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Development of Novel Stair Climbing Robot

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Abstract: ***Over past few decades, attempts are made to develop robots that can move on rough terrains but only few robots that are suitable for rough terrains. The aim of this paper is to introduce a new class of locomotive concepts that will have excellent off-road capabilities. A prototype of this class, a four wheeled cum six wheeled robot is developed for climbing the stairs by changing the horizontal distance. It will possess maximum gripping capacity and stability during motion in rough terrain. The robot has wireless control of which will steer the robot in the target area from remote.***
Keywords: Rough terrains, stair climbing, Wheeled robot, Remote

I. INTRODUCTION

Stair climbing robot is able to cope with stairs, very rough terrain, and is able to move fast on flat ground. Pradhan et al presented details of a prototype robot which can navigate in very rough terrain, ascend and descend staircase as well as sloping surface and cross ditches. The robot is made up of six differentially steered wheels and some passive mechanism, making it suitable to cross long ditches and landscape undulation(1).Basil Hamed presented the design and implementation feedback RF controlled stair climbing robot and provided the complete integrated control architecture and control strategy for a system of reconfigurable robots that can climb stairs(2).

Jeyabalaji et al proposed a stair climbing robot that looks a lot like the human leg and can adjust itself according to the height of the step with a payload of about 4 Kg. The automatic adjustment in the robot proposed by them, according to the height of the stair is done by connecting an Android device that has an application programmed in OpenCV with an Arduino in Host mode. The Android Device uses it camera to calculate the height of the stair and sends it to the Arduino for further calculation(3).

Kalantari et al dicussed thePlanning and implementation of a safe autonomous stair climbing algorithm for a tracked mobile robot. Two major factors conspired by them, defined to make the climb as safe as possible. Based on these factors a desired trajectory is planned. Data of two laser range finders are used to locate the robot over the stairs. The error signal is generated by comparing the located and desired postures. To compensate this error, a kinematics based controller is utilized. A combination of a nominal feedforward command with a feedback action on error at each time step is used in this tracking control scheme(4).

Mourikis et al prolposed an algorithm for autonomous stair climbing with a tracked vehicle. The method achieved robust performance under real-world conditions, without assuming prior knowledge of the stair geometry, the dynamics of the vehicle's interaction with the stair surface, or lighting conditions. The approach relies on fast and accurate estimation of the robot's heading and its position relative to the stair boundaries (5).

Helmick et al presented the design and implementation of a new set of estimation and control algorithms that increase the speed and effectiveness of stair climbing. They developed a Kalman filter that fuses data with internal measurements and provided attitude estimates of improved accuracy at higher rate.(6).

Liu et al divided the stairs-climbing process into riser climbing, riser crossing, and nose line climbing. During each climbing process, robot's mobility has been analyzed for its kinematics and dynamics factor. The track velocity and acceleration's influences on riser climbing have been analyzed(7).

II. MATERIALS AND METHODS

A. Shorter Link

The robot consists of shorter link of size 200 mm. It is made up of mild steel. Six longer links are present in the robot on both side three links each in the transverse direction. One side of the longitudinal direction is fully occupied by a set of three shorter links.

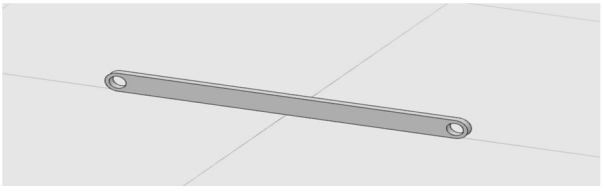

Fig.1 Shorter link

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B. Longer Link

The robot consists of Longer link of size 400 mm. It is made up of mild steel. Two longer links are present in the robot on both side each in the transverse direction. One side of the longitudinal direction is fully occupied by the longer links.

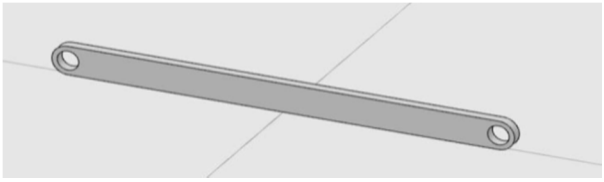

Fig.2 Longer link

C. Robot Wheel

The robot is designed with hard rubber wheels. The robot consists of 4 wheel in the normal position and 6 wheels in the expanded position.

