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Solar Rover Boat

Mr. Sahil R Nikam
Department of ElectronicsEngineering
Universal College of Engineering, Vasai (Kaman), India

Mr. Aakash J Jadhav
Department of Electronics Engineering
Universal College of Engineering, Vasai (Kaman), India

Mrs. Purva D Sawant
Department of Electronics Engineering
Universal College of Engineering, Vasai (Kaman), India

HoD. Kaveri Sawant
Department of Electronics &
Telecommunication Engineering
Universal College of Engineering, Vasai (Kaman), India

Prof. Sampada Pimple
Department of Electronics &
Telecommunication Engineering
Universal College of Engineering, Vasai (Kaman), India

Abstract: *This project is about implementing a Solar-Powered Rover which is capable of maneuverer on land as well as on water. This rover can be driven on land like a car and can float on water using its floatation devices and with the attached flaps on the wheels, it is capable of steering. Since this is a surveillance project, it has a Wireless Camera on-board with a flashlight to light up the area in front of it and its onboard electronics will be powered by a Lithium Battery pack; which will be charged by the solar cells mounted on the top of it. The Robot can also conduct spy operations by infiltrating into the enemy's territory through rivers or land.*
It will work on abandoned areas where humans are restricted to enter or human life is too risky to be sent. This project was inspired while reading about surveillance and terror threat that come from abandoned cities or wastelands due to some accidents like the Chernobyl Incident of 1986 or the Fukushima Daiichi disaster of 2011. Such contaminated places are harder for security personnel to keep an eye on due to the risk of their lives, but similar to a gold mine for Black Market Salvagers who salvage things like catalytic converters of unused cars. To counteract such problems, a robot that can walk through such an area, and is manually controlled by security officers from a safer distance is an adequate solution.
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I. Introduction:

Technology in the field of surveillance and security has improved drastically due to improvements in camera technology and the introduction of Facial Detection which is most widely used in many corporate surveillance purposes.

All this is fantastic in keeping a busy area under secure monitoring, there are quite a few abandoned areas or locality which are usually monitored by security cameras, but since they can't eliminate the creation of 'Blind Spots' and assigning security personnel is risky as well as non-reliable. Also, depending on the reason for being abandoned, which can be due to any toxic or radioactive incident, sending men can be harmful and can even pose a risk of spread of contamination.

Such places are prime locations for a lot of black-marketing operations like extortion, salvaging/dumpster diving, etc. Hence, they need to be under heavy monitoring at all costs. Some locations like Pripyat City of Chernobyl or Fukushima Daichi are the best examples of places where such things happen. It is

also noted by some research that car parts from such exclusion zone areas are sold on the black market and hence posing the risk of spreading radioactive contamination.

So, on these considerations, we have come up with our problem statement;

1. Coming up with a system that can overcome the Blind Spot issue of traditional cameras.
2. The system should be operated easily without any special training.
3. Cover places like Land and Rivers
4. Longer Run time

II. Overview of Rover's Operation:

The main idea of this project is to design some kind of robot which is capable of manoeuvring on land. Since such a robot should also cross rivers to keep an eye on the surface of the water, it should have a system that can make it float.

Such technique was used by "American Sherman Tanks" in World War 2 during 'Normandy Landings', also known as the D-Day on 6th June 1944. There, they added a floatation screen on the outer side of the tank and two propellers in the back to make the tank float in open waters or rivers. It was designed by Nicholas Straussler and had three variants; DD Valentine, DD Sherman and DD M-10 Tank Destroyer. But this technique was not since, during simulations and development, they were tested in a river and controlled environment but during the attack, the open seas flooded the insides of the tanks and hence half of the battalion was drowned in the sea.

Sherman DD (Duplex Drive) amphibious tank with waterproof float screens. When in the water the float screen was raised and the rear propellers came into operation.

In our project, we decided on building a rover chassis that will be able to float on river water using a few swimming floatation devices usually used in swimming training. This rover will have an IoT based control system, which means that a WiFi signal of enough coverage will be able to make it in range instead of developing a new specialized RF transmitter. The controller will be any Android or IOS device with the IoT app to control the rover. The control system will be simple as controlling a toy robot and hence there is no need for any specialized training.

The Rover will mound a Solar Panel System that can charge the onboard battery unit and help it run day and night. The motors are Gear DC motors that produce enough torque to climb a few obstacles. The navigation of the rover will be done by the wheels that have a few fins/paddles that can help it navigate on water. Once it is out of the water, the wheels make contact with the ground (the paddles will not interfere on land) and walk on land just like a normal rover.

