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Design of Intelligent Inspection Scheme Combining UAV and Intelligent Vehicle

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Abstract

Intelligent patrol inspection plays an important role in power grid construction. This scheme proposed a new type of electric power inspection way. Using the unique advantages of Unmanned Aerial Vehicle (UAV), the dual system of UAV and intelligent vehicle is combined to carry out electric patrol inspection. In high voltage substations, give priority to with smart car checking power meter. In the field work, we use drones to realize the detection of high voltage power lines. The scheme can greatly reduce the manpower and improve the detection efficiency.

Keywords

UAV; Instrument Detection; One Car More than One Machine; High Voltage Line Inspection.

1. Introduction

Where there is equipment and transmission lines, power inspectors will go. But Traditional detection methods have some shortcomings. High-voltage transmission lines linked to the outfield frame will inevitably be affected by the natural surroundings and cause responsibility, but the wide range of transmission lines makes it impossible for inspection personnel to quickly and accurately find the fault range. Intelligent detection is a key to solve the problem.

Based on the above problems and requirements, a new power inspection mode is designed. This system is designed based on micro controller RT1061 carrying uav system of electric power inspection smart car. The Unmanned Aerial Vehicle (UAV) system is mainly used to detect the high voltage transmission network during field work. The smart car is designed with crawler wheels. Considering the scope of high-voltage power grid, the smart car can carry multiple UAVs. The dual system coordination of UAV and intelligent vehicle can realize large-scale detection. Substation in the inspection of the body is smart car, carrying infrared tube, high-definition cameras, image processor, etc., according to the desired trajectory, automatically avoid obstacles, achieve image acquisition of electric meter. Checking with automatically generated inspection report, upload the first machine, inspection personnel to its remote real-time monitoring. The smart car system has good flexibility, mobility and all-weather properties.

2. System workflow

Start the smart car. An infrared tracking module symmetrically mounted on the front of the bottom plate starts to look for black tracks. When a black line is detected, the SCM generates an 8-bit PWM wave. The turbine drive motor adapts the direction and speed of the intelligent car by using the feedback signal got from the SCM, so that it moves along the predetermined black track. At the same time, the HC-SR04 ultrasonic module in front of the bottom plate sends ultrasonic signals to

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accomplish obstacle avoidance. When inspecting electric instrument in high-voltage substation, intelligent car is matched with camera to collect instrument image and obtain instrument value. When arrived at field working point, the microcontroller sends a take-off signal to the drone, and the inspection UAV mounted on the intelligent vehicle will fly along their respective flight routes and conduct positioning and autonomous cruise along the power grid. The parasite is equipped with Hall sensors to discover damage to high-voltage power lines. Two kinds of work situations of testing signal can be sent via wireless communication module is the highest place machine. The system flow chart is shown in Figure 1.

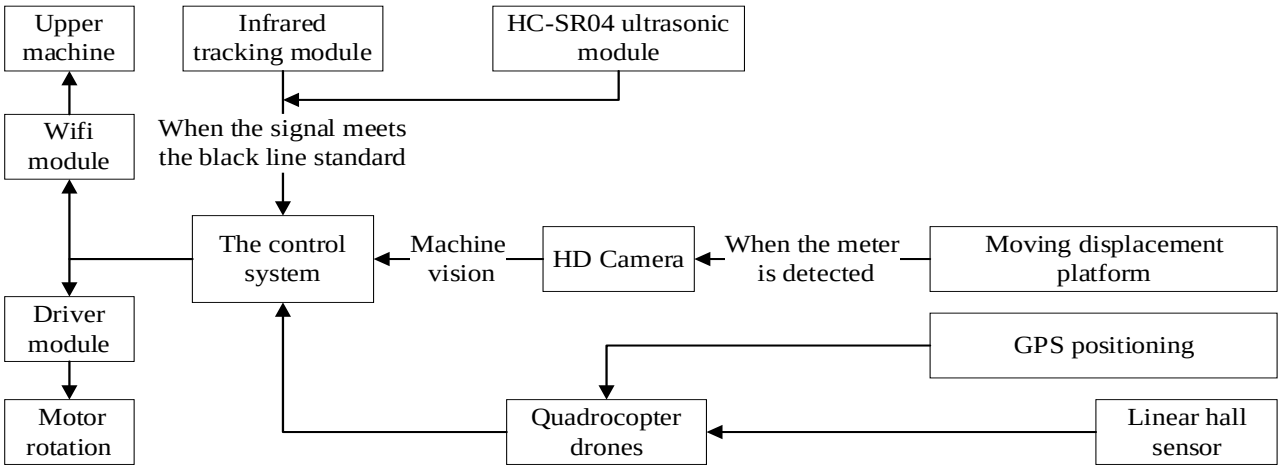

Fig. 1 System flow chart

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3. Mechanical structure design of UAV

