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Iot Based Hexapod Spider Robot for Surveillance

R B Durairaj, R Mohana Prakash and A Ramanan

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Iot Based Hexapod Spider Robot for Surveillance

Authors: [1]R.B. Durairaj, R. Mohana Prakash, A. Ramanan

Department of Mechatronics

Department of Mechanical

Sathyabama Institute of science and technology, chennai

Corresponding Author email - rbdurairajmech@gmail.com

Corresponding Author email - mohanaprakash48@gmail.com

Corresponding Author email - ramananjackson567@gmail.com

ABSTRACT- The design and construction of a versatile Hexapod spider robot using a surveillance camera are discussed in this project. It is a 50 cm tall IOT-based Hexapod spider robot that can be controlled from any location using a mobile device. It contains a 360° surveillance camera for the robot's vision system. The goal of this project is to create a multi-legged robot that resembles a biological spider for the military's defence sector to spy on the opposition. We can employ a robot to spy on the enemy sector instead of utilising humans, avoiding human casualties in the process. This robot features a high-spec device setup. In this project, a multifunctional Hexapod spider robot that uses surveillance cameras is designed and built. The robot, a 50 cm tall and width 50*50 IOT-based hexapod spider, can be controlled from any location using a mobile device and contains a 360-degree surveillance camera for vision. This project's goal is to create a multi-legged robot with the appearance of a biological spider for the army's defence sector to spy on the opposition. Robots can be used as enemy sector spies in place of people, saving human lives and allowing us to spy without risk. High-end specifications are present in this robot.

I INTRODUCTION

It is a Hexapod Spider Robot used for Surveillance. People today frequently use robots for a variety of purposes. Robot development is mostly done to speed up work completion and improve output in terms of quality, consistency, and productivity. This Hexapod robot has six legs and resembles a biological spider. High-tech components like sensors, motors, cameras, and control systems were utilised in this robot. Robots can learn about their surroundings using sensors. This can be used to direct the behaviour of the robot. Some sensors are commonly used components of technology. Using cameras, a robot may create a visual representation of its surroundings, enabling it to assess environmental characteristics that can only Shape and colour, which are determined by vision, as well as other crucial characteristics like size and distance of things, are also determined by vision. Many of a robot's moving components, including joints on robotic limbs and wheels on robotic vehicles, can be powered by motors. Servo motors (mg955 torque of the motor is 1kg-cm), buck converter, Li-ion battery (11.8v and 4000 mah), and Arduino nano are among the hardware components. The microcontroller also reduces the ecological effect of this robot, as do the reusable electrical components like servos. Second, the software components provide the spider's justification. These robots were created specifically for the military, and the defence industry can use them to assist troops in an emergency.

II LITERATURE SURVEY

1.1 QUADRUPED SPIDER ROBOT FOR SURVEILLANCE

[1] The primary goal of this project is to create a surveillance robot with four legs that resembles a biological spider. The four legs of this robot have two joints and two connections. For the robot's

vision, it has a surveillance camera and face detector. This machine was originally designed as a little four-legged spider robot. The Hc-05 Bluetooth module was used to drive the robot, while PLA filament was used as the primary raw material to construct the spider body on a 3D printer. The idea behind this robot is to use surveillance cameras to move like a biological spider.

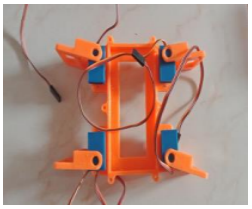

fig 1.2 THE ROBOT BODY

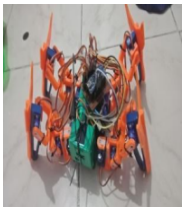

fig 1.3 THE COMPLETE ROBOT

2.1 Hardware implementation of autonomous hexapod spider robot

[2]One of the uncommon applications of a robot with six legs is the hexapod. These robots can move on any surface and are frequently employed in the military and other businesses for spying. The autonomous hexapod spider robot's features. It was controlled by an Arduino Uno based on a servo-controlled module from SSC. A 2.5 kg servo with a cm of torque is utilised in the robot to demonstrate various working actions, and the robot is controlled through Bluetooth using a Hc-05 module. The location, movement, and rotational angle of servo motors are all controlled by software