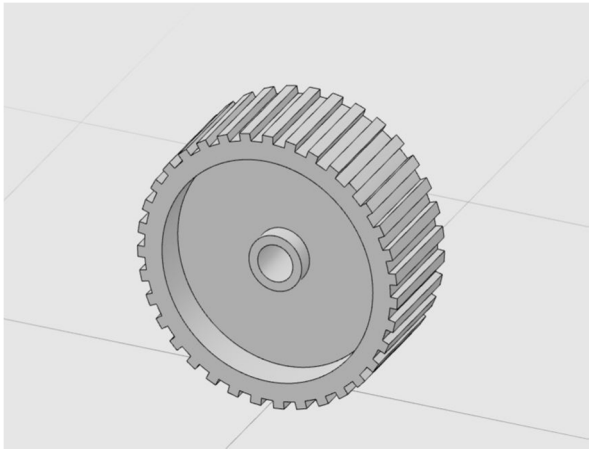

Fig.3 Robot wheel

D. Horizontal Solid Member

The horizontal solid member which connects the combination of vertical members on both side. It is made up of mild steel. It provides rigid support to the robot.

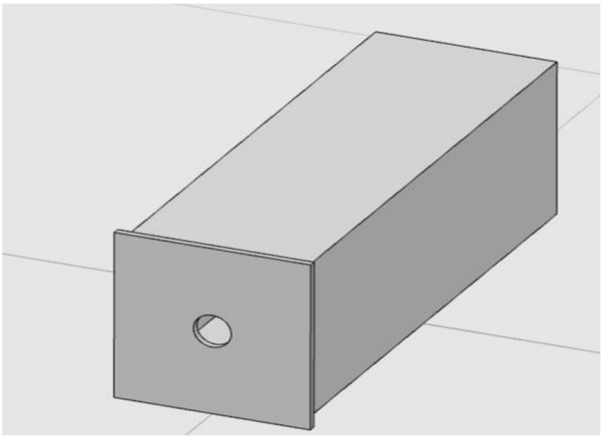

Fig.4 Horizontal solid member

E. Electrical and Electronic Components

The electrical and electronic components present in the robot are geared motor, motor drive, microprocessor and remote control. Four geared motors are used in normal mode and six geared motors are used in the expanded mode. The start, stop, forward and reverse movement of the robot is control by Remote control. The motor drive is used to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. The motor drivers are controlled using microcontroller unit calculating the motion control signals.

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III. NOVEL STAIR CLIMBING ROBOT

The novel stair climbing robot is having two configurations normal mode and expanded mode.

A. Star climbing: Normal mode

In the normal stair climbing mode, the number wheels are in operations are 4.The distance between the wheel which is connected in the longer and the wheel connected in the shorter wheel is 410 mm.

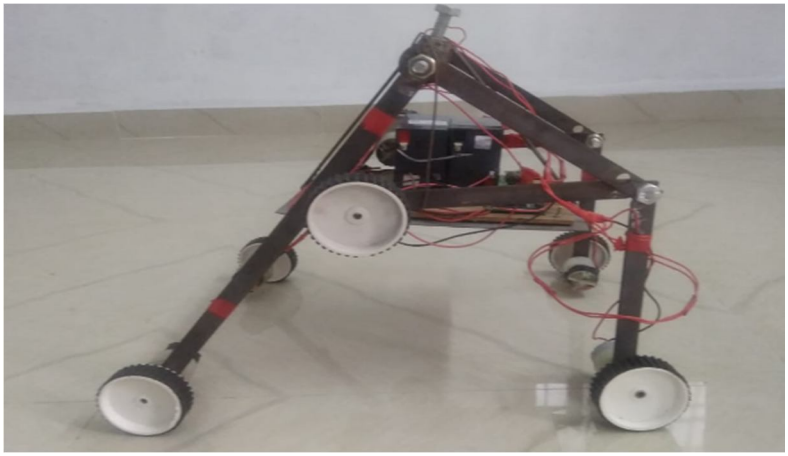

Fig 5: Stair climbing: Normal mode

B. Star Climbing: Expanded Mode

In the Expanded stair climbing, the number wheels are in operations are 6.The distance between the wheel which is connected in the longer and the wheel connected in the shorter wheel is 540 mm.

Fig6: Stair climbing: Expanded mode

IV. RESULT AND DISCUSSION

In the normal mode, the shorter links are almost straight. The link which is perpendicular to it is hinged. The stair climbing capability of the normal is restricted because the front links are almost straight but the robot can climb steps of smaller size.

