

# Design and Implementation of Hybrid Quadruped Robot (Watchdog\_X)

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**Abstract:** The Quadruped Mechanical Canine is an inventive creation at the outstandingly front of advanced mechanics, carefully anticipating to reflect the dexterity and flexibility of its normal accessory. Interlacing state-of-the-art arranging with man-made brainpower, this quadrupedal consider brags bounty of functionalities, making it imperative over unmistakable spaces. Drawing motivation from the biomechanics of fair to goodness canines, its advancement framework easily overcomes assorted scenes, though cutting edge sensors and actuators guarantee unmatched security and flexibility. In addition, the combination of AI calculations locks within the quadruped to unreservedly explore through perplexing and ceaselessly progressing conditions. In development, the quadruped offers an normal affiliation point that updates client commitment through highlights like voice confirmation and standard tongue managing with. Clients can dependably conversation with the mechanical canine, giving orders and getting reactions, in this way creating a more particular and drawing in inclusion. Past essential distraction, its utility comes to out to essential spaces like chasing and protect, discernment, and supporting people with adaptability challenges. With its more diminutive orchestrate and adaptability, the quadruped succeeds in errands insides bound or unsafe spaces, epitomizing a modify in point of see in mechanical advancement through the satisfying compromise of man-made brainpower, biomechanics, and client communication.

**Keywords:** *Quadruped Robotic Dog, Agility, Versatility, Locomotion, Sensors, Adaptability, User Interface, Applications.*

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## I. INTRODUCTION

### ➤ Overview

This wander centres on making a quadruped robot utilizing in-house 3D printed components for both the robot and its more distant controller. Our approach incorporates applying aturnaround kinematics calculation to choose the joint parameters imperative to accomplish needed courses of action (position and turn) for each conclusion effector of the robot.

### ➤ Motivation

While wheeled robots are commonly utilized for investigating level scene due to their straightforwardness in arrange, era, and programming, they fight with obstructions like harsh scene or sharp rots. Our motivation stems from the require for a course of action that can investigate such challenging circumstances effectively.

### ➤ Issue Definition and Goals

Profitable improvement of objects is basic over diverse divisions such as work environments, military operations, clinics, and mechanical offices. Be that because it may, ordinary wheeled robots go up against obstacles in exploring troublesome region. Our objective is to address these

obstacles by making a quadruped robot able of investigating distinctive circumstances.

### ➤ Amplify Scope & Confinements

This expand focuses to create a course of action for address transportation completely diverse and uncommon scenes. It incorporates examine, arrange, re-enactment, and the calculation of walking cycles. Deliverables consolidate 3D printed robot components and servo motors. Affirmation criteria will be based on the viable execution of the robot's walk. In any case, not all conceivable strides will be included in this amplify.

### ➤ Methods and Issue Understanding

Our proposed quadruped arrange caters to distinctive applications such as military, mechanical, and helpful sections though keeping up sensibility. An elusive more remote controller energizes robot control, emphasizing a cost-effective backend between component replacement and insignificant impact on execution This tour focuses on four-legged robots offering 3D printed internal parts more robots and remote controllers will take over. Our method incorporates the use of transition energy calculations to select the joint parameters required to generate the required action sequences (position and path) for each of the robot's end effectors.

## II. THEORY

### ➤ *Strolling Movement*

Leg movements include variety, amount of running, walking and jumping. For this project, the focus is solely on recreational movement. It involved adjusting the leg and positioning it, which was named walking. The movements and groupings of the legs vary, affecting their motivation and intensity.

The Quadruped robotic dog with wheels outlined in Figure 1.

Graceful gait is categorized as stable and powerful. The rigid leg allows for any recoil without the adverse effect of stiffness, while the rigid leg remains rigid throughout the system, of course, between moves.

