A Review of Surveillance Type Mobile Robotic System

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Abstract—*In the present work,serial communication has been established between a drone(quadcopter) and a bot(6 wheeled land rover).Raspberry-piis installed on drone and Arduino on bot,serially communicating using bluetooth module.The above setup is capable of avoiding obstacles with the drone capable of sending pictures to a PC hence also acting as a surveillance system.This has a large potential in the field of defence,mines and rescue operations.*

Keywords— *Drone,Rocker-bogie bot,SerialCommunication,Arduino,Raspberry-pi,ArdupilotPixhawk.*

I.INTRODUCTION

A **drone** is a flying robot that can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems, working in conjunction with onboard sensors and GPS.

A quadcopter, or multirotor, drone, or quadrotor, is a simple flying mechanical vehicle that has four arms, and in each arm there is a motor attached to a propeller.Multicopters with three, six or eight arms are also possible, but work on the same principal as a quadcopter. Two of the rotors turn clockwise, while the other two turn counter clockwise.Quadcopters are aerodynamically unstable and require a flight computer or flight controller to convert your input commands into commands that change the RPMs of the propellers to produce the desired motion.
Six wheel bot having rocker-bogie mechanism is used due to the inherent design advantages which is explained in depth in further sections.
Serial communication is a communication technique used in telecommunications wherein data transfer occurs by transmitting data one bit at a time in a sequential order over a computer bus or a communication channel. It is the simplest form of communication between a sender and a receiver.
Because of the synchronization difficulties involved in parallel communication, along with cable cost, serial communication is considered best for long-distance communication.
In the context of our project serial communication has been established between the drone and the bot using two microprocessors, Arduino and Raspberry-pi.
The surface of Earth is never plain but full of obstacles and hilly terrain. It becomes very difficult to see what lies beyond those obstacles.
If we attempt to make the bot reach from point A to point B(situated beyond obstacles) it would be difficult to determine the optimum path based on trial and error.Time consuming, inefficient and a tedious task.
Implementing the drone-bot system in the above scenario will help achieve multiple purposes which are mentioned in the applications section.

A. Objectives:

The statement of the dissertation work is as follows:"Todevelop an automated autonomous robot system capable of activating the drone on encounter with an obstacle and subsequently bypassing the obstacle".
On encountering the obstacle,the drone which is seated on top of the bot gets a command from thebot to take off.Operator is able to inspect the obstacle as well as surrounding by images/video transferred on a PC by the camera installed on the drone.Subsequently the drone comes back and lands on thebot.The bot then avoids the obstacle with the help of proximity sensors.

RELATED WORK:

There are many outdoor robotic applications where a robot must reach a goalposition or explore an area without previous knowledge of the environment around it. The ground robot is able to navigate in an unknown largeenvironment aided by visual feedback from a camera on board the aerial robot.At thesame time, theobstacles are mapped in real-time by putting together the information fromthe camera and the positioning system of the ground robot[1].In the present work automated guidedmobile robot gain information about theenvironment from sensors, the microcontroller usesthis information to activate all actuators.Autonomous vehicle operates in areas which areharmful to human or too small to enter.The CMOScamera is used for vision based applications[2]. Two automatedobstacle avoiding robots are designed as master andslave robot. To establish the communication betweenmaster and slave Bluetooth has been used.Interfacings and programming of motor drives,microcontroller and sensors has been done usingArduino-mega as it is easy to program and supportsalmost many important features[3]. The primary mechanical feature of the rocker bogiedesignis its drive train simplicity, which is accomplished by using only two motors for mobility. Both motorsare locatedinside the body where thermal variation is kept to a minimum, increasing reliability and efficiency[4].Using CAD software the design of the rover has been fine tuned and byexperimenting with prototypes and models of the rover in the experimental setup of the live test, improvements and featurewere included into the Geo-survey rover. The result of the project was the implementation of independent directional controlutilizing minimum drive modules which increases the efficiency of the battery and increases the operating time of the rover[5]. The need to develop a highly stable suspension system capable of operating in multi terrain surfaceswhile keeping all the wheels in contact with the ground. The design has a mechanism that can traverse terrainswhere the left and right rockers individually climb different obstacles[6].The flight controller used isPixhawk2 was originally designed for the quadcopter3DR Solo, while a standalone version was later released. It is130 built on the PX4 FMUv3 and designed by the Pixhawk communityin collaboration with 3D Robotics. The form factor haschanged into a cube, which features triple redundant IMUs, twobarometers andthe ability to connect up to three GNSS modules.The cube connects to a carrier board through a single135 DF17 connector. The standard carrier board provides severalIOs, similar to the original Pixhawk mentioned above. In addition,a version of the carrier board is available which has an interfacefor the Intel Edison, which is meant to run as a companioncomputer. Other companion computers can be connected140 through theIOs. A derivative of the Pixhawk 2, called PixhawkMini has been made, which is an evolution of the Pixfalcon[7].Sensors connected to the Raspberry Picommunicates with raspberry pi onground bot station using wirelessZigbee technology. In this experiment, live sensor data is transmitted overzigbeechan-nel and receivedusing zigbee receiver and graph can be displayed at Ubuntu laptop.[8]