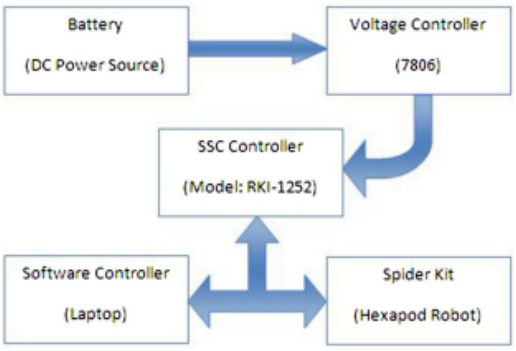

FIG 2.1 BLOCK DIAGRAM

FIG 2.3 SERVO CONTROLLER

FIG 2.4 HEXAPOD SPIDER ROBOT

3.1 Adaptive Intelligent Spider Robot

[3] The adaptive, intelligent spider robot is the subject of this research. The quadruped spider robot uses an integrated sensor to wirelessly monitor its surroundings. This project suggests a self-adaptive, intelligent spider robot that operates independently of human interaction. When faced with challenges, the intelligent adaptive spider robot quickly adjusts to new circumstances. Hardware requirements include a smart controller that incorporates GH-311 ultrasonic sensors to detect obstacles in front of the spider robot, GH-312 smoke sensors to detect smoke in a specific area, and LM35 temperature sensors to obtain the ambient temperature. Device communication is implemented using a mobile wireless router module made by TP Link, model TL-MR3420.

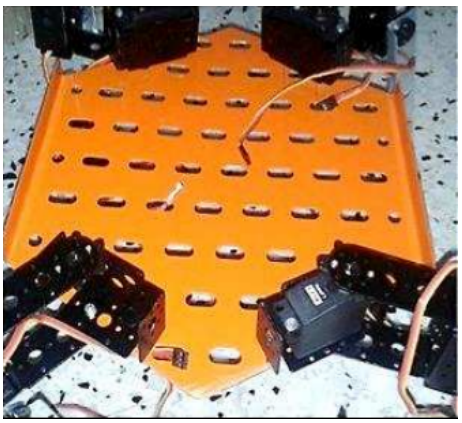

FIG 3.2 ALUMINIUM STRUCTURE OF PROPOSED ROBOT

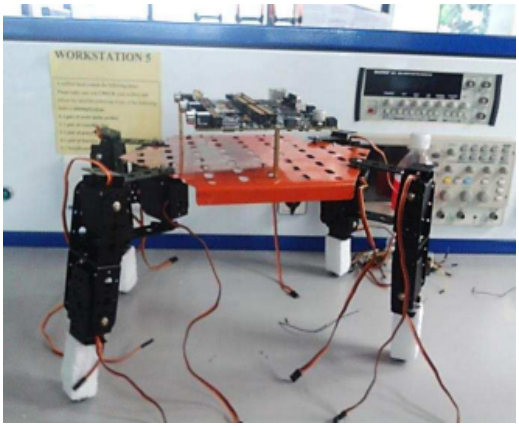

FIG 3.3 JOINTS USING U-BRACKETS FOR THE ROBOT LEG

4.1 Arduino Quadruped Robot

[4] Our goal is to create a type of off-road robot that can mimic the speed, mobility, and autonomy of living things. They have the ability to move across outside terrain that is too rocky, wet, muddy, snowy, rutted, and steep for conventional vehicles. The hardware components for a quadruped robot include an Arduino, a knee, toe, and thigh servo, as well as a power source (battery). The Arduino (IDE) software specification is used to run programmes. C++ is a language that has been installed. The quadruped robot was commanded to move by a programme, and it was controlled by an Arduino board. Gait pattern, which describes how and in what order the legs are moved, how the body is balanced, and how an animal or robot moves, how it progresses.