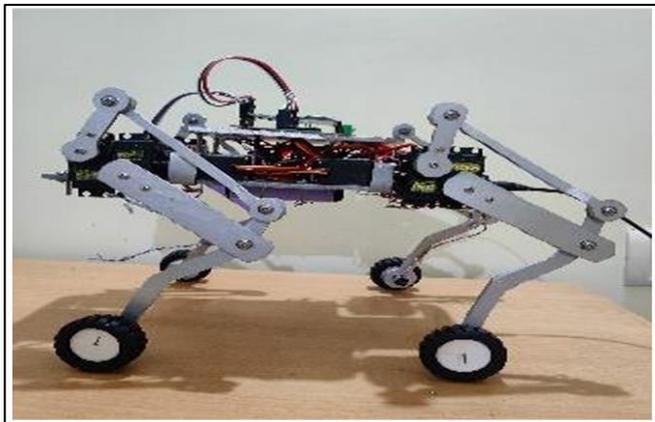


Fig 1 Quadruped robotic Dog with Wheels

Typical forms of walking include walking, jogging and jogging. The need to utilize appropriate less developed parts of the project forces an expansion of walkability. In any case, improvements in servo characteristics and speed may lead to the discovery of new gaits as the model progresses. Finally, the expansion means recognizing a variety of four-legged movements.

The structure of watchdog X is shown in figure 2.

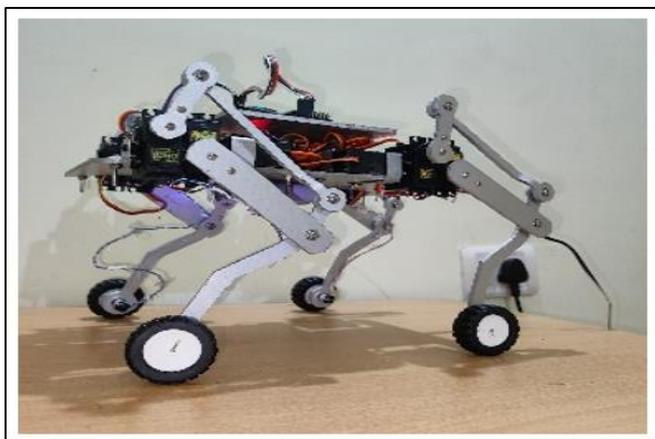


Fig 2 Structure of Watchdog X

### ➤ *Leg Component*

Each leg will comprise of a two joint servo engine component in arrange to imitate the leg of a canine or comparative four-legged creature. Each servo will be independently controlled with a microcontroller controlling the points and time outlines.

### ➤ *Turning Movement*

Due to confinements of soundness and progressed versatility, a streamlined way of turning was be assessed. Instead of moving all four legs at the same time, as it were two legs at a time pushes forward to turn left or right. Essentially, to a toy car that's moving its wheels on as it were one side, turning the car towards the side inverse to the wheels moving.

### ➤ *Backwards Strolling*

The in reverse movement of Guard dog X is very comparative to when moving forward except that all joints are within the inverse heading. Since strolling in reverse includes a somewhat diverse arrangement the ideal stride can shift from the one being ideal when moving forward. To assess the contrasts this was tried utilizing the models.

### ➤ *SERVO Engines*

A servo engine is made out of an electric engine associated with a servo control circuit as well as a potentiometer. The yield shaft is associated to the potentiometer which can decide each degree turned, by the relative alter in resistance.

Generally, servo motors have exceptionally tall accuracy input and are utilized for all sorts of side interest ventures. In this case a closed criticism circle is accomplished by having the potentiometer sending data around the position to the servo control circuit.

## III. SYSTEM DESIGN

### ➤ *System Organization*

The arranging of the quadruped robot includes two essential levels: high-level control and low-level control. At the tall level, control centres on directing the robot's behaviour, which incorporates setting the walk controller (blocked-off controller) and the alter sensor (IMU-9600) for security checking. On the other hand, the low-level controller is particularly committed to controlling the positions of the legs' joints utilizing inverse kinematics.

The control instrument of the quadruped is outlined in Figure 3.

