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Smartphone Controlled Robotic Vehicle with Unique Bearing-Alignment Mechanism and Robotic Arm for Dangerous Object Disposal

Whiley Samuel Effiom; Akwukwaegbu, Isdore Onyema; Nsan-Awaji Peterson Ene-Nte

Department of Electrical and Electronic Engineering,
Faculty of Engineering, Federal University of Technology, Owerri, Nigeria

ABSTRACT

Robotics technology is rapidly developing in engineering because it can automate complex activities with higher accuracy and speed. Previously, only trained humans in a bomb suit could do duties that automated and autonomous equipment can now perform. In many situations, human attention is not required, such as discovering and spreading explosives, monitoring a site, or identifying land mines.For safety reasons, the robotic vehicle in this project will use a 6-degree robotic arm to pick and place a dangerous object. The robot vehicle is remote operated using an Android application via Bluetooth. The Bluetooth device connects to the microcontroller to run DC motors through a motor driver IC. Any Android smartphone/tablet/etc. can execute remote control through touch-screen GUI (Graphical User Interface). In this case, Arduino controls the whole setup, increasing circuit complexity and speed. The robotic system consists of a manipulator, an end-effector, a moving base, and a camera for visual inputs. These power the robotic arm's joints, linkages, and end-effectors. The Rocker-Bogie method allows the robot to travel more readily on any terrain.

KEYWORDS: *6-degree motion, Remote Operation, Bluetooth Device, Rocker-Bogie method*

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1. INTRODUCTION

Robotics is a field of engineering science and technology concerned with robots, their design, production, use, and structural arrangement. Robotics is a branch of engineering that encompasses electronics, mechanics, and software. Today's robotics research is focused on developing systems that exhibit modularity, flexibility, redundancy, fault tolerance, a general and extensible software environment, and seamless connectivity to other machines. While some researchers work to completely automate a manufacturing process or task by providing sensor-based intelligence to the robot arm, others work to solidify the analytical foundations upon which many of robotics' fundamental concepts are built. In our rapidly changing civilization, time and manpower restrictions are important for completing large-scale tasks. Automation is critical in reducing human effort in the majority of routine and regularly performed tasks. Picking and placement from source to destination is a significant and often performed task. In today's rapidly evolving world, time and manpower are significant restraints on the accomplishment of large-scale tasks. Automation enables you to do repetitive chores without becoming fatigued. One of the most important responsibilities done is the choosing and placement of work from one location to another. The pick and place robot is a mechatronic system controlled by a microcontroller that recognizes an item, picks it up from its source position, and sets it in the desired location. Nowadays, robots are indispensable in practically every industry. This is mostly owing to the fact that it is capable of doing tasks with more precision and speed than even the most competent human operator.

Unlike humans, robots are often designed to do certain activities, but people may switch tasks at any moment and are more adaptable, a limitation that will likely be solved in the future as technology advances. Sensors and actuators allow these robots to interact with the physical environment. Robots may take the place of humans in some dangerous duty positions without endangering human life. The nuclear sector pioneered the development and usage of robotic arms for radioactive material handling. Robotic arms enabled scientists to operate controls for robotic arms positioned in radioactive rooms from clean, safe rooms, utilization of complex things, equipment, and appliances previously unimaginable prior to the advent of modern technology. Military teams are not excluded, since they are tasked with the responsibility of handling hazardous or radioactive items and bear the hazards associated with approaching dangerous areas. Explosives and improvised explosive devices are the most often used weapons in attacks, and they have taken numerous lives. Furthermore, military troops are exposed to risk when performing reconnaissance activities. This has necessitated the construction of a robotic arm capable of disposing of hazardous materials such as bombs or explosives prior to their detonation, therefore safeguarding lives and property. Additionally, these robots may operate in environments that are harmful to human life. The device is activated through remote control, providing an additional layer of security and avoiding the loss of proven and tested individuals. The number of mobile device usage is increasing as a result of their mobility, efficiency, and capacity to be utilized anywhere and at any time. Their usage is expected to continue to grow over the next three years, to the point where mobile application development projects targeting smart phones and tablets will outweigh native PC development projects by a ratio of four to one [1]. Android technology in robotics and industrial robot control systems may provide a more intuitive and efficient method for controlling and monitoring a robot's operation, even from a remote location. Google offers free technical help and documentation. Applications development may be carried out irrespective of the operating system on which they are run, and the development environment and associated tools are all available for free [2].This paper describes a method for controlling and monitoring robots remotely through an Android smartphone and Bluetooth connection. The system comprises of an Android-based smartphone and a real-time control system. The solution for real-time control of robots communicates wirelessly with the Android mobile, ensuring the user's location independence.

