Pole Climbing Robot

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ABSTRACT: 3D CLIMBER is a climbing pole robot built at ISR-UC. This can ascend with bends and branches from 3D structures, and search the entire region of the structure. Once the mechanical system had been completed, some experiments are performed to prove principle. The cost of installing, tracking and maintaining a fixed camera system can be high and there is no need for continuous surveying in all areas. The increase in crime in urban areas highlights the need for a more robust and reliable surveillance program, which could result in fewer crimes. A temporary surveillance device that can ascend to achieve an elevated view has great potential both for military and civilian use. This paper illustrates how the patent pending climbing robotic system (PC-101) has been developed to be used by the Metropolitan Police Forensic Department in London to investigate outdoor crime scenes, especially those related to car accidents. Climbing robots are commonly used for inspection of vertical and inclined poles cabling on high voltage power transmission tower in various applications in industrial and hazardous environments. Pole climbing to tackle any problems relating to power transmission lines, bridge repair and maintenance, trees climbing, lamp posts climbing etc. Designing Pole Climbing Robot (PCR) aims in this article.

KEYWORDS: BT Module, NDT Techniques, Pole Climbing Robot, Self-Locking, Unmanned Aerial Vehicles, Wireless Control System.

INTRODUCTION

Pole climbing robots have many uses in the maintenance and inspection of 3D tubular structures created by humans. One program conducts regular NDT probe inspections to track progression of material corrosion and welding defects. NDT techniques are applied to elevated structures by dexterous technicians, where hazardous contaminants flow through the pipes. It's incredibly hard and can be classified in the 3D work. A climbing robot is that kinds of robot that can help people climb poles or potentially convey an instrument or gear at a dangerous or construction spot[1]. PCR's strategy and movement can be affected by robot execution so steadiness assumes a vital part for stable robot when moving to a pole in this way. A climbing robot is that kinds of robot that can help people climb poles or potentially convey an instrument or gear at a dangerous or construction spot. PCR's strategy and movement can be affected by robot execution so steadiness assumes a vital part for stable robot when moving to a pole in this way. The most important thing is steadiness which should be remembered when working with robot. Wheeled post climbing robot has various points of interest because it is a fast moving robot due to the fact that we must use wheels to set up actuators both to get a grip on and to ascend the shaft. Robot climbing has numerous uses in both modern and dangerous condition[2]. The most well-known function is commonly used by the Pole climbing robot, which is the repair of energy transmission lines, scaffolds and lamppost and climbing tree supports. Remarkable and modern errands are the cleaning of electric lights on lampposts in parkways. There's so much Pole climbing robot that's just mechanical based that can carry men. Pre-installed cameras are the standard approach to video surveillance. The climbing system is powered by warm wheel reduction mechanism servomotors. They had used two wheels so instead of three in this process, so there would be the risk of slipping. The rod climbing robot specially built to detect the fractures of the internal steel wire in the suspension bridges[3].

CLIMBING POLES

Crisis situations such as natural disasters, chemical pollution, or protests require a precise, swift, and reliable assessment of the situation in the crisis. Cameras or any form of suitable sensor will provide the gathered data. They are generally gathered from various observation points and then centralized into the coordination centre. Observation data from an elevated point of view may bring considerable benefit, particularly in urban environments where many obstacles prevent clear vision. Unmanned Aerial Vehicles (UAVs) may be seen as a solution but their use is currently restricted due to their possible threat in the event of a crash and limited endurance. The preferred solution proposed here is a climbing robot capable of carrying minimal energy, sensors and communication devices in addition to typical elevated urban structures such as pillars, lampposts or pipes for water evacuation[4].

ROLLING SELF-LOCKING AND POLE-CLIMBING ROBOTS

Patent databases require multiple robots to be found dedicated to trestle structure or ladder climbing. Such devices typically use grippers placed on an extensible frame are in this paper not suited to what call a stick. This work covers tubular-shaped points, with cylindrical or conical form and circular or polygonal segment. Concrete poles not covered with a square or H-shape section. Self-locking or butting is a physical phenomenon where locking is obtained only by friction and whatever the external forces intensity. It is an interesting feature, as it means no energy is required to hold the robot at the top of the pole. Starting in the early 20th century, static self-locking has been used for climbing shoes or for hunting stands for tree climbing. Strangely enough, it does not seem like up to now any climbing machine or robot is using the theory. For this purpose, our robot had chosen to follow this theory[5].