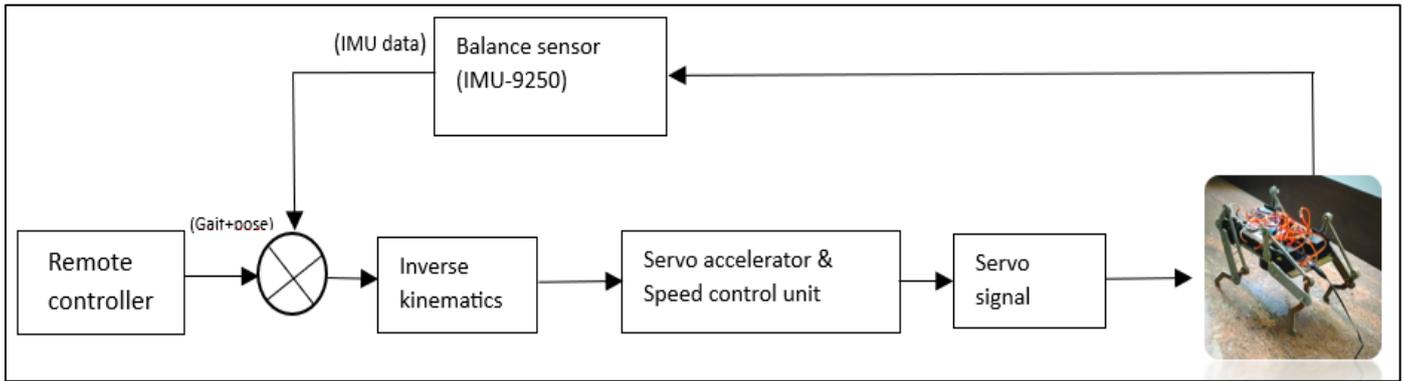


Fig 3 Control Block Diagram

The low-level controller capacities by getting commands from the high-level controller to alter the positions of the legs. Its part is to precisely take after the commanded strolling course. To guarantee strong execution, a proposed strong controller will be actualized inside the low-level control framework.

#### IV. METHODOLOGY

##### ➤ Mechanical Design Strategy

The mechanical framework of Watchdog X envelops its outline, incitation framework, and bolster saddle structure. Important features of the frame include the forelegs, hind legs, and spine.

Our approach to designing the robot's configuration meant preserving the natural authenticity of the original demonstration while optimizing it. Key objectives included dealing with pedestrian individuals crouching behind the aircraft, improving the length of pull-outs by modifying contact points, minimal stiffness and providing materials the contents have been difficult enough in the first place.

Changes were made to achieve these goals. For the case, truss systems replaced the open cut-outs to extend leg strength. Furthermore, elements with strong sex differences were modified to strengthen the passage holes and nut systems by reconstruction without compromising the supporting sharpness.

To the extent that these changes were driven by necessity, they were also welcomed by restructuring. This reinforced the integration of individual cell types into single macroscopic structures. Careful planning for the event allowed the twelve items to be combined into one front bear unit. This optimization not only reduces the overall component testing but also reduces the framework weight, the BPA calculation.

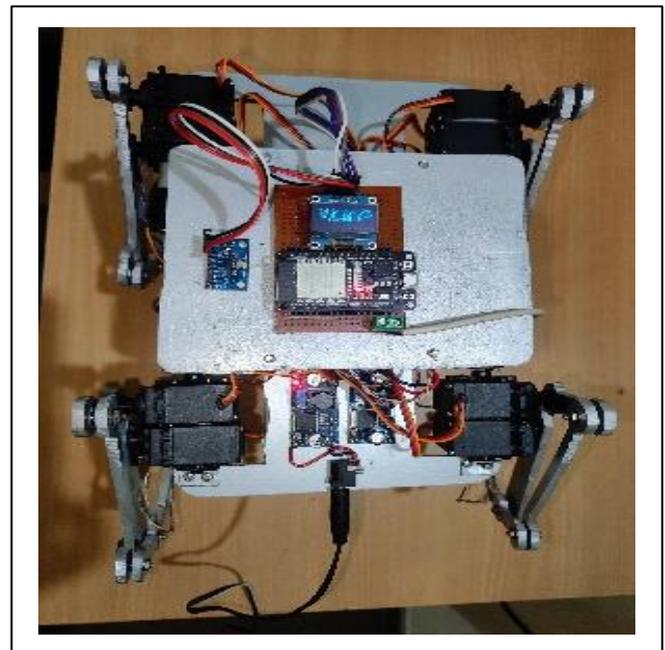


Fig 4 Top View

Additionally, both legs and wheels were consistently coordinates into each of the four legs to upgrade portability and manoeuvrability. The wheels are associated through vigorous hub congregations safely affixed to the leg structure. This expansion empowers Watchdog X to explore different landscape with expanded deftness and versatility.