There is also an onboard WiFi camera that will send the live feed of the rover and also houses a bright light that will illuminate anything in front of it. An onboard GPS module will also send its live location to the operator if the in-camera stops working suspiciously or is required to be traced if any problem occurred.

The system is a 4-wheel drive robot with cuboidal chassis. This chassis will have 4 wheels controlled individually with each high-torque DC motor. The wheels are 6 inches in diameter giving plenty of ground clearance underneath. The wheels will have a paddle-like structure which will help to push water to navigate in water.

Rear view of a Sherman DD with its screen raised, showing the twin propellers in their lowered position

III. Proposed System

A. Description of system

Our system is basically a Rover which will have 4 wheels; basically a 4-wheel drive robot which have attached fins on either side of the wheels. When on Land, the wheels will make contact on the ground and swill be responsible for movement on land. On water, the fins will rotate and basically push water causing the motion which is similar to that of the land. Since our used wheels are also hollow plastic, they will also create buoyancy in water as well increasing the payload capacity. To add more buoyancy, we used a swimming kick board; usually used for swimming training and was acquired from scrap from a swimming training center near one of the team member's localities. There is also a bicycle tire tube attached to increase the lifting which was salvaged from a scrap bicycle.

The control electronics are based on an Arduino Nano, built around the ATMega328P microcontroller. The Arduino is connected to an ESP8266 WiFi Module to grab the WiFi signal to connect itself to an internet connection. The Arduino will be running an IoT sketch (Program) which will take command from the controlling device which will be an Android device connected to the internet. The output of the Arduino is connected to a relay bank to control the motors in either direction and to a MOSFET to control the LED flashlight. There is also a GPS module to send the necessary GPS coordinates to the controller.

The onboard camera which is the ESP32 Cam Board will connect to the WiFi as well and send the live video feed to the controller. This Camera will be housed on the top to record what's in the front of the rover.

The Solar panel will be housed on the top to gather solar energy. The power generated goes into a Solar Charger which will regulate the power from the panel to be charged by the battery. Once the battery is charged, if the energy is enough, the rover could be driven with just the solar power directly.

B. Working:

The working can be divided into two segments since there is an Electrical/Electronic Side and Mechanical Side.

- Mechanical Side

There are four wheels on either side of the rover. These wheels were salvaged from a kid's tricycle for free. They are always hollow from the inside to make them light weight, but there are also holes to them for some reasons which we were not able to find. We sealed those holes using 2 Component Hardener called "M-Seal" usually used for plumbing which made them airtight. The stock holes were 7mm diameter, so we used a 16mm Mild Steel Rod, turned it on the lathe to make a drive shaft. We attached this drive shaft on the wheel permanently using 2 component adhesives. On the inside, we mounted the DC Motors and added flexible aluminium shaft couplers usually used in 3D Printers to connect Lead Screw to Stepper Motor. This coupler couples the motor shaft to the Mild Steel Drive Shaft. The configuration of the motor is such that the Left Side motors are in sync and Right-Side motors are in sync.

- Electrical Side

On the electrical side, to drive this motor, we had two options, one was to use 4 different H-Bridges made of MOSFETs for each motor and build the Motor driver from scratch. But since this was time consuming and most importantly, a non-reliable costly method, we used an 8 Channel Relay Bank which we salvaged from one of our Mini Projects of Home Automation. This relay bank can easily drive 4 motors individually and is easy to control.

This relay bank is controlled by two types of control PCBs we designed for this project.

- The first PCB was the initial iteration where we used an Arduino Nano Microcontroller in combination with ESP-01 WiFi module and run an IoT script from BLYNK IoT Platform. In this way we can control the robot using WiFi and Smartphone as controller.
- The second PCB was a more developed edition where we used an Arduino Nano Microcontroller as well but as a receiver, we used a FlySky R-6 Receiver module usually used with FlySky RC Controllers for drone. The transmitter was a FlySky FS-T6 Controller which approximate range of 1Km.

All these PCBs have a Boost Converter to control front and Back lights as well. To power the control board, there is a 2S2P battery pack. To power the motors, there is another 3S2P Battery Pack. These both Battery Packs are Li-ION Technology. There is also a solar panel on top of the rover. This solar panel is a 20W panel with open circuit voltage of 20V and Short Circuit Current of 1A. The Output of the panel directly connects to the charge controller's Solar Panel terminal side. The Battery terminal is directly connected to the Charge side of the Battey's BMS which then safely charges the battery. The Load side of the BMS then powers the motor driver and driving the motors simultaneously. The charge controller also charges the control board's Battery pack.