II.DESIGN

A major limitation of helicopters is the need for extensive, and costly, maintenance for reliable operation. Unmanned Air Vehicle (UAV) rotorcraft are no exception. Simplifying the mechanical structure of such craft clearly produces logistical benefits. Quadrotors are an alternative form of rotorcraft which do not have the complicated swashplates and linkages found in conventional designs, and instead use varying rotor speeds to manoeuvre. Due to the great reduction of mechanical complexity and wear, it is expected that well-designed quadrotors will prove inherently more robust and reliable.

Extensive research has been conducted till now on quadrotor drones therefore variants of it are available in market. Readymade drones as well as drone parts can be purchased having standard dimensions, specifications, material, etc. For our project we chose to buy already available drone components with standard dimensions in the market and then we assembled it ourselves.

For the demonstration purpose we have designed a CAD model. Software used for design: SolidWorks 2016

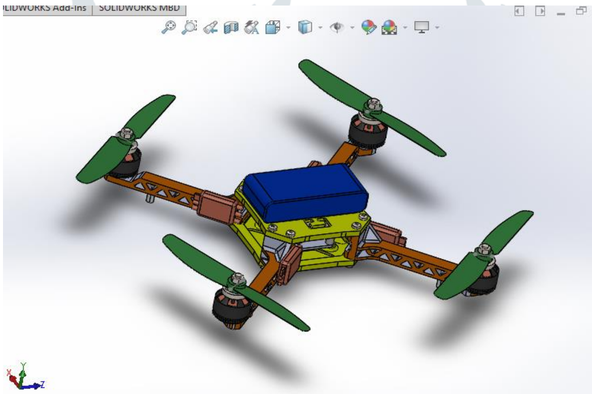

Fig1.Quadcoptor Design in Solidworks

DESIGN SPECIFICATIONS:

1. Chassis Size (Distance between diagonal endpoints): 450mm

2. Propeller Size: 10in x 4.5in

3. Estimated Weight of Drone: 2-2.5kg

1) MOBILE ROBOT:

2.1) Types of wheeled mobile robots:

The mobile robots which are generally used for different applications are as follows:
1. Land-based wheeled robot
2. Land-based tracked robot
3. Land-based legged robot
4. Air-based: plane, helicopter, blimp
5. Water-based; boat, submarine
6. Misc. and combination robot
5. Stationary robot (arm, manipulator etc.)

Land-based wheeled robot can be further classified according to number wheels as:
1. 2 wheeled bot / self balancing bot
2. 4 wheeled bot (most widely used)
3. 6 wheeled bot

For our project we are using a 6 wheeled bot with rocker bogie mechanism. A rocker bogie mechanism robot has inherent design advantages than a 4 wheel bot.

ROCKER BOGIE MECHANISM MOBILE ROBOT:

The Rocker-Bogie system has been the suspension arrangement used in the Mars rovers. It is currently NASA's favoured design. The term “rocker” comes from the rocking aspect of the larger links on each side of the suspension system. These rockers are connected to each other and the vehicle chassis through a differential. Relative to the chassis, when one rocker goes up, the other goes down. The chassis maintains the average pitch angle of both rockers. One end of a rocker is fitted with a drive wheel and the other end is pivoted to a bogie. The term “bogie” refers to the links that have a drive wheel at each end. Robots using rocker bogie mechanismmakes use of a suspension mechanism that consists of several rigid elements connected through joints of a certain number of degrees of freedom (DOF) resulting in a structure that has one system DOF. This enables them to move along uneven terrain without losing contact with the ground. The suspension has 6 wheels with symmetric structure for both sides. Each side has 3wheels which are connected to each other two with links. The main linkage called rocker has 2 joints while first joint is connected to front wheel, the other joint is assembled to another linkage called bogie, which is similar to train wagon suspension member.

