a certain task to be performed. This National Instrument board helps in collecting feedback information from this sensor embedded on the spider robotic frame and processes the information; hence, implementing the given job. For instance, if this ultrasonic detector is used to sense an item hindering the spider robot's movement route, this detector will automatically convey the response information to the programmed National Instrument board. With the help of this board, it will then process the information consequently and assess the information to give a suitable outcome, such as enrichment for the location of the spider robot to escape the hitch that leads to self-localization. These spider robots will then start moving on again until this robot reaches its target or faces additional problems on its movement path. The spider robotic program consists of three digital input and output ports; this includes an ultrasonic detector, smoke detector, and temperature detector. It also consists of four (4) types of walking processes ready to perform singly when this ultrasonic detector identifies any difficulty in front of the spider robots. When there is no difficulty in the spider robot direction, the remaining three (3) of the walking algorithms would not implement. In this case, the only moving algorithm performed is the algorithm for the spider robot moving on. If this ultrasonic detector notices a hitch in the forward-facing of the spider robot, the spider robot will dismiss the walking forward process and then trigger either the walking left-right or backward walking process. The feedback information that is from the sensor will be performed consequently; henceforth, calling the information that has been made in the memory block to the pulse-width modulated generator for each of the servomotors. In this case, when you implement the forward walking procedure, the spider robot limb moves step-by-step. With eight legs of the spider robots taking their respective locations, the spider robot will then be able to push its body forward. This procedure will be repeated to make a forward movement for the spider robot. The smoke and temperature sensor will perform individually without touching the walking process of the robot. The information that you obtained from both the smoke and temperature sensor is displayed on the front panel of your monitor. The wireless watching system is an interface on your laptop. On your observing system interface, you can assign a green light-emitting diode indicator to represent the direct direction taken by the spider robot when the walking process is executed. If in this process the spider robots sense smoke, this red light-emitting diode that you assigned to this sensor indicator will nimble up to signal possible menace. Your surrounding temperature is monitored and updated with the help of an indicator thermometer on your laptop or desktop monitoring system.

2.3 Areas of applications of the spider robotic systems

1. We can use this spider robot in discovering dangerous or rough areas in which humankind can have full access easily. For example, searching for survivors after a terrible nuclear tragedy, exploring war zones, or inspecting unstable buildings after a natural tragedy such as an earthquake, tsunami, or volcanic eruption.
2. We can also use spider robots in defusing bombs such as land mines.
3. We can also equip the spider robots with sensors and weapons; such a robot is used in a crisis or war to avoid risking human lives on the battlefield.
4. We can also use this spider robot in guarding our properties or areas of high importance.

III. Key Advancements and Trends of the robotic system

i) AI and Machine Learning:
AI is enabling robots to understand and interact with their environment, make decisions, and even learn from experience.

ii) **Human-Robot Collaboration:**
Robots are becoming more adept at interacting with humans in shared spaces, making them valuable partners in various tasks.

iii) **Mobility and Versatility:**
Robots are becoming more mobile and capable of navigating diverse environments, expanding their range of applications.

iv) **Advanced Surgical Systems:**
Robotic-assisted surgery is revolutionizing minimally invasive procedures, offering surgeons enhanced precision and patients improved outcomes.

v) **Robotics in Manufacturing:**
Robots are increasing efficiency, precision, and productivity in manufacturing by automating tasks and improving quality.

vi) **Agriculture Robotics:**
Robotics is transforming agriculture by automating tasks like planting, harvesting, and crop treatment, improving efficiency and sustainability.

vii) **Service Robots:**
Service robots are becoming more common in various settings, providing assistance with tasks like transportation, delivery, and even companionship.

viii) **Emerging Technologies:**
Technologies like cyber-physical systems, the Internet of Things, and big data analytics are enabling the creation of intelligent robotic systems and production ecosystems [40-41].

IV. Conclusion

The final section of this study reviewed some research on spider robots, explained how they operate, outlined their building and manufacturing procedures, and discussed their practical uses. Technological advancements [27–39] will enable the spider robot system to monitor all important environments, evaluate the state of those environments to which full access is feasible because of their complexity, and perform the required actions in regions that are off-limits to both wheeled and two-legged robots.

Challenges and Future Directions:

i) Implementation Costs:
The high cost of robotic systems can be a barrier to adoption, particularly in emerging economies.

ii) Integration Complexity:
Integrating robots with existing systems can be challenging, requiring careful planning and expertise.

iii) Safety and Ethical Considerations:
As robots become more autonomous and capable, it's crucial to address safety and ethical concerns.

iv) Future Research:
Continued research into areas like AI, robotics, and human-robot interaction is essential for realizing the full potential of robotics.

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CITATION

Aduku, L. S., Lawal, S. L., Surajo, A., & Baballe, M. A. (2025). The Principal Development in Robotic Systems and their uses. In Global Journal of Research in Engineering & Computer Sciences (Vol. 5, Number 4, pp. 7–12). https://doi.org/10.5281/zenodo.15852103