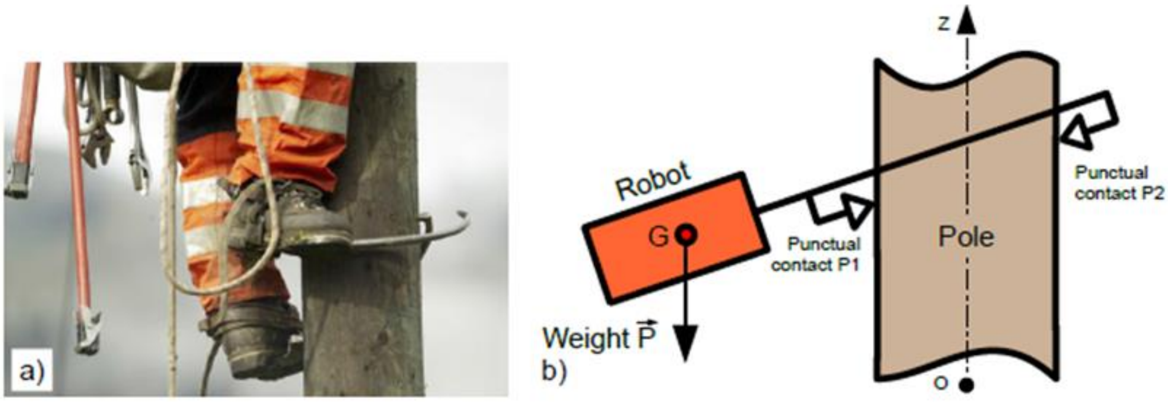

Fig.1: Self-Locking on a Pole for a Man or a Robot

The robot must satisfy the locking criterion to be able to sustain itself. One required condition is that the centre of mass G be moved laterally enough with respect to the contact points P1 and P2, depending on the conditions of friction. To build a climbing robot based on the concept of self-locking, two frames can be fitted with the locking system and connected by a contracting mechanism. Locating the touch point's directly on rollers seems a lot easier. This allows rolling self-lock which is the original concept to be used for the robot, to be accomplished. They need at least two rollers[6]. Both can be actuated but only the one closest to the centre of the mass, near to the heavy parts e.g. the electric motor and batteries is easier to actuate. The resulting robot shows up in Figure 1, 2. The Roller R1 is the only actuator. R1 transmits a reaction force from the pole to the robot at the contact point C1: a normal force N1 but also a tangential force T1. On the contrary, roller R2 is a free one and only transmits a normal force N2 at the point of contact C2, given that R2 is mounted on roller bearings which guarantee very low resistant torque. This means the robot is only powered by roller R1. The condition of rolling self-locking comes from the fundamental theory of statics. Equation originates in its horizontal projection along y:

$$N1=N2$$

A vertical projection along z gives the robot's mass being m and the gravity acceleration being g.

$$T1= mg$$

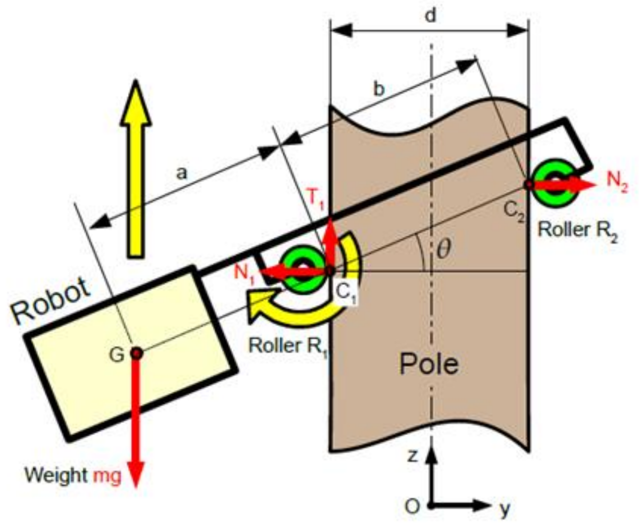

Fig.2: Rolling Self-Locking with Two Contact Points

The number of torques around x in point C1 gives with a GC1 overhanging distance being the distance between the C1C2 touch points and the robot's tilting angle.

