(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application :08/04/2025

(21) Application No.202541034584 A

(43) Publication Date : 09/05/2025

(54) Title of the invention : QUADRUPED CLIMBING ROBOT WITH TRIPLE SPIKES AT EACH LEG AS END EFFECTOR

(51) International classification :B62D0057032000, B62D0057024000, B62D0057020000, G05D0001000000, B25J0009140000

(86) International Application No :NA
Filing Date :NA

(87) International Publication No : NA

(61) Patent of Addition to Application Number :NA
Filing Date :NA

(62) Divisional to Application Number :NA
Filing Date :NA

(71)**Name of Applicant :**

1)Periyar Maniammai Institute of Science & Technology
Address of Applicant :Periyar Nagar, Vallam, Thanjavur- 613403, Tamil Nadu, India ---------- ----------

Name of Applicant : NA

Address of Applicant : NA

(72)**Name of Inventor :**

1)Dr. R. Rakesh
Address of Applicant :Assistant Professor (SG), Department of Electronics and Communication Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

2)Mr. N. Shivakumar
Address of Applicant :Assistant Professor (SS), Department of Mechanical Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

3)Dr. V. Hamsadhwani
Address of Applicant :Associate Professor, Department of Electrical and Electronics Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

4)Dr. C. Rajanandhini
Address of Applicant :Associate Professor, Department of Electronics and Communication Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

5)Mr. R. K. Muthuraman
Address of Applicant :Assistant Professor (SS), Department of Aerospace Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

6)Dr. Arunganesh. K
Address of Applicant :Assistant Professor (SG), Department of Electrical and Electronics Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

7)Mr. U. Saravanakumar
Address of Applicant :Assistant Professor (SS), Department of Electronics and Communication Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

8)Mr. N. Dharmaraj
Address of Applicant :Assistant Professor, Department of CCE, Rajalakshmi Institute of Technology, Chennai, Tamil Nadu ---------- ----------

9)Mr. R. Darshan
Address of Applicant :Department of Electronics and Communication Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

10)Mr. S. Kabilan
Address of Applicant :Department of Electronics and Communication Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

11)Mr. S. Soundara Pandiyan
Address of Applicant :Department of Electronics and Communication Engineering, Periyar Maniammai Institute of Science & Technology, Periyar Nagar, Vallam, Thanjavur, Tamil Nadu – 613403 ---------- ----------

(57) Abstract :

The present invention relates to the field of bioinspired climbing robots, specifically quadruped robots equipped with triple spikes at each leg to enable mechanical hooking for vertical and inverted surface locomotion. This invention is designed for applications in extraterrestrial planetary exploration, high-altitude terrain analysis, and industrial inspections on irregular or soft surfaces such as thermocol walls. [02] BACKGROUND OF THE INVENTION Existing climbing robots face limitations in navigating discontinuous or soft surfaces (e.g., thermocol, rocky terrain) due to reliance on suction, magnetic adhesion, or grippers. Traditional mechanisms fail to maintain grip on porous or irregular substrates. Additionally, lightweight, compact designs for space or high-altitude missions remain underdeveloped. Prior art includes quadruped robots with servo-driven legs but lacks adaptive mechanical hooking systems. Current adhesion methods struggle with energy efficiency and surface adaptability. This invention addresses these gaps through a triple-spike end effector and optimized gait control, enabling stable climbing on challenging surfaces without fixed infrastructure. [03] SUMMARY OF THE PRESENT INVENTION The invention introduces a quadruped robot with four legs, each controlled by three servo motors (12 motors total) divided into four channels (A, B, C, D). Key innovations include: 1. Triple-spike mechanical hooking system: Three sharp needles at each leg's end effector penetrate surfaces like thermocol or rocky cracks, replacing conventional adhesion. 2. Dynamic gait control: Sequential activation of servo channels (A0–D2) enables adaptive movement patterns for stability on vertical surfaces. 3. Lightweight, modular design: Optimized for extraterrestrial missions and industrial inspections. 4. Arduino-based control system: Manages servo sequences, surface adaptation, and obstacle avoidance. 5. Applications span planetary exploration (e.g., Mars rock crevices), high-altitude rescue missions, and industrial maintenance on soft or uneven structures. BRIEF DESCRIPTION OF THE DRAWINGS • Fig. 1: Quadruped robot climbing a vertical thermocol wall. • Fig. 2: Block diagram of Arduino control system. • Fig. 3: Flowchart of gait sequence and servo channel activation. • Fig. 4: 3D model of leg assembly with triple spikes. • Fig. 5: System architecture showing collaboration with PMIST Robotics Lab, Bosch Rexroth, and IIT Bombay. DETAILED DESCRIPTION OF THE INVENTION Design Overview: Leg Mechanism: Each leg operates via three servo motors (hip, knee, ankle), enabling 3DoF movement. Spikes are retractable to minimise drag during non-climbing phases. Control Channels: Channel A: Motors A0 (hip), A1 (knee), A2 (ankle) Channels B, C, D follow analogous configurations. Gait Algorithm: Channels activate sequentially (A→B→C→D) to mimic insect-like climbing, with real-time adjustments based on surface feedback. Mechanical Hooking System: The triple spikes (stainless steel needles) penetrate soft substrates at 30°–45° angles, distributing weight evenly. Penetration depth is controlled via servo torque calibration. Control System: An Arduino Mega processes input from IR proximity sensors and inertial measurement units (IMUs) to adjust gait and spike engagement. Remote operation is enabled via Bluetooth/Wi-Fi. Collaborative Development: Prototyped at PMIST Robotics Lab in partnership with Bosch Rexroth, IIT Bombay, and Prag Robotics, integrating industrial-grade actuators and AI-driven path planning.

No. of Pages : 14 No. of Claims : 6