FIG 4.2 BLOCK DIAGRAM

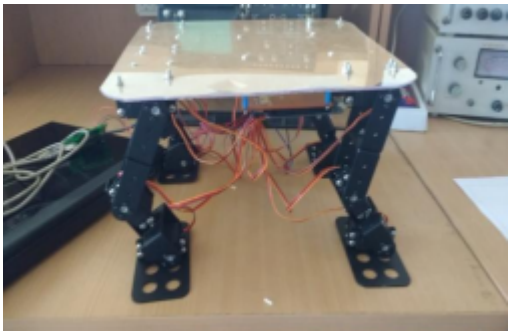

FIG 4.3 ARDUINO BASED QUADRUPED ROBOT

5.1 multitasking spider hexapod robot

[5] These Hexapod robots, which have six legs, are multi-legged and can be utilised for a variety of tasks. These robots are more advantageous to the environment since they can carry out tasks where human labour is ineffective. They have deployed cutting-edge technologies in this robot to perform hazardous tasks. The climbing abilities and camera system 360-degree vision of this model robot have been improved. SOC (system on chip) has been utilized to control the camera for monitoring the earthquake-affected area and providing the information by video recording footage. With the aid of a MQTT broker, the bot is capable of providing live streaming broadcasts.

FIG 5.2 ROUGH TERRAIN CRITICAL CLIMBING POSITION

This hexapod robot has a mountain-climbing section pump. This robot is capable of carrying a 20-pound burden on top of its body. In comparison to other hexapod robots, this one is better at climbing over obstacles. With the aid of an infrared sensor, it can detect dark and light surfaces in dangerous areas. A sound sensor module can also be used to detect sound.

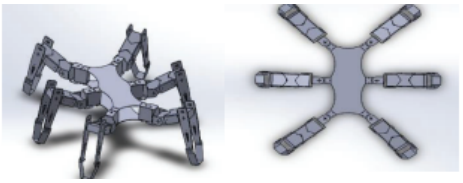

FIG 5.3 ROBOT DESIGN

FIG 5.4 ALUMINIUM STRUCTURE OF THE INTELLIGENT HEXAPOD ROBOT

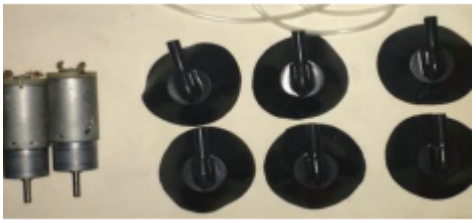

FIG 5.5 SUCTION CUPS AND MOTOR

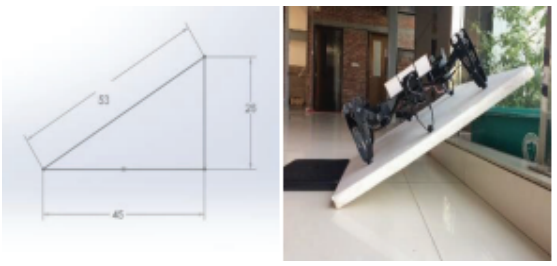

FIG 5.6 45 DEGREE ANGLE CLIMBING POSITION SLOPE

6.1 SIX-LEGGED SPIDER ROBOT

[6] The design and construction of a six-legged robot, or hexapod, are presented in this study. They created a legged robot with an appropriate control mechanism to provide an impressive marking behaviour. The main benefit of this robot is its lightweight design at 55 grams. The project's hardware includes an Arduino Mega, Bluetooth module, servo motor, battery, transmitter, and receiver, as well as a PCA9685 chip board for servo motor control. The embedded C programming language was utilised, the Arduino IDE software was used to install the programme, and since the robot is mobile, it can be operated using a smartphone.