##### ➤ Project Estimate

Once completed, the robot will be able to move and position its body in three different orientations: roll, pitch, and yaw. Gait, posture, and balance functions will be continually coordinated so that the robot can respond coherently.

Customers will require access to basic data on the remote controller, such as the robot's battery level and social status. The remote controller interface will enable the client to operate many aspects of the robot and compute its movement, location, altitude, and speed. Furthermore, a remote safety switch will enable the robot to instantly disconnect the controls in the event of a malfunction.

**V. ALGORITHM DETAILS**

➤ *We've Laid Out Six Fundamental Calculations Custom Fitted to Distinctive Functionalities:*

• *Motion-Synchronize:*

This calculation ensures the synchronous operation of all 12 servo motors interior the robot. In show disdain toward of each motor having different point changes, they all begin and conclude their exercises at the same time.

• *Motor:*

The Motor calculation amalgamates data yields from Rise, Posture, and Walk, making a bound together abdicate.

• *Rise:*

Competent for taking care of the vertical advancement of the robot by counting user-defined stature values (from the Blocked off Controller) to the current z-axis positions of each leg.

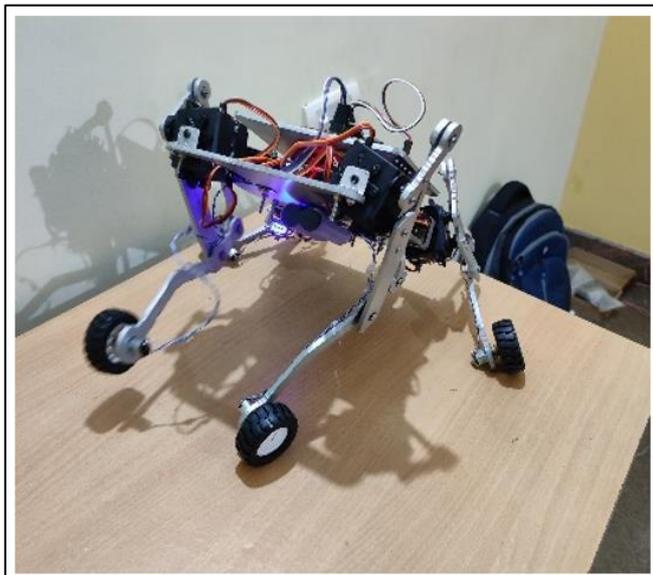


Fig 5 Handshaking Pose

• *Pose:*

This calculation incorporates three parameters: "roll", "pitch", and "yaw".

- ✓ Roll action lifts leg1 and leg3 together, though leg2 and leg4 move inside the converse heading.
- ✓ Pitch movement synchronizes rise of leg1 and leg2, though leg3 and leg4 act in limitation.
- ✓ Yaw action includes changes along the y-axis of the legs, with leg1 and leg2 moving inside the same heading, though leg3 and leg4 move inside the reverse heading.

• *Walk:*

This complex calculator organizes 8 different progressions in one step, ensuring that each leg performs cycles at the same time. To identify useful gait cycles in robots, it is important to understand the mechanism of quadrupedal gait.

Different poses can be displayed as shown in figure 4 and figure 5.