In the expanded mode, the front links are inclined. The stair capability is good because the inclined nature of the link. It will climb the stairs or obstacle twice the diameter of the wheel. This configuration provides more stability when compared to the normal mode

V. CONCLUSION

The novel stair climbing robot was designed and developed. The two configurations namely normal mode and expanded modes are developed and studied. In this work, the attempt of increasing the horizontal distance of the robot was successfully carried out. In future work, increase in the lateral distance of the robot will be attempted.

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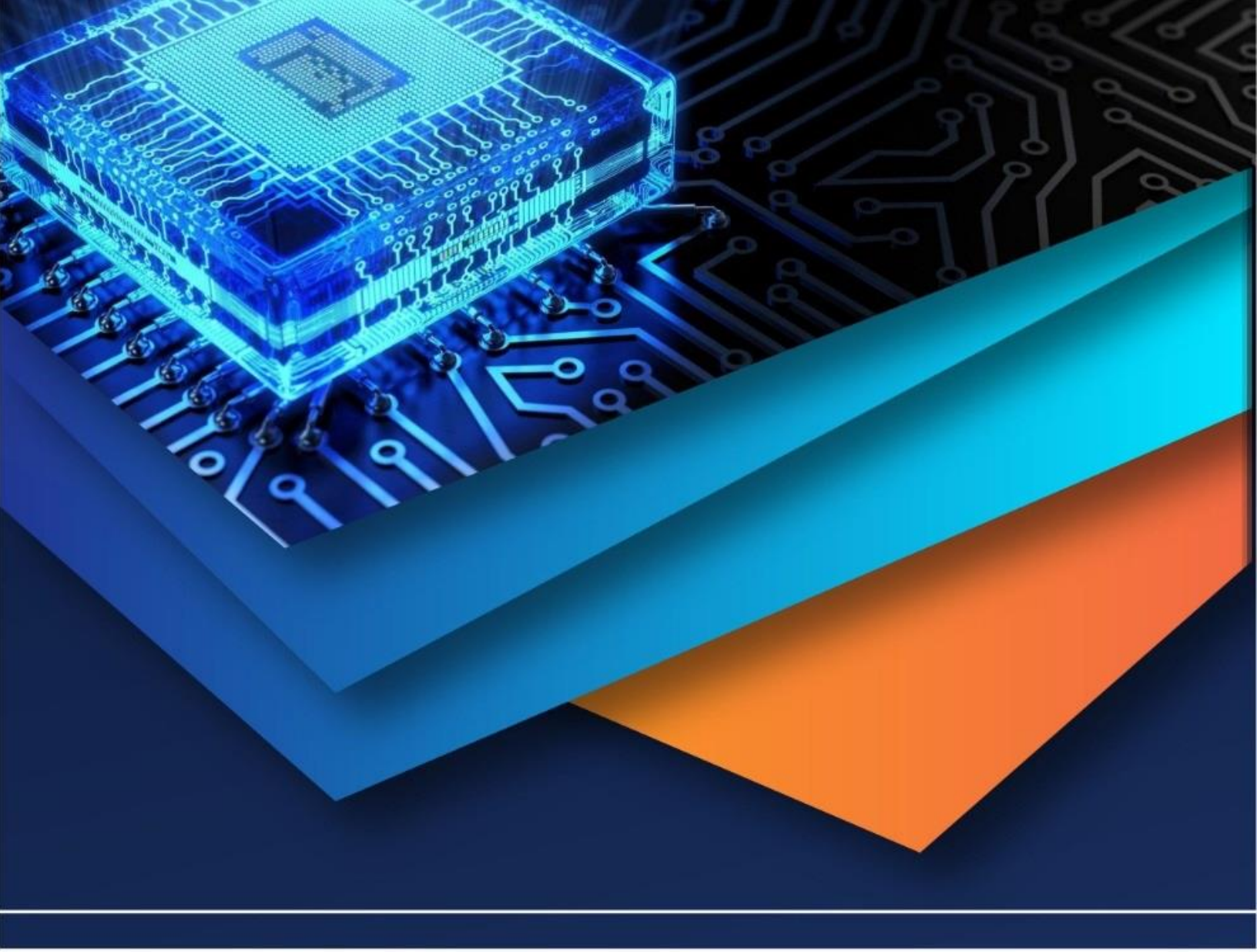

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