Considering the vehicle volume, carrying capacity, detection range and parking stability, the fuselage shell and parking platform of the UAV are specially designed. The intelligent car adopts crawler wheels and is made of titanium alloy material, which can be effectively applied to field work. The car plate with removable lightweight transparent panel, as parking the unmanned aerial vehicle platform. This panel has a certain distance with the car chassis, used for the installation of microcontroller, camera and other components. The fuselage of the quadrotor UAV is composed of a symmetrical cross-shaped steel body. The fuselage is covered with a protective mesh that protects the wings and allows for a floor-to-floor arrangement on lightweight panels. The effect plan of the protecting cover is indicated in Figure 2.

The outer frame of the aircraft can carry multiple UAVs in one car and inspect multiple high-voltage power transmission and transformation areas at one time. This design can effectively improve the inspection efficiency. On the smart car's lightweight panels, the drones are stacked. An additional shield prevents the upper and lower drones from interacting with each other. The floor layout is indicated in Figure 3.

Fig. 2 Effect drawing of protective cover2

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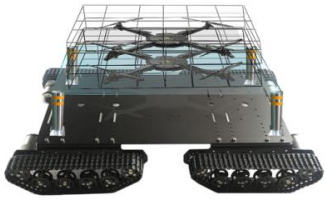

Fig. 3 Floor layout concept drawing

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4. Hardware Design

The chief equipment of the system is the RT1061 microcontroller. The system mainly includes image acquisition and processing module, automatic patrol obstacle avoidance module, quadrotor UAV system, linear Hall sensor module and so on [1]. The overall design is indicated in Figure 4.