2. LITERATURE REVIEW

The Prototype robot will be capable of navigating in tough terrain, ascending and descending staircases, sloping surfaces, and crossing ditches. The robot is made up of six differentially steered wheels and various passive mechanisms, allowing it to traverse lengthy ditches and undulating terrain. Analyses of the built robot's static stability have been performed, and the robot's navigation performance has been evaluated via simulation in various environments. The embedded system of the robot has also been described, and experimental validation has been performed. Finally, the robot's limits and their causes have been investigated [3]. The majority of military organizations today rely on robots to do numerous dangerous tasks that humans cannot perform. These military robots are often equipped with an integrated system that includes video displays, sensors, grippers, and cameras. Military robots come in a variety of forms, depending on their intended use. This robotic vehicle may take the place of a soldier in a border region to offer surveillance. Using the internet as a communication channel, it detects the presence of an object, captures it with a camera, and streams it live to the authorized person. Surveillance has a significant impact. This article describes a smart surveillance robot for military use that employs a microcontroller for security purposes. The Microcontroller delivers a wireless command, which is received by an authorized user on a web page, and the robot moves as a result. [5]. The following are the materials used in the assembly of this robot:

1. HC-05 Bluetooth Module: This simple Bluetooth module is intended for the construction of transparent serial wireless connections that may be used in a Master or Slave configuration. With a 2.4GHz transceiver and base band Bluetooth V2.0 + EDR (Enhanced data rate) 3Mbps modulation, this Bluetooth Serial port is fully functional. The Bluecore 04-External Bluetooth single chip CSR module with CMOS technology and the AFH system are used in this [6].
2. Motor Driver L298N: This is a device for connecting motors that enables you to manage the speed and direction of four motors at the same time. The most popular driver for bidirectional motor driving applications is the L298N dual H-bridge driver. That process is simplified by the L298N Motor Driver IC, which has aided in a variety of applications with relative simplicity. The L298N is a 15-pin motor driver integrated circuit. This is intended to deliver bidirectional driving currents at voltages ranging from 5 to 36 volts. The L298N is also capable of driving tiny

and silent large motors. With only four microcontroller pins, this motor driver IC can operate four tiny motors in any direction, forward or backward [7].

3. Arduino: It is an open-source board based on the MicrochipATmega328P Microcontroller created by Arduino.cc. The panel features a set of digital and analog input / output (I / O) pins that may be connected to other boards (shielding) and other circuits. The panel features 14 virtual I/O pins (six of which are PWM output capability), 6 analog I/O pins, and can be programmed using an Arduino IDE through a USB type B connector. It may be supplied with a USB connection or an external 9-volt battery, although it takes voltages ranging from 7 to 20 volts.
4. DC Motors: The robot is powered by six 12V DC motors. Each wheel of the robot base has a motor linked to it. The power from the motors is transferred to the robot base, allowing the robot to be driven and steered with ease. The motion and its possibilities are determined by the function written into the microcontroller, which executes the application's signal command [8]. The L298N IC connects the DC actuators through pins 4 and 5, and the other actuators via pins 6 and 7.
5. The MG 966 servo motor is a rotary actuator or linear actuator that accurately regulates angular or linear position, direction, and rate. It comprises of a suitable motor connected to a position feedback sensor. The MG996R is a servo motor with a metal gear and a maximum stall torque of 11 kg/cm. The motor, like other RC servos, rotates from 0 to 180 degrees depending on the duty cycle of the PWM wave given to its signal pin. To make this motor revolve, power it with +5V through the Red and Brown wires and transmit RX and TX signals over Bluetooth to the Orange wire. The signal pins of the servomotors are linked to the Arduino mega communication RX, TX from 14 to 19 pins [9].
6. Wireless Video Camera: A wireless video camera is used to promote night vision and better monitoring. The camera module also supports a video transmitter, and the receiver module is interfaced with the control module via an LCD display. Live video feedback from this camera is received by tuning the receiver to a specific frequency, and the LCD is connected to the receiver module via the AV port, and thus live feedback can be viewed by the user. The video picture from an onboard camera is relayed by radio frequency to a personal video display on the ground in the form of a screen or video goggles in an FPV system. The camera is powered directly by a 9V 2A regulator circuit. The camera transmits and receives radio frequency signals on its own [10].