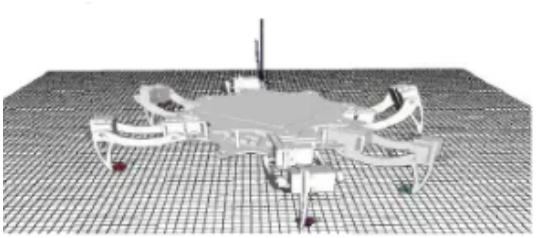

FIG 6.2 HEXAPOD

7.1 DESIGN AND SIMULATION OF CASSINO HEXAPOD ROBOT

[7] In this project, a cassino hexapod robot is described as a walking machine. There are many distinct kinds of walking machines; some of the robots are built around wheels, while others have anthropomorphic legs. A hybrid robot is a type of

walking machine robot that has both wheels and legs.

FIG 7.1 ATHLETE ROBOT

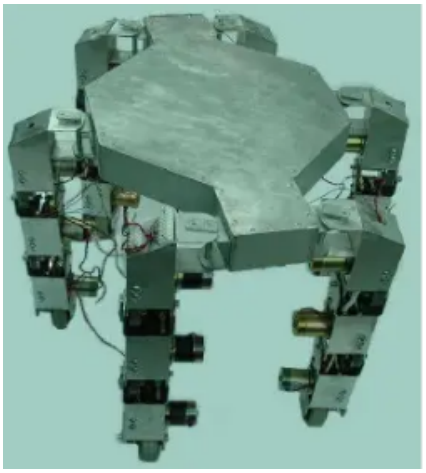

FIG 7.2 THE ASSEMBLED CASSINO HEXAPOD

These hybrid machine robots are efficiency for all kind of in an obstacle-filled area, the legs can be used to get around, while on flat ground, the wheels can get the animal moving quickly. A PLC is used to control the various motors of the Hexapod in order to control the casino robot. A RS 232/PPI cable can be used to download the PC programme to the PLC's flash memory. The control system, sensor system, and robot mechanics all contribute to the Hexapod's body's increased flexibility.

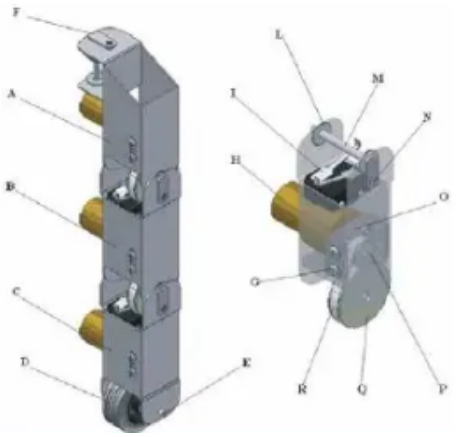

FIG 7.3 A 3D MODEL VIEW FOR THE MODULAR LEGIN CASSINO HEXAPOD ROBOT WITH A BASIC MODULE

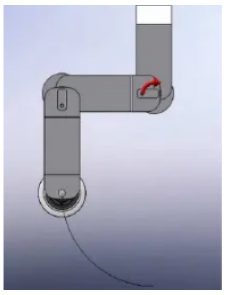

FIG 7.4 SCHEME OF THE ONE LEG MODELING

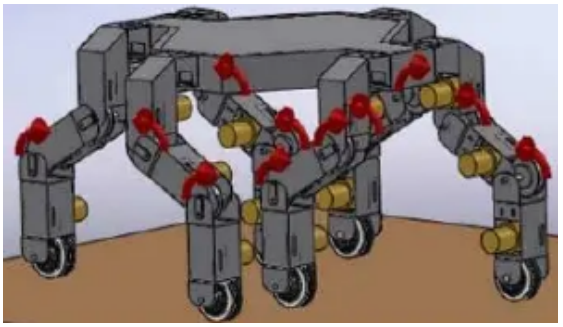

FIG 7.5 THE CAD MODEL OF HEXAPOD FOR DYNAMIC ANALYSIS

8.1 CONTROLLING OF THE HEXAPOD LEGGED WITH NONLINEAR STICK-SLIP VIBRATIONS

[8] This article introduces the built prototype of the hexapod robot, which was created using the biomechanics of inspection insets for walking robots. The mechanical architecture, electronic control system, and devices fitted on the robot body