These is also a GPS Module onboard to provide GPS Location using IoT as well as a ESP32 Camera Module which sends live video feed using WiFi.

IV. Components:

- Solar Panel: The utilized solar panel is a 20W Panel with rated Open Circuit Voltage of 20W and Short Circuit current of 1A.
- Charge Controller: The charge controller is a PWM Technology charge controller to efficiently charge the Battery packs.
- Camera: The used camera is a ESP32 Camera Board with integrated WiFi and Bluetooth, as well as a MicroSD card slot for offline recording. One of our team mate's close friends provided they had it laying around useless.
- GPS Module: It is a NEO-6M UART GPS Module which grabs live GPS feed and display it on Blynk IOT app on Google Maps. It was salvaged from one of our team mate's mini projects.
- Relay Bank: The Relay Bank is an 8-Channel Relay bank with operating voltage of 5V. This was salvaged from earlier Mini Project on Home Automation.
- RC Controller: The utilized RC Controller is FlySky FS-T6 transmitter and FlySky R6 Receiver usually used for Drones and RC Planes etc.
- WiFi Module: We used an ESP-01 board to connect the utilized microcontroller to Internet to connect to an Internet of Things network
- Arduino: We used an Arduino Microcontroller development board's version Nano; which is based around ATMega328P Microcontroller, since it is easy to integrate on a prototype dotted board for initial prototype build. It can also be soldered permanently and hence avoids loose connection.
- LEDs: There are total 4 LEDs; a pair of two White 1.5W LED as front Headlight and a pair of two Red 1.5W LEDs as tail lights.
- Motors: The Motors are Johnson Gear Brushed DC Motors with 5Kg Torque each and 100RPM.
- Battery Pack: All the batteries were salvaged from Laptop's Battery pack and useless power banks. The two custom battery packs are;
  - 2S2P battery pack
  - 3S2P battery pack

V. Conclusion:

Hence when this rover is implemented in a real-world situation, the majority of the drawbacks caused by traditional surveillance methods are solved. Such rovers are suitable for guarding places like military bases, sensitive events, exclusion zones, etc. Due to its solar capabilities and the fact that it is capable of manoeuvring on land and water which is the majority of the conditions it will encounter, this rover will prove its usefulness in the field of security and surveillance. Following are some of its snaps on Land and Water.

The Test Video of the project is uploaded on our YouTube Channel "SAPTronics"

Link: https://youtu.be/SY_w15uuPjo

Movement on Water

Movement on Land

Footage of On-board Camera

Reference:

[1]. "Autonomous Solar-Powered Rover" by YouTube channel 'rctestflight' (Link - https://youtu.be/nv2FbwjIZRE)

[2]. Documentary about D-Day Amphibious Sherman Tanks, "D-Day In HD: The Allies Secret Weapon Is a Failure" by HistoryTV (Link https://youtu.be/MYckxfxqPhc)

[3]. Tutorial/Lesson on Solar Panels, "Electronic Basics #29: Solar Panel & Charge Controller" by GreatScottlLabs (Link - https://youtu.be/sU-hSFFwSmo)

[4]. Advanced Theory for DC Motors, "Brushed DC Motors and How to Drive Them" by Electroboom (Link - https://youtu.be/yO9xIVv8ryc)

[5]. Information on using Blynk IoT platform from official Blynk's YouTube channel (Link - https://www.youtube.com/c/blynk)

[6]. Tutorial on using SolidWorks, "SOLIDWORKS: Become a Certified Associate Today (CSWA)" on Udemy; created by Tayseer (Link - https://www.udemy.com/course/solidwokrs-go-from-nothing-tocertified-associate-level/)

[7]. Amphibian Subterranean Robot for Mine Exploration, by Atanu Maity, Somajyoti Majumder and Dip Narayan Ray (November 2013)

[8]. Locomotive strategies for Amphibious Robots - A Review, By MohammedRafeeq,Siti FauziahToha,SalmiahAhmad &MohdAsyraf Razib (February 2021)

[9]. Means for Imparting Buoyancy to Vehicles (US2390747A), By NicholasStraussler (March 1942)

[10]. Modular Design and Initial Gait Study for an Amphibian Robotic Turtle, by K. H. Low,ChunlinZhou, T. W.Ong &Junzhi Yu (May 2008)

[11]. Outdoor Navigation with a Spherical Amphibious Robot, by ViktorKaznov &MattiasSeeman (December 2010)