3. METHODOLOGY

This project is split into modules to aid in the interpretation of the circuit.

The microcontroller is the brains of this project, since it is responsible for controlling the robot. The robot moves in response to the microcontroller's input controls. The proposed system for a Smartphone Controlled Robotic Vehicle with Unique Bearing-Alignment Mechanism and Robotic Arm for Dangerous Object Disposal utilizes an Arduino UNO (microcontroller Atmega 328), DC motor drivers, and Servo motor drivers to power the DC motors and servo motors, respectively, and a Robotic Arm to pick up and drop bombs that is monitored by a camera. The entire system is controlled via Bluetooth in response to the user's commands. The robot was created with the purpose of picking up and placing the payload. The Rocker-Bogie approach is used to enable the robot to travel on any terrain surfaces.

Block Diagram of the Mobile Robot

Fig 1 depicts the system's block diagram. Six DC motors, six servo motors, a driver IC and a power supply power the ATmega328 microcontroller IC. An arm attached to the moving vehicle serves as the pick and place robotic arm. It doesn't matter whether the road is smooth or bumpy; the vehicle can go on any surface. Smooth and dependable functioning is ensured by using the Rocker-Bogie technique. The pick and place robot is powered by twelve motors: six DC motors for vehicle movement and six servo motors for picking and placing. In order to operate the robotic arm, a jaw must be attached to the arm assembly. The Atmega328 microcontroller is utilized to operate the motor. A Bluetooth module connects an Android mobile to the microcontroller, which receives the input signal or control signal. Input 1, 2, and output 1, 2 are part of one set of arrangements in L298. Input 3, 4, and output 3, 4 are part of the other group. When the software is running, the Motor receives orders from the Android device.