are all discussed in great depth. We are interested in controlling the robot legs with several oscillators working a so-called Central Pattern Generator (CPG), and we propose another model of CPG based on the oscillator describing stick-slip induced vibrations, in order to determine the relationship between movements frequently used by insects legs and stable trajectories of mechanical systems.

9.1 SPIDER ROBOT FOR SECURITY SYSTEM

[9] This wireless environment monitoring spider robot is a tool. A spider robot is useful for monitoring in hazardous or nuclear situations and can move in places where other robots cannot. like tracing and finding missing items, uneven surfaces, etc. This application can be used in hazardous or challenging environments that are difficult for humans to fully access. the process by which the spider robot was made. There are three subsystems, including the spider robot's body construction, sensor, and control algorithm. Aluminum is employed in this spider robot's construction because it can withstand pressure and tensile stress. Because of the position and angle of the legs, the six-legged robot is remotely controlled. This spider needs to be held steady in order to maintain its balance. The spider robot can be utilised for a variety of tasks, including defusing bombs, equipping weapons to reduce risk during combat, and guarding very valuable areas of our assets.

10.1 ARDUINO ANT ROBOT

The six legs, head, antennas, mandibles, belly, and even a working eye make up this Ant robot. I created a custom Android app to operate this robot. Four buttons on this software allow us to direct the robot to travel forward or backward as well as turn left or right. We kept an ultrasonic sensor in this to be able to detect any defensive object. Going back will stop the attack, but putting our hand closer will cause it to attack and bite us.

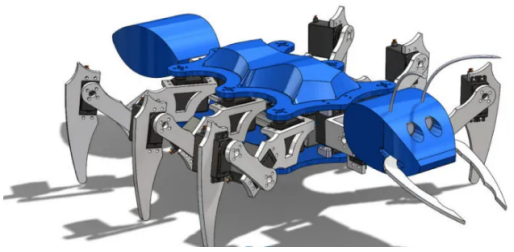

FIG 10.2 ANT ROBOT

Each of the six legs of the hexapod is made up of three joints and three servo motors and 18 servo motors in total. using the Creality CR-10 3D Printer, which performed superbly for all of the prints. We utilised the HC-05 Bluetooth module, together with some capacitors and resistors, to communicate with the smartphone. I'll use a 3S LiPo battery with a voltage of about 12V to power the robot. I am able to tolerate higher current draws, making it appropriate for this project. In this case, the servo motor requires 4.8 to 7.2 volts, thus we are using a DC-DC buck converter to change the 12 volts to 5 volts. There are various methods for programming a hexapod movement, such as forward or inverse kinematics. These techniques incorporate math for each joint. Using the MIT APP inventor, I created the app.

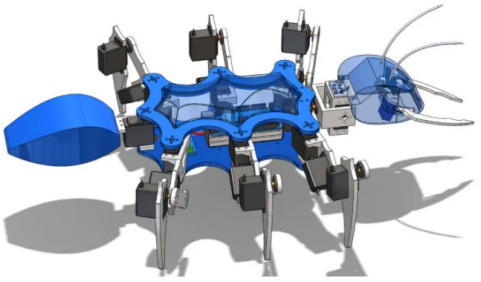

FIG 10.3 3D MODEL OF ANT ROBOT

SUMMARY:

In this essay, a six-legged robot called a hexapod is designed and built. They built a robot with legs and an effective control system that exhibits excellent production behaviour. This robot's biggest advantage is that it weighs only 55 grams.