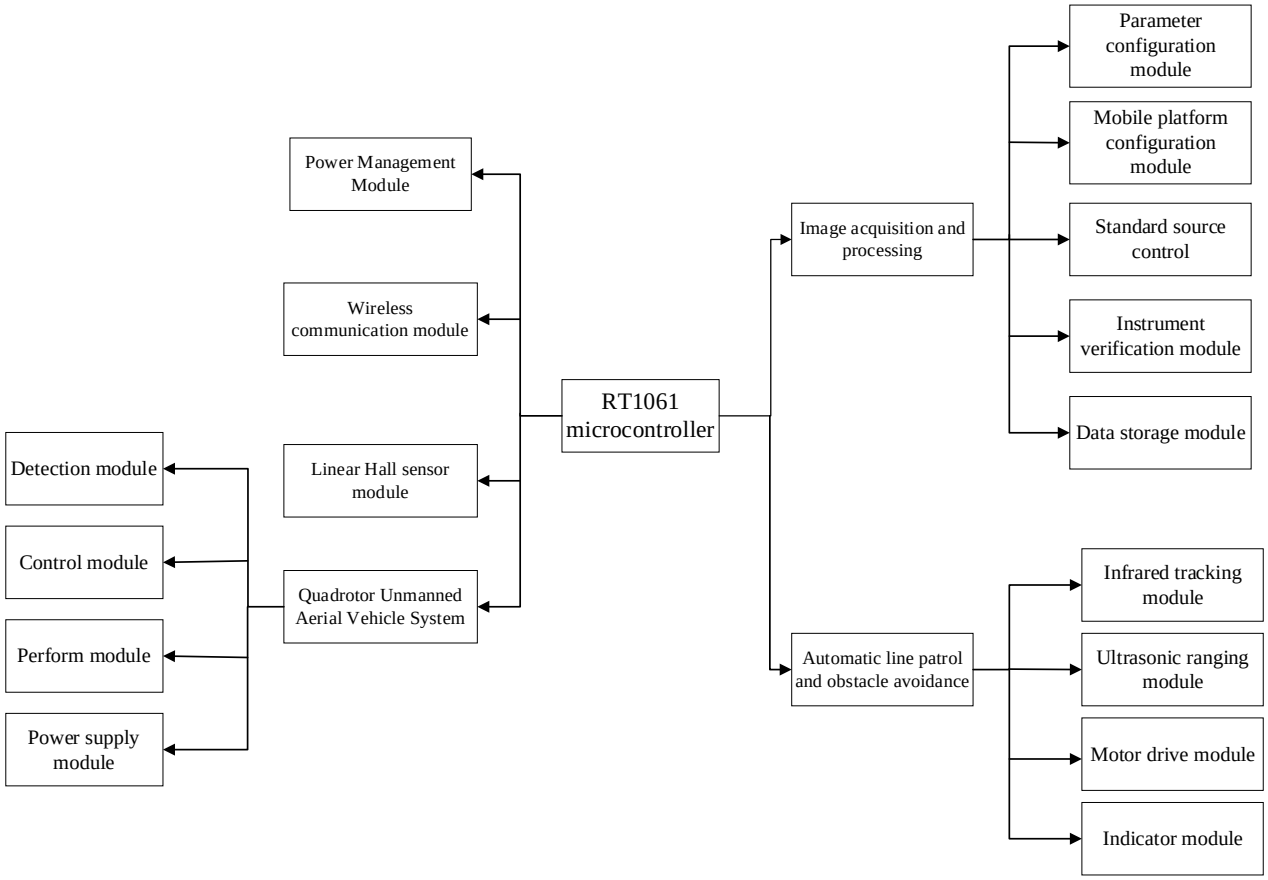

Fig. 4 Overall architecture diagram

4

4.1 Automatic line finding and obstacle avoidance design

It is composed of two groups of infrared tube, voltage comparison core, potentiometer and status indicator light on the bottom plate of the trolley. The RPR220 sensor is symmetrically installed on the bottom plate of the trolley to prevent the dead Angle of line inspection.

The patrol track is black. Because black has a small reflectivity to light, it can be judged by comparing the voltage core to determine whether it meets the standard. When the detaching trajectory is detected, the MCU sends the driving signal to the driving module [2]. After amplification, the signal can drive the motor to turn left or right, so that the intelligent car can adjust its direction in time. Thus the car automatic tracking is realized.

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4.2 Quadrotor UAV system

The GPS positioning system enables the drone to locate and cruise autonomously along the power grid. Hall sensors can change the attractive meadow around the high voltage course into the corresponding voltage signal. The SCM scales the voltage signal through the hardware circuit. The conversion value is compared with the normal value for the same distance of the high voltage line. This can tell if the high voltage line is damaged.

4.3 Ultrasonic ranging module

HC-SR04 ultrasonic module is used to realize obstacle detection. An ultrasonic transmitter sends an ultrasonic signal and clocks it. The ultrasonic wave will come back at once when it encounters an obstacle. The receiver quits the clock when it gets the reflected signals [3]. By multiplying time by the ultrasonic velocity, we can get the distance between the car and the obstacle. When the measured distance reaches the obstacle avoidance condition, the smart car starts to turn left or right.

4.4 Wireless communication module

Smart car through Bluetooth module or WiFi module, through the signal amplification device, can realize the smart car and mobile phone or computer long-distance interconnection and real-time information transmission.