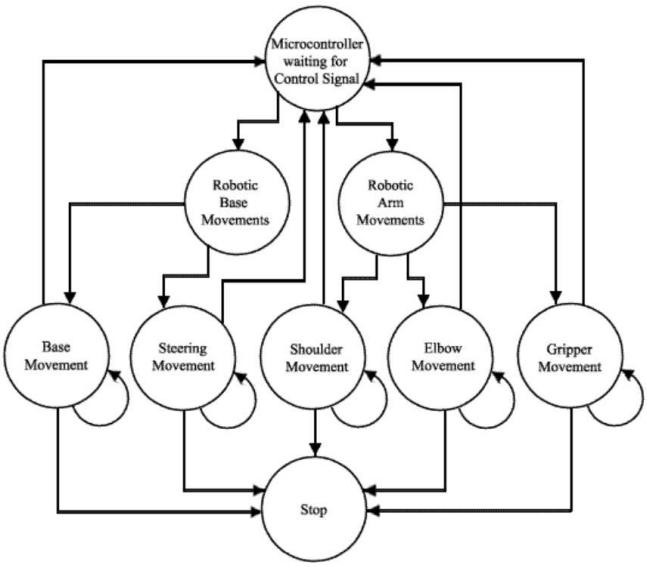

Figure 1: Pick and Place Robot Block Diagram

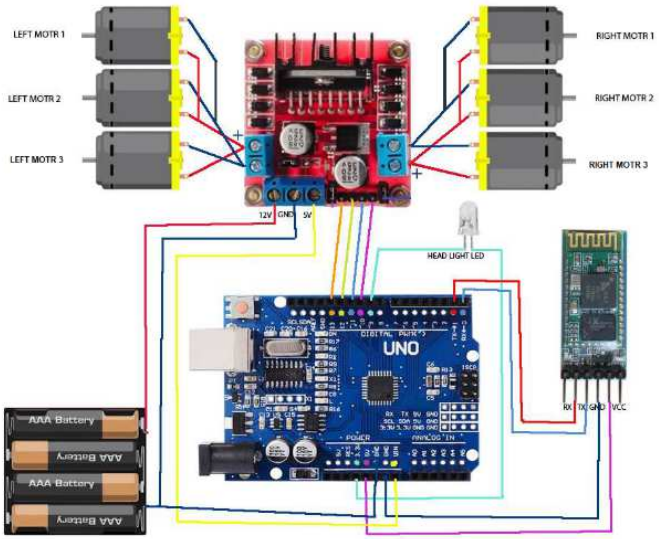

Figure 2: Circuit diagram of the DC wheel motors

Bluetooth Communication

An AVR Atmega328 microcontroller will be used to construct an HC-05 Bluetooth based Android Mobile controlled wireless robot. Here, we'll utilize the Android phone as an input device to control the motor's movement in various directions. The HC-05 Bluetooth Module communicates with Android devices through Bluetooth, while the Atmega328 Microcontroller communicates with the HC-05 Bluetooth Module via the UART serial communication protocol. Bluetooth is used to link the Android Mobile to the HC-05 Bluetooth module. It is possible to use a Bluetooth terminal app on an Android phone to operate the HC-05 Bluetooth module by entering an input signal from the Android phone's Bluetooth. Received control signals are sent to the Atmega328 microcontroller via UART from the HC-05 Bluetooth module Control signals are received and processed by a microcontroller (L298), which then sends a control signal to the robot's DC Motor Driver (L298) as shown in fig 2, which in turn communicates the robot's intended motion direction to an Android mobile phone. The robot may be driven in any direction by pressing the forward, backward, left, right, and stop buttons on the keyboard. Controlling the servos for motions such as raising and lowering an arm, and opening or closing an arm are all made possible via the usage of signals through an Android app.

The Robotic Arm

For the purposes of this article, "robotic arm" as shown in fig. 3, refers to a sort of mechanical arm that can be programmed and has comparable capabilities to a human arm. In an articulated robot, the joints connecting the manipulator's links enable it to rotate. In a linear manipulator, the joints allow it to translate. A kinematic chain is formed by the manipulator's linkages. The end effector of the manipulator is akin to the human hand, and it serves as the end of the kinematic chain. In a standard robotic arm, there are seven metal segments and six joints that connect each one. Each joint of the robot is controlled by a separate servo motor that is rotated by the Android device. An expert in remote handling technology has created the disarming robot for tough and risky duties. With the help of lithium ion batteries, this device can function totally on its own. The manipulator arm's low center of gravity allows it to safely lift 25 lbs. In this project, bombs are disposed of using this device.

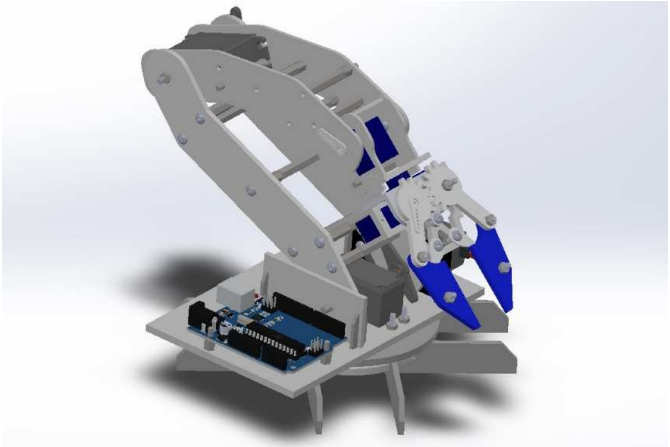

Figure3: A Robotic Arm

Here is a visual representation of the robot arm overall control function in fig. 4. Cameras keep an eye on the robot arm, which can pick up and dump explosives wirelessly, and the device is operated by Bluetooth. The Arduino controls all of the robot's components, including the motor drivers, servo motor drivers, wireless A/V cameras, and Bluetooth modules.

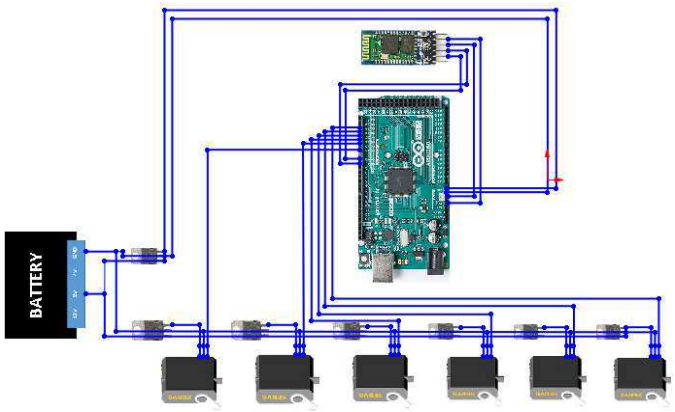

Figure 4: Circuit diagram of the Robot Arm Servo motors.