$$mg\ a \cos\theta = b \sin\theta\ N2$$

The non-slipping condition at point C1, based on Coulomb friction law and using the friction coefficient μ

$$T1 \leq \mu\ N1$$

The non-slipping condition

$$N1 \geq mg/\ \mu$$

The expression of N1

$$N_1 = \frac{a\,m\,g}{b\tan(\theta)}$$

The Rolling Self-Locking Condition:

$$a \geq \frac{b\tan(\theta)}{\mu} \quad \text{with} \quad \theta = \arccos(d/b)$$

It can be shown that this does not depend on the mass but rather on the properties of geometry and friction. Self-locking happens only when the gap is long enough to overhang. The higher the friction μ and the lower the friction will be a. The locking is retained with shorter distance values a when the tilting angle decreases. This is because when the corner angle decreases, normal forces increase. For a robot that is quasi horizontal, forces move toward infinity[7].

DESIGN AND IMPLEMENTATION

The proposer architecture and configuration block diagram is shown in Figure 3.

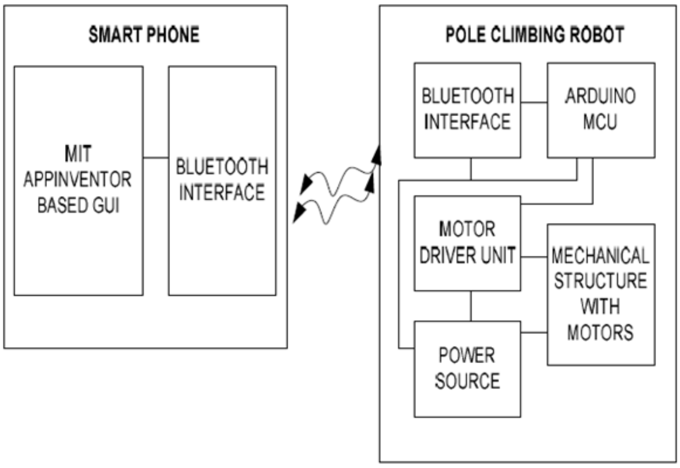

Fig.3: Block Diagram of the System

The user can very easily control the motion of the climbing robot using the Interface built with the MIT application inventor. The built app allows the user to pair smartphone blue tooth (BT) with the blue tooth interface mounted in the robot for pole climb. If the BT smart phone interface understands the BT robot interface, the up and down icons make controlling quite simple. The robot for pole climbing is an 8-wheeled structure with four wheels at the top and four wheels at the bottom, diagonally opposite each other. Figure 4 displays the configuration of a robot climbing post. The motors are controlled by an Arduino based MCU driver unit. The motors attached to the legs are coordinated in a simple way, depending on whether the robot should climb up or down, the entire motors move up or down. The specific motor controlling mechanism of the robot's motion is seen here. Mechanism for relay based motor driving is introduced and evaluated in the first scenario[8].

Fig.4: Pole Climbing Robot

It is the cheapest implementation but with a trade-off. The motor speed is not controllable. This shouldn't be a concern as race robots are not pole climbing robots. Along with the relays, this system used the HC-05 BT module. Figure 3 displays setup. The relays will monitor the movement direction of the motors the wheels are connected to for climbing up or down, but at a steady non-varying speed[9].

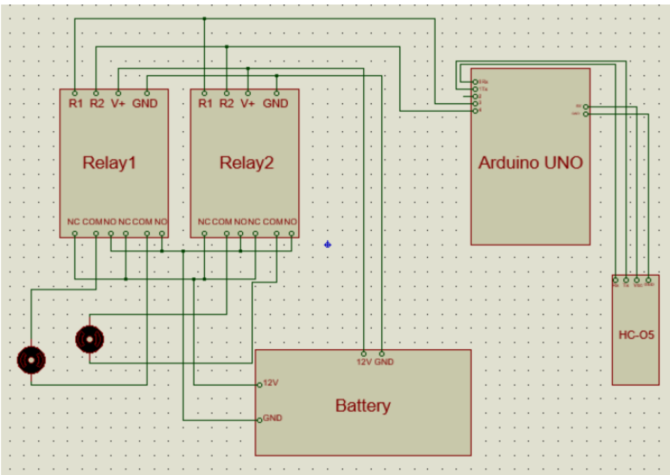

Figure 5: Circuit Diagram of Controlling Motor with 2 Relay Boards.

