Works
of Fengxiaoxiao Li

- **Self Introduction**
- **Academic Experience & Works**

Background

Fengxiaoxiao Li | 2003.8 | Anhui,China

Educational Background

University of Electronic Science and Technology of China (UESTC)

- BEng in Aircraft Control and Information Engineering
- GPA: 3.74/4.0 08/2021 - present
- Rank: 19.04% (4/21)

Academic Experience:

- All-terrain Foldable Multi-legged Exploration Robot (Supervisor: Prof. Zhengwei Wang)
- Modular Classified Controlled Sounding Rocket (Supervisor: Prof. Hui Li)
- Formation Control and Cooperative Reconnaissance Planning of Multi-UAV Systems (Surpervisor: Dr. Mengji Shi)

Awards

UESTC **Outstanding** Student Scholarship in **2022 &2023**

UESTC College Students' Innovative Entrepreneurial Training Plan Program Yunhui Scholarship **(top 7%)**

Multi-Legged All-Terrain Exploration Robot

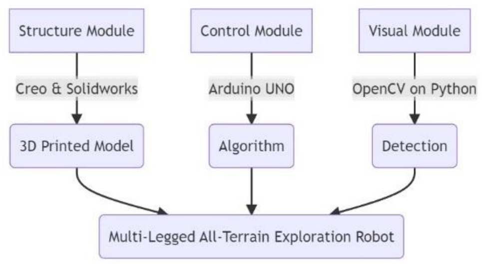
Fengxiaoxiao Li ,Chenyu Zhang, Guodi Xia, Qianqian Huang, Xiangyu Cheng

Zhenwei Science and Technology Co. Ltd, University of Electronic Science and Technology of China, Chengdu, China

Abstract

In current extraterrestrial exploration, particularly in lunar and extreme terrain conditions on Earth, common wheeled robots encounter issues such as high friction, challenging steering, and floating dust. In response to these challenges, this paper proposes a multi-legged robot that reduces friction with the ground and achieves easy steering. The design of the linkage mechanism was based on arthropod's movement patterns, which was modeled and simulated using Creo, controlled by Arduino, and integrated with a vision module developed through Python's OpenCV platform and esp32cam kit. Ultimately, a remotely operated multi-legged exploration robot with image feedback was designed. This design offers a novel approach for exploration equipment under special terrain conditions and paves the way for unmanned exploration in a wider range of scenarios.

Composition



Structure Module

The robot mainly consists of the body, the intelligent interaction module, six legs and the steering mechanism.

The main structure of the body is two parallel and opposite hollow flat plates connected by a rotational axis. The body houses a power unit and a controller, and is equipped with a microcontroller and a Bluetooth module on the surface for interaction. A camera is mounted on the bracket extending from the top of the body. The leg mechanism is designed as six mirrored parts symmetrically distributed on both sides of the body, utilizing a linkage mechanism (specifically, a six-bar linkage).

Due to the superior performance of the legged structure, the robot can naturally overcome obstacles during travel. By repeating this cycle, the robot can achieve forward and backward movement.

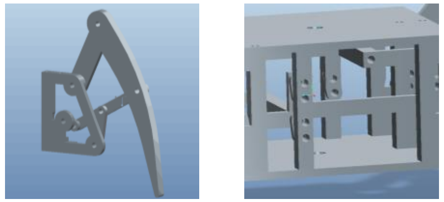


Fig. Detector partial structure

Control Module

The control algorithm, which is based on Arduino UNO, includes the pace input of the movement, and the robot's response to different scenarios
(acceleration, deceleration, steering, emergency stop). The driving power of the robot is provided by two two-phase 57 stepping motors, and the wiring mode of the stepping motor has also become a problem to be considered. In addition, the basic procedure requires that the external keys can control the positive reversal of the motor, accelerate the deceleration and stop. In the wiring of the controller, this design adopts the common cathode wiring method.

During motion, two motors control the movement of both groups of legs simultaneously. And if it were to shift the direction of the motion, the robot merely have to manipulate the steering motor to rotate to a certain angle.

Fig. 57 Stepper motor and TB6600 drive

Visual Module

The visual recognition section developed based on Opencv enables the probe robot to have object recognition capabilities, which can recognize and classify objects around it through visual sensors and image processing algorithms. It can recognize specific objects and act accordingly as needed. This function is of great significance in applications such as search and rescue, patrol and safety monitoring.

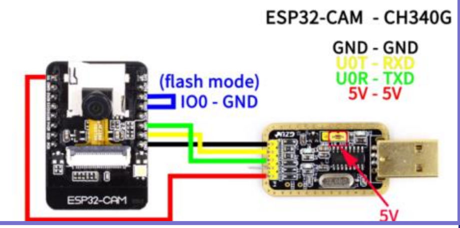


Fig. ESP32-CAM Module wiring diagram

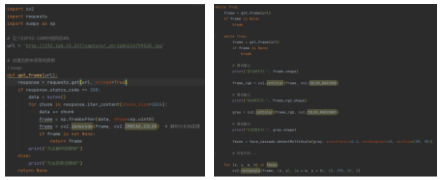


Fig. Partial code of recognition

Result

The robot designed ultimately has a total length of 74.85~80.85cm (including the legs), a body length of 30.00cm (not including the legs), a total width of 25.00cm, and a height of 33.50cm (not including the camera).