This model robot now has a camera system with 360-degree vision and increased climbing

capabilities. The camera used to monitor the earthquake-affected area and provide information by video capturing footage is controlled by a SOC (system on chip).

To interface with the smartphone, we used the HC-05 Bluetooth module together with a few capacitors and resistors. To power the robot, I'll use a 3S LiPo battery with a voltage of roughly 12V. I can handle current draws that are higher.

We are interested in controlling the robot legs using a number of oscillators that operate a so-called Central Pattern Generator (CPG), and we propose a different model of CPG based on an oscillator that describes vibrations caused by stick-slip in order to identify the connection between stable mechanical systems and common movements used by insect legs.

CONCLUSION :

The primary objective of this project is to construct a hexapod spider robot that can be utilised for real-time detection. All terrains, including stiff and smooth surfaces, can be used with this architecture. Multiple legs can be used by a hexapod robot to facilitate easy walking. Webcams and Bluetooth modules can be used to wirelessly operate robots. A Hexapod spider robot for a surveillance fabrication project has been created and tested. It has been created and incorporates functionality from all of the hardware components. Second, the project has been implemented effectively to the usage of cutting-edge hardware and innovative technologies.

REFERENCE

[1] 1Prof. Mahesh Jadhav, 2Prasad Kubal, 3Sarthak Ghanekar, 4Rahul Dawal, 1Assistant Professor, FAMT, Department of Electronics Engineering, “IOT BASED QUADRUPEDAL SPIDER ROBOT FOR SURVEILLANCE” © 2022 IJCRT | Volume 10, Issue 4 April 2022 | ISSN: 2320-2882.

[2] Gaurav Verma, Puja Rai, Bhavana Chauhan1, Anoop Kumar1, Parth Pandey, Vaibhav Karnail, “Hardware implementation of autonomous hexapod spider robot” Int. j. inf. tecnol. DOI 10.1007/s41870-017-0038-3, published 24 August 2017

[3] Rozita Teymourzadeh, CEng, Member IEEE/IET, Rahim Nakhli Mahal, Ng Keng Shen, and Kok Wai Chan, “Adaptive Intelligent Spider Robot” 2011 6th

[4] Mr.V.Arun, Mr.S.V.S.Prasad , G.Sridhar Reddy , L.Ruthwik Reddy , M.Venkatesh , M.Sai Pavan Kumar , “Arduino Quadruped Robot" p- ISSN: 2278-8735.Volume 11, Issue 3, Ver. III (May-Jun .2016), PP 46-50

[5] Md. Imran Uddin Dhaka, Md. Shahriar Alamgir, Md. Iqbal Hossain, Md. Arif Abdulla Samy, “multitasking spider hexapod robot” 29 November - 1 December 2019, Dhaka, Bangladesh

[6] Damodharan , Mahalakshmi , Abhishek , Kalyanasundaram, “SIX-LEGGED SPIDER ROBOT” ©IJARW | ISSN (0) - 2582-1008 September 2020 Vol. 2 Issue.

[7] CARBONE G.', YATSUN A., CECCARELLI M., YATSUN S, “Design and Simulation of Cassino Hexapod Robot” Proceedings of the 13th WSEAS International Conference on SYSTEMS

[8] DARIUSZ GRZELCZYK, BARTOSZ STANCZYK, JAN AWREJCEWICZ, “controlling of the Hexapod legs with nonlinear Stick - Slip vibrations.” 6th January 2016 Lodz University of technology , poland.

[9] Mehmet Cavas, Muhammad Ahmad Baballe, “ Spider Robot for security system” November 2019 international journal of new computer architectures and their Applications 9(1): 19-24.