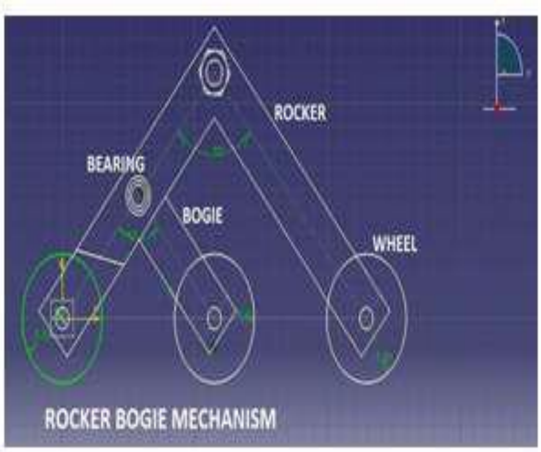

Fig2. Nomenclature

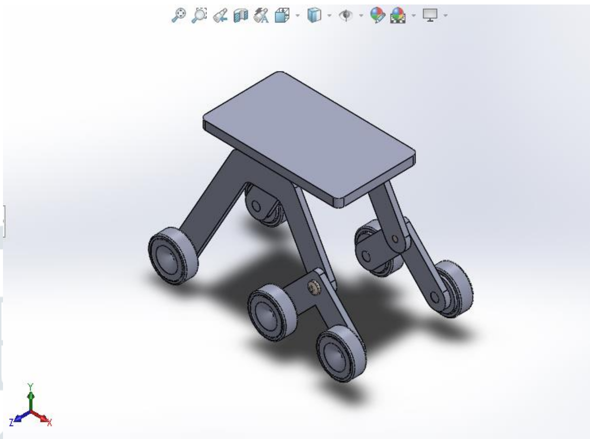

Fig3. CAD Design of robot

Advantages of Rocker bogie mechanism bot:

1. Load on each wheel is nearly identical.
2. Has no axles or springs which helps to maintain equal traction force on all the wheels.
3. Can climb over blocks twice the height of the wheel while keeping all 6 wheels on the ground.
4. Each wheel can individually lift almost the entire mass.
5. Distributing the weight and drive torque to six wheels instead of four, gives the rover greater traction and stability. For designing of the robot SolidWorks 2016 software is used.

STEERING MECHANISM:

For steering of our bot we are using differential steering for its simplicity

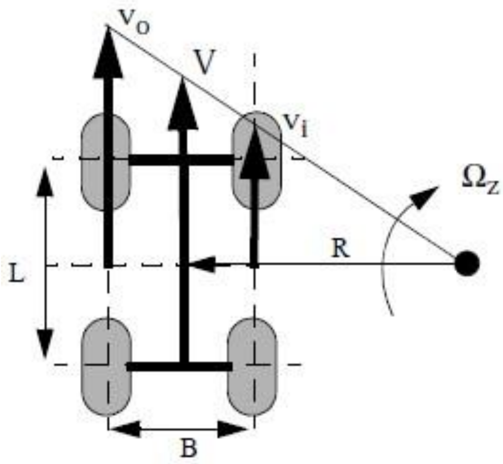

Fig4. Differential Steering

$$\frac{v_o}{v_i} = \frac{R+\frac{B}{2}}{R-\frac{B}{2}}$$

$$R= \frac{\frac{B}{2}\left(\frac{v_o}{v_i}+1\right)}{\left(\frac{v_o}{v_i}-1\right)} = \frac{B}{2}\left(\frac{v_o+v_i}{v_o-v_i}\right)$$

COMMUNICATION IN DRONE SECTION:

Communication between companion PC i.e. Raspberry-pi to the Ardupilot hardware in our case which is PixHawk Autopilot is done using MAVlink protocolwhich usesMAVproxy commands which is an Opensource project.
We are supervising everything using our laptop i.e. Ground Control Station QGC station on laptop to the Raspberry-pi using MAVlink protocol.
Connection of raspberry-pi is done by SSH(Telnet client) to the laptop on same Wi-Fi network to send commands if needed.
For programming the code we are using DRONEKIT in Raspberry-pi using python programming language which converts python commands to MAVlink commands.
Currently we are using the SITL (**S**oftware **I**n**T**he **L**oop) drone for testing our codes.

CONCLUSION:

A hybrid robotic system can been designed and implemented in order to provide a safe navigation system forUGV, using the aerial image from a camera onboard the UAV, as oneof the source of information about the environment and another being the sensor data which is onboard the UGV. Hence obstacles can be successfully detected and avoided using our collaborative robotics concept.

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