Compared to the relays, motor drivers are a bit expensive but the controls and connections are simple. The additional feature for the motor driver who isn't in the relay is to control the motor speed by adjusting the PWM Pulse Width Modulation. The PWM signal can be controlled via Arduino MCU. You can also control the direction of the motors using the Arduino MCU using the motor driver board's direction control signals. Single motor driver is not necessary to drive all the engines. The load it has to push it gets heated up rapidly. High Torque 12.00 V DC motors with a maximum load current of up to 7.50 are each of the motors that drive the wheels. The PWM signal can be controlled via Arduino MCU. the BT interface powered by an android application that built using the MIT app inventor (Open Source Ware), instead of using the serial monitor via smartphone to control the motors using the Arduino MCU. The circuit with Arduino MCU for the Bluetooth module is shown in Figure 5. UART serial converter module is used for the HC-05 BT transceiver module. It works at 5V at 50 mA which the Arduino MCU is able to produce[10]. Figure 6 shows Controlling motor with 2 motor drivers.

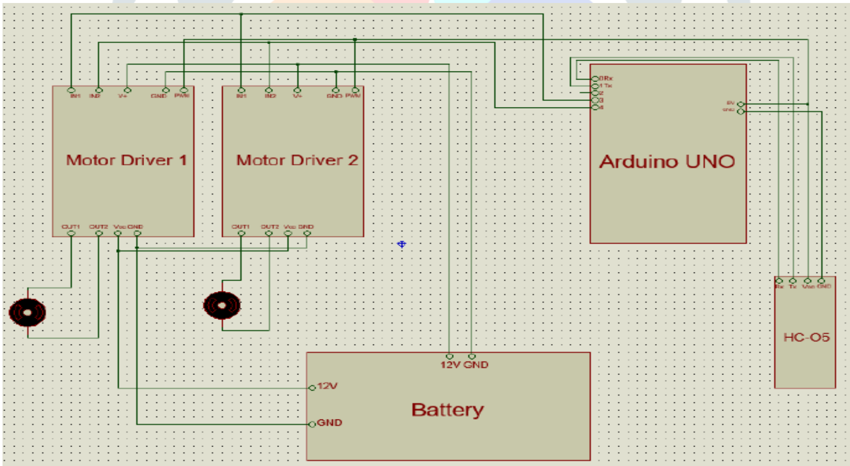

Figure 6: Circuit Diagram of Controlling Motor with 2 Motor Drivers.

This module is configurable at baud levels from 1.2 Kbps to 115 Kbps. It has an area of approximately 10 metres. The BT module will start blinking continuously when the Arduino board is driven signalling it is ready to pair with some unit. The BT module can be combined with the smart phone on which our device is enabled at this stage. When combined, a second will blink twice.

WIRELESS CONTROL SYSTEM

The platform control is accomplished with the aid of a 2.4 GHz Xbee transceiver that interacts with the microcontroller and motor speed controllers to travel up or down from a 30 m operating range. The drive mechanism, weapon, and camera can be selected independently from the remote handheld. The machine is in locomotion, the arm is in the retracted position that sets the platform weight to be closer to the lighting column to maintain stability. Arm articulation depends on servo motors tuned to high-torque hardware (Figure 7)[11].

Fig.7: Ground Control Unit with Joystick for Arm Articulation and System Locomotion

CONCLUSION

The pole climbing robot works with our android-controlled circuit which uses Bluetooth technology. We can only use one motor driver which helps to reduce the size and cost of the circuit. For typical pole heights this works perfect. The architecture of the pole climbing robot V2 is based on the revolutionary rolling self-locking concept, which requires no energy to hold itself at a given altitude. The robot can also perform axial rotation, can cross tangential obstacles and, thanks to passive normal force control with springs and a force amplifying attachment, can climb poles with a strong conical shape. To order to serve both purposes the robot should be able to ascend straight poles horizontally & vertically. The PC-101 device is a fully integrated control machine that can climb up columns of street lighting to achieve an elevated viewpoint of a targeted area. PC-101 is much more reliable, cost-effective and safer than the other approaches compared to current systems used to achieve the same desired elevation. With more growth, this device has tremendous potential to be used for surveillance by local law enforcement or any other organisations, businesses or authorities in a day-to-day operation.

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