Artificial & Computational Intelligence

A general review on advancement in the robotic system

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Abstract
The robot is a device that is used in monitoring surroundings wirelessly especially the spider robots or flying spider robots. The spider robots function without interfacing, it can easily adapt to the new situation or obstacles it encounters due to its legs of locomotion on like the ordinary wheels or two legs robots. This review work will help in solving the problems in which ordinary existing robots normally faced especially the wheels or legs robots. The spider robots normally help in the monitoring of toxic or nuclear environments and working in an environment that ordinary robots cannot do like; climbing of trees or walls, walking on rough surfaces in which both the wheels and walking robots cannot do, the spider robots also help in tracing and locating of missing items. The introduction of the spider robotic system help in solving the problems that the ordinary robots faced. The spider robots help in providing information on the state of environments or places in which ordinary robots or human cannot provide because of the toxic of the environment or unsafety ness of the area need to be observed or monitored.

Keywords: Toxic Environments, Spider Robots, Sensors, Arduino, microcontroller, National instrument.

1. 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 lavatories, and this has led to prolonged achievements and improved safety restrictions. As result to this, improvements in engineering and resources science have been enforcing to an extensive of nuclear-connected projects, which stretch from the framework of a rector and additional structures through to the processes by which they are disbanded [2]. For instance, static and monorail-type teleoperated engines have been in usage subsequently the beginning of the nuclear energy to handlebar 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 the1960s 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 on a wider range of work jobs in radioactivity 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 unescapable that several jobs had to been commenced tenuously, accompanying 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 considered as 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 in a policy to entomb the damaged plant in clay and sand to restraint 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 majority marketable fields, such as entertainment, transport, and medicine [9]. Most of the robots that we are acquainted with making 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 robotic 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 environment 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 example load, external forces and ingest as tiny 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 view 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 was 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 Evarchaarcuata 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 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 human are incapable to complete a certain mission in this real-life, such mission include locating a lost object or items or finding a missing individual in a jungle for more than a day and also discovering a pothole with 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 bases 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 bases 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 been simulated in their study. Roy conducted another study in the same year with Pratihar discovered that unlike duty features will lead to many energy intakes. These duties 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 simulated the technique of attaining extreme steadiness with the minimum energy intake steps. Henry, Menon, and Boscariol, in the year 2013, examined on 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 its 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 been nominated to relate with the suggested well designed robotic supervisor for interfacing and processor [27]. The suggested smart system gathers data about the environments particularly in available areas and aids the robot to choose the finest route course to be taken. The National Instrument implanted field-programmable gate array board has been selected to merge with spider robot for the tenacity of great enactment adeptness as well as being user-friendly and compatibility. 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 robotic is fit to be employed in ambiguous environments [27].

2. Materials and Methods

2.1 The method used in producing the spider robotic system

The recommended spider robot is divided into (3) three, 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 robotic must be tough adequate to 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 this includes compression and tensile stress alongside the axis of the movement of this moving parts of the spider robot caused by the burden carried. The eight-leg pairs of the spider robot will be attached on a frame of the spider at certain angles that will enable it to maintain the stability and the whole spider robot will be controlled remotely. To help keep this spider design steady to 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 then 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 design signifies straight ahead from an outside perspective. This results in two vector quantities chain 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 (3) three degree of freedom (DOF). Among the degree of freedom (DOF), one of these degrees of freedom is alongside the z-axis and also function 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 vigor 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 a joint to each other. The whole project of the spider robotic is carried out using 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 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 principle operation of the spider robotic system

With the help of the Arduino receiver or microcontroller, it takes the signal from the transmitter and aid 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 results 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 of the four electric motors are wired in parallel, with two being reverse. This is because there will be two electric motors at either end of the research and when one pair of the leg 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 robotic moving forward or backward and dodging the problems on the way of the robot 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; henceforth, implementing the given job. For instance, if this ultrasonic detector used to sense an item hindering the spider robotic 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 assesses the information to gives a suitable outcome such as enrichment for the location of the spider robotic 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 facing 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 frontage 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 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 its respective location, 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 display on your 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 robotic 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 monitor and update with the help of 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, also exploring in war zones, for inspecting unstable buildings after a natural tragedy such as earthquake, tsunami, or a 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.

3. Conclusion

In conclusion, this paper reviewed some studies relating to spider robots, highlighted its principle of operation, it also summarizes how it is made or constructed and the areas of applications in real life in this world. With the help of advancement in technology, the spider robot system will be able to monitor every important environment also analyzes the situation of such environment in which one can have full access due to the complication of such places and implement the proper action needs to be executed in such areas in which both wheel and two leg robots cannot do.

References

[1] Iborra, A. Pastor, J.A, B. Álvarez, C. Fernández, J.M, FernándezMeroño,. Robots in radioactive environments. "IEEE Robot. Automation". Mag. 10, https://doi.org/ 10.1109/MRA.2003.1256294,pp, 12–22, 2003.

[2] Cortez, R.A, Papageorgiou, X. H.G, Tanner, A.V, Klimenko, K.N, Borozdin, W.C, Priedhorsky, Experimental implementation of robotic sequential nuclear search. "Mediterranean Conference on Control and Automation. MED", https://doi.org/10.1109/MED.2007.4433797, 2007.