Mechanism of the Rocker-Bogie

Rocker-Bogie mechanisms are the most common linking mechanisms for a six-wheeled robot. The Rocker-primary Bogie's frame includes two 'rocker or rover' linkages on each side as shown in fig 5. To one end of the rocker, a little linkage known as "Bogie" is attached. Bogie refers to the front and center wheels, respectively. Rocker and bogie are connected to passive joint so that all six wheels are constantly in touch with ground.

The Rocker-Bogie approach was used to maneuver the robot on all terrain surfaces and allow it to climb steps of roughly 5 to 8cms in height. Both the Rover and the Bogie steps are included in this approach. An extraterrestrial remote control Rover is a vehicle designed for hard terrain travel. There are several applications for robotic rovers in the realms of science, exploration, and defense. A six-wheeled Rocker-Bogie Suspension system will let the rover avoid obstacles more easily. " Obstacles that aren't movable aren't a problem for this vehicle. Using a Bluetooth-enabled remote control, the rover receives commands. Whenever one rocker rises, the other rocker descends at the same time. For both rockers, the chassis extends the common pitch angle. The driving wheel is attached to one end of a rocker, and the Bogie is attached to the other end. The links with a driving wheel at the other end are referred to as "Bogies" in the industry. The suspension has three wheels on each side, with a symmetrical configuration. Links connect two of the three wheels on either side of the rotor. As a railway wagon suspension part, the primary linkage, called a rocker, has two joints, one of which is attached to the front wheel and the other to another linkage, called a bogie.

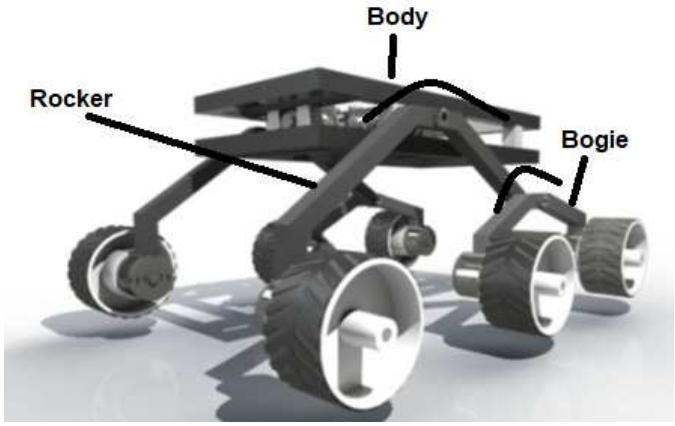

Figure 5: Rocker-Bogie Suspension,

4. RESULT

The All-Terrain Offensive and Defensive Robot was successfully implemented. Using the technology, the robot may now move left or right, go forward or backward, or just remain in the same place it was before.

Benefits and Usefulness:

1. Good traction
2. All-terrain robot with weight expansion capability
3. Low power consumption
4. Wireless control (Bluetooth)

Applications

In the military, bombs and other explosives may be discarded, and other goods can be transported using this method.

5. CONCLUSION

The mobile robot with Rocker-Bogie suspension has been finished, and its functioning has been tested and determined to be accurate. The report outlines the step-by-step method that culminated in a robotic research platform. The key distinguishing aspect of this is a soft catching arm. We know that when dealing with an explosive object such as a bomb, it will be handled easily. The maximum weight that this model can support is determined on the capacity of the DC Servo motors employed. The Wireless Bomb Disposal Robot was created to satisfy the demands of the bomb disposal unit, the Army, the police, and the personnel who work with radioactive materials. This will help to remodel the nation's discriminating shield against rebellions and terrorists. The primary goal of this study is accomplished since the created system is highly exact and precise in operation, as well as cost-effective. With such technology, squads may detect the barrage as soon as possible and dismantle it in a comfortable manner, allowing human lives to be spared simply. It detects the sent signal and controls the robot in forward, backward, left turn, and right turn motions. It also enables viewers to precisely

observe what is presently occurring in the immediate region. Considering the intricacy of previous circuits, the circuit built for this is simple. This design methodology may now be used in a variety of applications in difficult locations and circumstances. It may, for example, be utilized by squad soldiers as well as for dealing with mines. Furthermore, certain applications may be connected to espionage in hostage situations.

FUTURE SCOPE

1. The robot may be improved by integrating wireless cameras, night-vision cameras, explosive detectors, and other devices to help it discover explosives and provide correct eyesight support.
2. The power limitations may be solved by charging the batteries using solar panels.
3. Sensors may be utilized to automatically identify obstructions and stop to weep a buzzer for notification, so avoiding accidents.

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