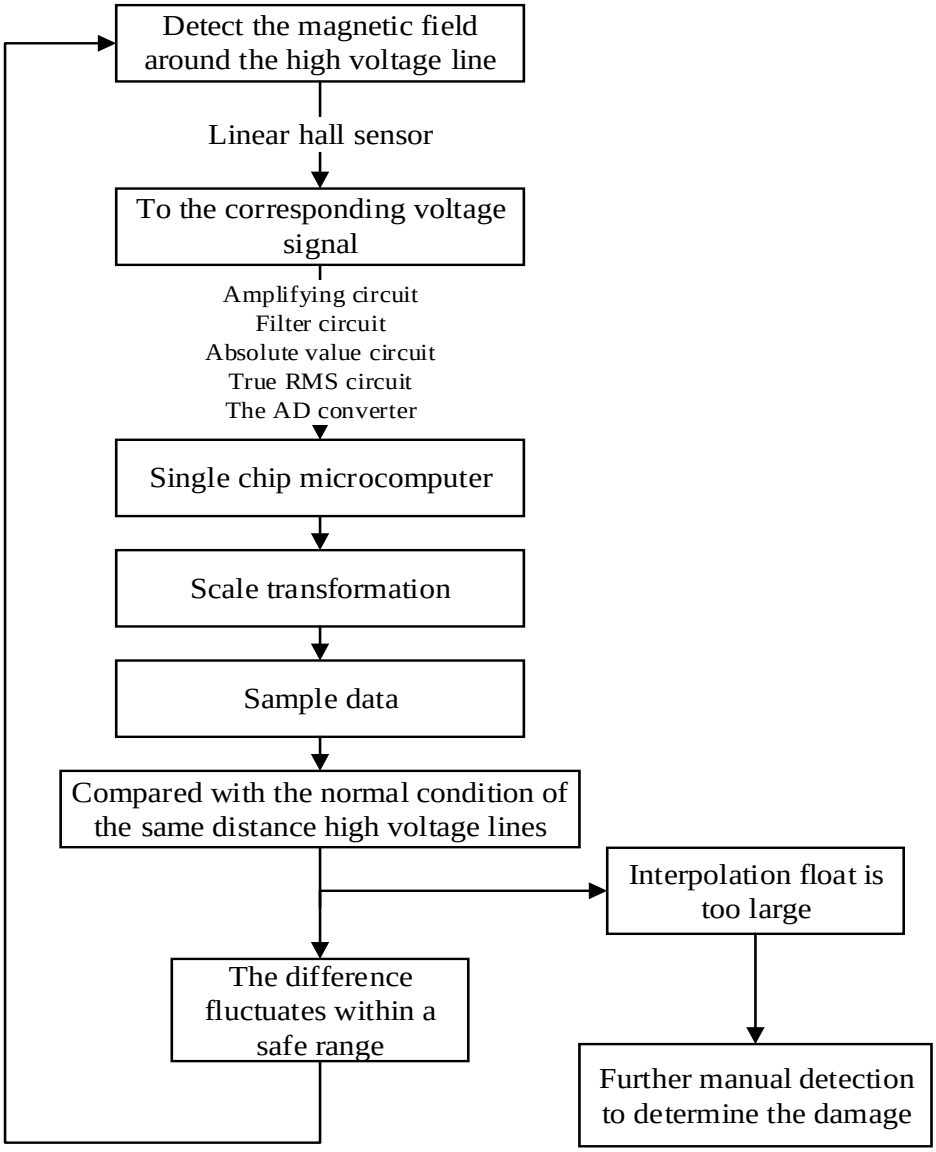

Fig. 5 Flow chart of Hall sensor detection

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5. Software module

5.1 Software design of linear Hall sensor

Hall sensor can transform the magnetic field around the high tension line into the corresponding voltage signal. The voltage signal is further processed by amplifier circuit, filter circuit, absolute value circuit, true RMS circuit and AD converter circuit [4]. The microcontroller scales the processed voltage signal to obtain a value. This value is compared with the normal value of the high voltage wire at the same distance . If the difference between the two is found to float within the safe range, there is no problem with the high voltage wire [5]. If the difference between the two is too large, the damage of the high voltage line will be further determined by manual detection. The flow chart is shown in Figure 5.5

5.2 Instrument software plan of image acquisition

Displacement of the mobile platform to drive mobile visual system, can realize the position of the camera [6]. When the power meter appears in front of the camera, the camera captures the image. Instrument testing flow chart as shown in 6.