[3] Abouaf, J. Trial by fire: The teleoperated robot targets Chernobyl. IEEE Computer. Graph. Appl. 18, https://doi.org/10.1109/38.689654,pp, 10–14, 1998.

[4] Bagatin, M. Gerardin, S. Paccagnella, A. Space, and terrestrial radiation effects in Flash memories Radiation effects in recon fi gurable FPGAs. Semicond. Sci. Technol, 32, pp, 1-8, 2017.

[5] Berry, R. Loebakka, K. E. Hall, Sensors for mobile robots. "In Proceedings of the 3rd Conference on Robot Vision and Sensory Controls", pp. 584–588,1983.

[6] Bloss, R. 2010. How do you decommission a nuclear installation? "Call in the robots. Ind. Robot anInt". 37, 133–136. https://doi.org/10.1108/01439911011018902

[7] Bogue, R.. Robots in the nuclear industry: a review of technologies and applications. Ind. Robot An Int. J. 38, https://doi.org/10.1108/ 01439911111106327, pp- 113–118, 2011.

[8] Bradley, D.A, Seward, D.W, 1998. The development, control, and operation of an autonomous robotic excavator. "Intell. Rob", pp, 73–97. https://doi.org/10.1023/ A: 1007932011161.

[9] Briones, Bustamante, L. P. Serna, M.A,Robicen: a wall-climbing pneumatic robot for inspection in nuclear power plants. Robot. Compute, pp287–292,1994.

[10] Kim, J. H. H. J. Ko, Kim, S. H. Ji, M. G. and Lee, J. B. "Intelligent system of the spider robot for the various moving functions," in Proc. 2009 18th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN 2009), Toyama, Japan, pp. 226-231.

[11] Ijspeert, A. Central pattern generators for locomotion control in animals and robots: a review, Neural Networks 21 (4) (2008) 642–653.

[12] Cruse, H. D. Brunn, C. Bartling, J. Dean, M. Dreifert, T. Kindermann, Walking: a complex behavior controlled by simple networks, Adaptive Behavior 3 (1995) pp 385–418.

[13] Figliolini, G. Rea, P. Mechanics, and simulation of six-legged walking robots, in Climbing and Walking Robots Towards New Applications, I-Tech Education and Publishing, Austria, 2007, pp. 1–22.

[14] Autumn, K. Peattie, A. Mechanisms of adhesion in geckos, The Journal of Integrative and Comparative Biology 42 (6) (2002) 1081–1090.

[15] Autumn, K. Sitti, M. Liang, Y. Peattie, A. Hansen, W. Sponberg, S. Kenny, T. R. Fearing, J. Israelachvili, R. Full, Evidence for van der Waals adhesion in gecko setae, Proceedings of the National Academy of Sciences of the USA 99 (19) (2002) 12252–12256.

[16] A. Kesel, A. Martin, T. Seidl, Adhesion measurements on the attachment devices of the jumping spider Evarchaarcuata, Journal of Experimental Biology 206 (2003) 2733–2738.

[17] A. Kesel, A. Martin, T. Seidl, Getting a grip on spider attachment: an AFM approach to microstructure adhesion in arthropods, Smart Materials and Structures 13 (2004) 512–518.

[18] H. Gao, X. Wang, H. Yao, S. Gorb, E. Arzt, Mechanics of hierarchical adhesion structures of geckos, Mechanics of Materials 37 (2– 3) (2005) 275–285.

[19] K. Autumn, Y. Liang, S. Hsieh, W. Zesch, W. Chan, T. Kenny, R. Fearing, R. Full,

[20] S. Soyguder and H. Ali. Kinematic and dynamic analysis of a hexapod walking-running bounding gaits robot and control actions. Computers and Electrical Engineering, 38(2), pp. 444-458.(2012).

[21] Sreerag, R. Muthukumaran, S. B. Sriram, S. John, and B. Thenkalvi, "Tarantula Bot: Rescue Assist Tele Robot," in Proc. 2012 Fourth International Conference on Advanced Computing (ICAC), pp. 1-6.

[22] Tian, W. J., and Geng, Y. "A New Household Security Robot System Based on Wireless Sensor Network," in Proc. 2009 Second International

Conference on Future Information Technology and Management Engineering (FITME '09), Sanya, China, pp. 187-190.

[23] Roy, S. S., and Pratihar, D. K. “Dynamic Modeling and Energy Consumption Analysis of Crab Walking of a Six-legged Robot,” in Proc. 2011 IEEE Conference on Technologies for Practical Robot Applications (TEPRA), Woburn, Massachusetts, pp. 82-87.

[24] J. A. Cobano, J. Estremera, and P. G. d. Santos. Accurate tracking of legged robots on natural terrain. Autonomous Robots, 28(2), pp. 231-244.(2010).

[25] S. S. Roy, A. K. Singh, and D. K. Pratihar. Estimation of optimal feet forces and joint torques for on-line control of the six-legged robot. Robotics and Computer-Integrated Manufacturing, 27(5), pp. 910-917. (2011).

[26] S. S. Roy and D. K. Pratihar. Dynamic modeling, stability, and energy consumption analysis of a realistic six-legged walking robot. Robotics and Computer-Integrated Manufacturing, 29(2), pp. 400416, 2013.

[27] Roy, S. S., and Pratihar. D. K.Effects of turning gait parameters on energy consumption and stability of a six-legged walking robot. Robotics and Autonomous Systems, 60(1), pp. 72-82, 2012.