[10] DEJAN,” Arduino Ant Hexapod Robot” Accepted 6 January 2016

[11] Sakhmina U. Asadullaeva, St. Petersburg, Russia, “Design of the Hexapod for Educational Project” 2021 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering DOI: 10.1109

[12] Min-Chan Hang, Chiou-Jye Huang, Feifei Liu, “The Development of a Hexapod Robot with Wireless Remote Control” IEEE International Conference on Applied System Innovation 2018

[13] Vitthal B. Jagtap, Amol B Jagdale, Pankaj S.Kadu, “Hexapod A Spider for Terrain and Obstacle Shunning by Arduino” International

Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) - 2016

[14] Saranya R, Kashwan K. R, “Octapod Spider-Gait-Walking Robot Implementation Using Nano Processor” International Conference on Advances in Human Machine Interaction (HMI - 2016), March 03-05, 2016

[15] Tolga Karakurt, Akif Durdu, Emre Hasan Dursun, “Petri-Net Based Control of Six Legged Spider Robot” 2015 IEEE

[16] Takahiro TANAKA, Shigeo HIROSE, “Development of Leg-wheel Hybrid Quadruped AirHopper” 2008 IEEE/RSJ International Conference on Intelligent Robots and Systems Acropolis Convention Center Nice, France, Sept, 22-26, 2008

[17] Satoshi Kitano, Shigeo Hirose, Gen Endo and Edwardo F. Fukushima, “ Development of Lightweight Sprawling-type Quadruped Robot TITAN-XIII and its Dynamic Walking” 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

November 3-7, 2013. Tokyo, Japan

[18] Fumitaka KIKUCHI , Yusuke OTA and Shigeo HIROSE, “ Basic Performance Experiments for Jumping Quadruped” Proceedings of the 2003 IEEE October 2003

[19] Amir Shapiro, Elon Rimon, Shraga Shoval, “IMMOBILIZATION BASED CONTROL OF SPIDER ROBOTS IN TUNNELS ENVIRONMENT” 2000 IEEE.

[20] Ye jing, Liu jian-hui, “ Research of Eight-legged Robot Gait Base on Bionics” 2009 Asia-Pacific Conference on Information Processing.

[21] Yongkang, Zhejiang, WEILIN CHENG, “Leg Structure Design for Special Hexapod Robot with Climbing Vertical Walls Ability” on June 14,2021 at 23:28:33 UTC from IEEE Xplore.

[22] Yang Pan, Feng Gao, “Mechanism Topology Design for Novel Parallel-Parallel Hexapod Robot” 9th - 11th July 2014.

[23] Qin Liu, Lei Cheng, ChaoNan Shen, QiuXuan Wu, “THE RESEARCH AND DESIGN OF HEXAPOD BIONIC ROBOT SYSTEM BASED ON ACTIVE OLFACTION” ©2019 IEE

[24] Tzou Jyhhwa , Liang C Y, “The Development of the Hexapod Bio-robot System” Proceedings of the 27th Chinese Control Conference July 16-18, 2008

[25] Zihan Zhou , Xiaoqing Zhu, “Design and Simulation of Special Hexapod Robot with Vertical Climbing Ability”2020 IEEE 5th Information Technology and Mechatronics Engineering Conference

[26] Zhenyu Lei, Daxin Xin, Jin Hua, “Motion Simulation of Bionic Hexapod Robot Based on Virtual Prototyping Technology” 0 © 2017 IEEE DOI 10.1109

[27] Jin Bo , Chen Cheng, Li Wei, Li Xiangyun, Design and configuration of a hexapod walking robot” 0 © 2011 IEEE DOI 10.1109

[28] Genji Tanaka†, Tetsuta Takamura, Yuki Shimura, Kazuhiro Motegi and Yoichi Shiraishi, “Development of Simulator and Analysis of Walking for Hexapod Robots” (SICE) September 10-13, 2019

[29] Weidong Liu, Haifeng Zheng, Li’e Gao,Le Li,Zeyu Li, “Motion Simulation of Underwater Hexapod Robot Based on Adams” ©2018 IEEE