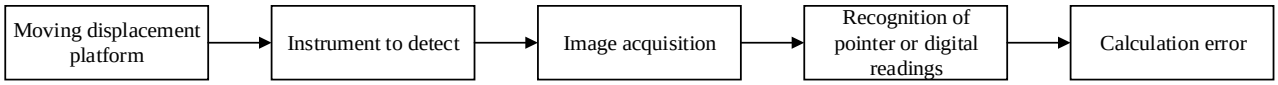

Fig. 6 Flow chart of instrument testing

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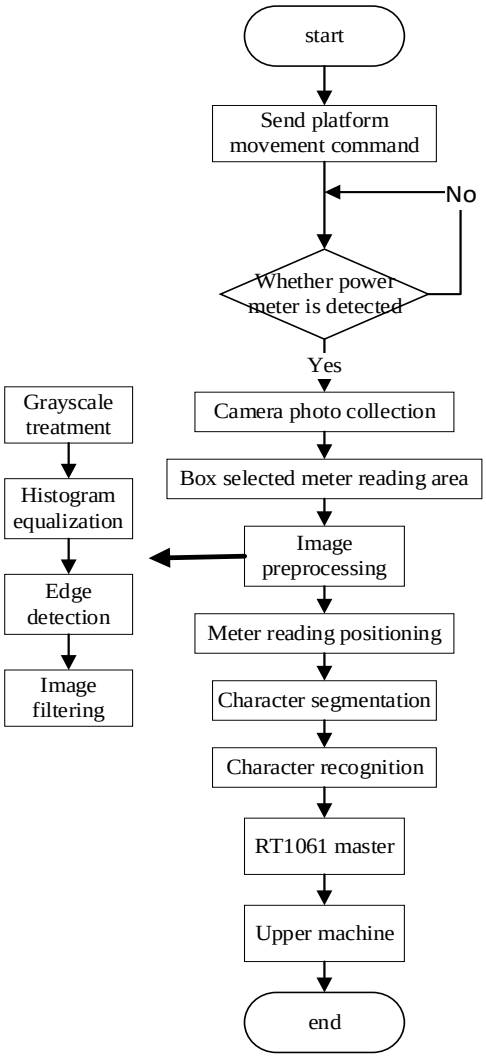

Fig. 7 Image processing flow chart

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For the collected instrument photos, we use the method of pattern recognition to judge the type of modified instrument. Image processing instrument for collecting photos can get the meter reading [7-8]. The camera will send the recognized instrument value to the main control chip of RT1061 through serial communication. The software flow is shown in Figure 7.7

6. Conclusion

UAV with the combination of the intelligent vehicle detection is a new type of intelligent detection way. High voltage substation adopts camera to collect instrument pictures and obtain instrument values through image processing. Intelligent vehicle patrol inspection according to the preset trajectory can effectively reduce human input; In field work, the dual system of UAV and intelligent vehicle is combined for patrol inspection. Linear hall components can effectively detect high tension line magnetic field condition to determine the line damage. It can be seen that this scheme can make operation more efficient and troubleshooting range more accurate. It meets the requirement of intelligent patrol examination.

Acknowledgments

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References

[1] Li K. Quick automatic focusing method and image acquisition apparatus:, US20150124155[P]. 2015.

[2] Qin Z, Wang K, Wang S, et al. Wireless earth magnetic induction detection system for vehicle and its installation method[J]. US, 2013.

[3] Ushanandhini M, Rajesh S, Rajakani M. [IEEE 2016 10th International Conference on Intelligent Systems and Control (ISCO) -Coimbatore, India (2016.1.7-2016.1.8)] 2016 10th International Conference on Intelligent Systems and Control (ISCO) -Wavelet based semisupervised learning for satellite i[J]. 2016:1-6.

[4] Dong B Z, Li D H. Design and Implementation of Digital Piezoelectric Constant Testing System[J]. Applied Mechanics and Materials, 2014, 668-669: 911-915.

[5] Linxin Li. The UAV intelligent inspection of transmission lines [A]. in:Curran Associates, Inc.. 2015 International conference on advances in mechanical engineering and industrial: AMEII 2015, Zhengzhou, Henan, China, April 11-12, 2015, Part 1 of 3[C]. 2015.186-189.

[6] Daniel Rosner, Cristiana Trifu, Cristian Tranca, Iuliu Vasilescu, Florin Stancu. Magnetic Field Sensor for UAV Power Line Acquisition and Tracking [A]. in: Institute of Electrical and Electronics Engineers.2018 17th RoEduNet Conference: Networking in Education and Research: RoEduNet 2018, Cluj-Napoca, Romania, 6-8 September 2018 [C]. 2018.1-5.

[7] Jingjing Zhang, Liang Liu, Binhai Wang, Xiguang Chen, Qian Wang, Tianru Zheng. High speed Automatic Power Line Detection and Tracking for a UAV-Based Inspection [A]. in: American Journal of Engineering and Technology Research. Proceedings of the 2011 international conference on opto-electronics engineering and information science. part 1[C]. 2011.378-381.

[8] Lamyae Fahmani, Jamila Garfaf, Khalid Boukhdir, Siham Benhadoul, Hicham Medromi. Unmanned Aerial Vehicles Inspection for Overhead High Voltage Transmission Lines [A]. in:Institute of Electrical and Electronics Engineers. 2020 1st International Conference on Innovative Research in Applied Science, Engineering and Technology: 1st International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET), 16-19 April 2020, Meknes, Morocco[C]. 2020.1-7.