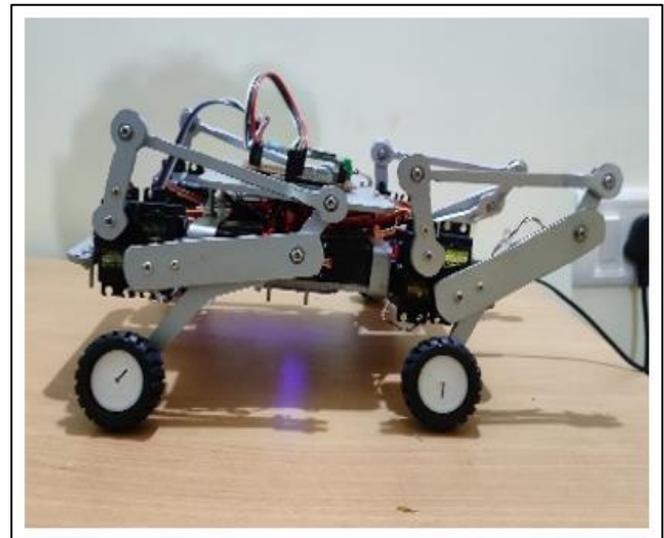


Fig 6 Stay low

• *Self-Balancing:*

Incorporates retaining the robot's agreement while running or walking enthusiastically. As the robot meets slants, changes are performed within the lengths of the legs to prepare for forward tilting. This coordination includes hip, bear, and elbow motors in each of the four legs, as well as changes within the legs' (x, y, z) encourages. When traveling upwards, legs 1 and 2 truncate while legs 3 and 4 stretch, and the opposite is true when moving downhill. This gives strength and adaptability when studying inclines.

**VI. APPLICATIONS**

- **Search and Rescue Operations:** This robot inspects dangerous situations like collapsed buildings and debris, potentially putting human defenders at risk.
- **Safety and surveillance:** Robotic dogs with cameras and sensors will provide security. They can track locations and send real-time pictures.
- **Logistics:** Four-legged robots can drive the last few miles of traffic in urban areas where conventional transportation may have barriers.
- **Medical Help:** Robotic dogs help in healthcare facilities by carrying therapeutic supplies, giving to patients with portability issues.
- **Agriculture:** Quadruped robots can be utilized in farming for works such as observing crops, assessing areas, little payloads of rural inputs. They can work in different landscapes.
- **Exploration of Dangerous Environments:** These robots can investigate situations that are dangerous to people, such as atomic offices, chemical plants, or zones with tall levels of contamination.
- **Research and Education:** Quadruped robotic dogs serve as profitable apparatuses for analysts and teachers in mechanical autonomy and manufactured insights. They give a hands-on stage for experimentation and learning in

areas like control frameworks, computer vision, and machine learning.

- Assistance for Individuals with Incapacities: Robotic dogs can be planned to help people with incapacities by giving back with assignments such as bringing things, opening entryways, or indeed advertising physical steadiness and companionship.
- Entertainment and Social Interaction: Quadruped robots can be utilized for amusement purposes, such as performing in appears, shows, or as intuitively companions.
- Military Applications: Robotic dogs can be conveyed for different military purposes, counting observation, observation, and carrying supplies in challenging territories.

## VII. CONCLUSION

The re-enactments of strolling have uncovered the foremost successful gait watched during different tests conducted on level surfaces. In any case, improvements can be made by providing additional building blocks. This adjustment means limiting the hole between the expected and actual directions, and the body and leg positions are less erroneous. Thus, this modification can lead to improved noise, body development speed and speed reduction. Furthermore, optimizing control computation for walking seems to eliminate errors in the initial phase, so that the robot moves with smooth walks. Also turn your wheels to adjust with the feet on the following step wheels allowing them to turn smoothly.

## FUTURE WORK

Looking ahead, future developments in automated motion appear to adopt a comprehensive approach. For starters, combining advanced tangible criticism instruments, such as proprioceptive sensors for limb position evaluation and natural sensors for landscape recognition, may increase the robot's suppleness and flexibility. Furthermore, exploring machine learning calculations to produce adaptable walk control methods provides a guarantee for future robot development refinements. Furthermore, testing using flexible actuators and adaptable structures may improve vitality proficiency, solidity, and deftness throughout diverse environments. Advanced refinements may include optimizing gait control calculations to reduce errors during the early development stage and investigating strategies to close the gap between anticipated and accomplished directions, thereby improving solidity and reducing speed fluctuations while increasing speed.

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