[30] Yanan Miao, “The Motion Planning of Hexapod Robot in the Non Structural Condition” ©2020 IEEE | DOI: 10.1109

[31] Yudi Isvara, Syawaludin Rachmatullah, Kusprasapta Mutijarsa, Dinara Enggar Prabakti, “Terrain Adaptation Gait Algorithm in a Hexapod Walking Robot” ©2014 IEEE

[32] Baoling Han , Lin Huang , Qingsheng Luo , Jia Xum, “The Biomimetic Research on New-style Hexapod Robot's Locomotion Planning” June 25 - 27, 2008 IEEE.

[33] El Hansali Hasnaa, Bennani Mohammed, “Planning tripod gait of an hexapod robot” ©2017 IEEE

[34] M. Atify, M. Bennani, A. Abouabdellah, “Propelling motion modeling of an Hexapod robot” ©2019 IEEE

[35] Ziad Sakr, Emil M. Petriu, “Hexapod Robot Locomotion using a Fuzzy Controller” ©2007 IEEE

[36] Chunyang Zhang, Xianzhi Jian, “Research on Gait Planning and Static Stability of Hexapod Walking Robot” 2015 IEEE DOI 10.1109.

[37] Jung-Min Yang Jong-Hwan Kim, “A Strategy of Optimal Fault Tolerant Gait for the Hexapod Robot in Crab Walking” @1998 IEEE

[38] Canh Toan Nguyen1, Hoa Phung, Tien Dat Nguyen, Choonghan Lee, Uikyum Kim5, Donghyouk Lee, “Biomimetic Printable Hexapod Robot Driven by Soft Actuator” ©2014 IEEE

[39] Katsuhiko INAGAKI and Hisato KOBAYASHI, “Adaptive Wave Gait for Hexapod Synchronized Walking” @1994 IEEE

[40] Ananchai Konthong, Anavat Monprajuck, Rashrita rattanavorragant, and Yutana Jewajinda, “An Intelligent Locomotion Control Architecture for Hexapod Robot” ©2018 IEEE

[41] Gao Jianhua, “Design and Kinematic Simulation for Six-DOF Leg Mechanism of Hexapod Robot” 2006 IEEE

[42] Marek Zak, Jaroslav Rozman, Frantisek V. Zboril, “Design of Omni-directional Hexapod Robot with Horizontal Coxa Joint” , on June 23,2020 at 13:34:22 UTC from IEEE Xplore

[43] Hung-Yuan Chung, Chun-Cheng Hou, Sheng-Yem Hsu, “A CPG-inspired Controller for a Hexapod Robot with Adaptive Walking” ©2014 IEEE

[45] Darwin Alulema, Cristian Andino, Diego Rodríguez, Víctor Proaño, “Balance Control by Diffuse Logic for a Phoenix Hexapod Robot” ©2017 IEEE

[46] Asep Najmurrokhman, Kusnandar, Udin Komarudin, “Speed Control and Obstacle Avoidance of A Hexapod Mobile Robot using Mamdani type Fuzzy Logic Controller” 31 July – 2 August 2019 IEEE

[47] ZHANG Guijuan, YU Guixin, YOU BO, “Hexagonal Hexapod Robot Foot-Modeled Dynamics Simulation Analysis” ©2013 IEEE

[48] Haibo Gao, Ma Jin, Yiqun Liu, Liang Ding, Haitao Yu, and Zongquan Deng, “Turning Gait Planning and Simulation Validation of a Hydraulic Hexapod Robot” ©2015 IEEE

[49] John Euler Chamorro Fuertes, Jairo Jose Marin Arciniegas, “Locomotion Control of PhantomX Hexapod Robot with Touch-Pressure Sensor and RoboComp” ©2020 IEEE

[50] Sorin Manoiu – Olaru, Mircea Nițulescu, “Locomotion Strategies over Obstacles for a Hexapod Robot Using Matlab” 2009 IEEE