Given the current advancement of multi-legged robots, this design holds substantial potential for further development and practical implementation.

Fig. Overall robot structure

Fig. Expected application scenario

Modular Classified Controlled Sounding Rocket

Fengxiaoxiao LI, & Group of Sounding Rocket in SAA

Univ. of Electronic Science and Technology of China , School of Aeronautics and Astronautics , Department of Aeronautical and Astronautical Engineering , Chendu ,China

Introduction

- Sounding rocket, as the only field exploration tool in near space, has been widely used in space weather forecast, middle and upper atmosphere research and material processing under microgravity conditions

- **Market** Background
  - Sounding rockets are developing towards the trend of small carrying and commercialization, but they are in the early stage of commercialization and the market scale is small
  - Most of the rocket models have fewer iterations, simple product structure, high customization, poor versatility, and can only meet a single scenario

- The independent design of a strong versatility, cost-effective, popular science, for the public model rocket has become the design direction and research focus

Methods – Subjects & Processing

- Model building
  - Modeling and iteration of rocket arrow body with solidworks modeling software
- Avionics system design
  - Drawing circuit boards according to the control requirements for rocket navigation
- Control algorithm designing
  - Master the tail control rotation parameters through aerodynamic analysis, write the control algorithm based on this and download it in the circuit board

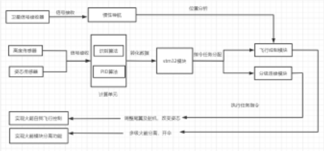


Fig. Technical approach

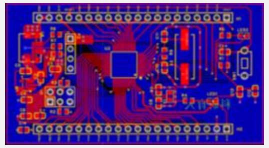


Fig. System core board

Model of the Rocket Body

Model of the rocket body includes

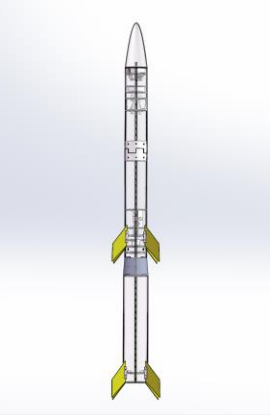


Fig. Main body model

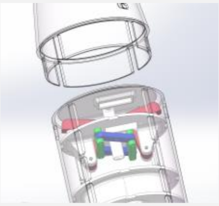


Fig. Open parachute structurel

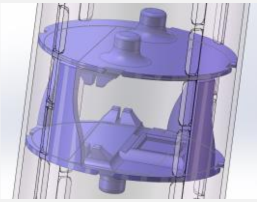


Fig.Avionics system granary

Fig. Separation mechanism

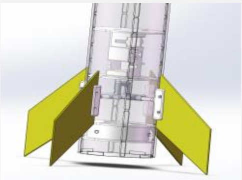


Fig. Controllable rear wing

Real-time Data Transmission from Sensors

- The position, attitude, temperature, **pitch angle**, **roll angle**, **yaw angle** and other parameters of the rocket are obtained in real time through the sensor

Fig. Sensor data feedback

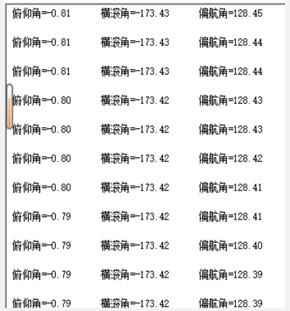


Fig. Pitch angle, roll angle, yaw angle

Results -Rocket Flight Simulation

The whole process of rocket launch, acceleration, flight, and separation is simulated by computer to predict the trajectory, speed, altitude and other parameters of the actual launch of the rocket

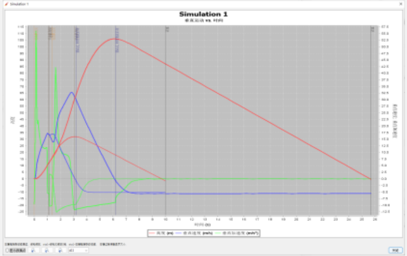


Fig. Rocket Flight Simulation

Conclusions & Future Reaserch

- The model controlled sounding rocket can adjust its attitude and release the parachute stably according to the demand of **opening height**

- According to the attitude of the rocket, the ten-axis sensor controls the tail of the rocket, so as to achieve a certain attitude correction. At the same time, if the attitude cannot be corrected (**the deviation is about 55°**), the head cone is controlled to pop out to complete the parachute opening

- Optimize the design of the **parachute opening structure**
  Design a more stable and simple parachute opening structure

Awards & References

- **Modular Classified Controlled Sounding Rocket** won the UESTC College Students' Innovative Entrepreneurial Training Plan Program Yunhui Scholarship (**Top 7 %**)

[1] ZHANG Shuliang, ZHU Jinlong, HE Yinsheng, et al.Launch device of uncontrolled sounding rocket [J].China Space Science and Technology,1982(05):6-15.

[2] He Li. Research and Development of Production Equipment for PCB and Its Application in China [J]. China Integrated Circuit, 2018,27 (07): 83-85.

This summer
Let's run towards dreams together!