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Design of the inspection system for power tower poles based on UAV and NB-IOT

Zixiu Zou[1], Jinlong Xie [2], Hua Zheng [3], Longtian Fu [4], Xiaobin Lin [5, *]

[1]Fuzhou Institute of Technology, Fujian, China, 350506

[2]Hunan Institute of Modern Logistics Vocational and Technology, Hunan, China, 410131

[3]Beijing Huaxin Chuanghe Technology Co. Ltd., Beijin, China,100011

[4]FuZhou University of International Studies and Trade, Fuzhou, China,350202

[5]Minjiang University, Fuzhou, China,350108

Abstract: This article focuses on the difficulties faced by power tower inspections, such as many locations, wide areas, most of them far away from towns, complex terrain, and harsh natural environment. This paper proposes a design scheme for a power tower inspection system based on UAV and NB-IOT technology. The sensor status is transmitted through NB-IOT, and the UAV is used to receive real-time video streams, which are transmitted back to the server through the RSTP protocol. Practice has proved that the scheme proposed in this article has higher adaptability and can greatly save costs.
Keywords: Power tower inspection; UAV; NB-IOT.

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1. INTRODUCTION

With the rapid development of my country's economy, there are more and more ultra-high voltage and ultra-long distance transmission lines. There are many distribution points and wide areas of transmission lines. Most of them are far away from towns. The terrain is complex and the natural environment is harsh. The power lines and towers are exposed to the wild for a long time, and are caused by continuous mechanical tension, lightning flashover, material aging, and human influence. Damages such as falling towers, broken strands, wear, corrosion, stress, etc. must be repaired or replaced in time. Scholars such as Golightly I proposed in 2003 to use helicopters and video technology to inspect power lines.The method selected uses gradient computation and dissimilarity measures evaluated along the gradient to find clusters of corners, which are then aggregated to individual representative points. Results are presented for its detection and error rates,But the cost is too high [1]; Scholars such as Jones DI built a laboratory test bench for the automatic power line inspection system .The construction of a laboratory test rig is described and results for closed-loop

visual tracking are presented.The experimental platform has not been tested in practice, and its effectiveness needs further observation [2]； Scholars such as Wan S have studied the influence of 500 kV AC power line on the safe distance of helicopter inspection, and the results show that the potential difference increases as the distance between the helicopter and the transmission line decreases. Considering the guarantee of discharge energy and personal safety, the safe distance of 500 kV AC transmission line is determined to be d≥15 m. The result indicates that the potential difference becomes higher with the decrease of the distance between the helicopter and transmission line. Considering the discharge energy and the guarantee of the persons' safety, the safe distance for 500 kV ac transmission lines is determined as d ≥ 15 m [3] .Pagnano A and other scholars have proposed the use of robots to automatically complete inspections in order to solve the high cost of technical personnel driving helicopter inspection power lines with cameras installed. However, the cost of robots themselves is also very high[4] . Power line inspections have generated a lot of data. Scholars such as Martinez C introduced a processing software, explaining the entire process of data processing and automatic generation of inspection reports [5] . Scholars such as Alhassan AB introduced in the article the development progress of climbing robots and flying robots in power line inspection, and made detailed comparative analysis and analysis. They believed that the capacity of on-board battery is limited, the line fault detection is unreliable, electromagnetic shielding, deicing mechanism and wind Challenges such as disturbance control technology are comprehensive problems faced by robots [6]. This article avoids the high cost of technical personnel driving a helicopter with a camera for inspections, and also avoids the high cost of automatic inspection robots, then proposes a cheap solution, that is, using drones and NB- Inspection method combined with IoT.

2. NB-IOT

In May 2014, Huawei proposed the narrowband technology NB M2M. In May 2015, it merged with NB OFDMA to form NB-CIoT; in July of the same year, NB-LTE and NB-CIoT were further merged to form NB-IoT, and in June 2016 freeze. NB-IoT is an emerging technology in the IoT field. NB-IoT is an important branch of the Internet. It is built on cellular networks and consumes only about 180kHz of bandwidth. NB-IoT supports long standby time (the device battery life can be used for at least 10 years). NB-IoT can be directly deployed on the GSM network, UMTS network or LTE network to reduce deployment costs and achieve smooth upgrades.

NB-IoT has four major characteristics: one is wide coverage, which will provide improved indoor coverage. In the same frequency band, NB-IoT has a gain of 20dB compared to the existing network, which is equivalent to an increase in the capacity of the coverage area by 100 times; With the ability to support connections, NB-IoT can support 100,000 connections in one sector, supporting low latency sensitivity, ultra-low equipment costs, low equipment power consumption and optimized network architecture; the third is lower power consumption, NB -The standby time of IoT terminal modules can be as long as 10 years; fourth is the lower module cost, and the company expects that a single connected module does not exceed US$5. Because NB-IoT has its own advantages of low power consumption, wide coverage, low cost, and large capacity, it can be widely used in a variety of vertical industries, such as remote meter reading, asset tracking, smart parking, and smart agriculture.

3. POWER TOWER INSPECTION BASED ON DRONE AND NB-IOT

In this paper, the use of drones and NB-IOT narrowband Internet of Things technology can effectively solve the many shortcomings of traditional manual inspections. Through the intelligent flight platform of drones, combined with high-definition integrated pan/tilt camera and image transmission system, the inspection line can be realized. Real-time image transmission, combined with the NB-IoT module and data acquisition system, can realize real-time data collection, which can effectively solve the traditional manual inspection workload, complex working conditions, variable natural environment, high risk factor of night inspection and long time-consuming , High cost, great difficulty, high risk and many other problems. The design scheme of the power tower inspection system based on UAV and NB-IOT narrowband Internet of Things technology, as shown in Figure 1.

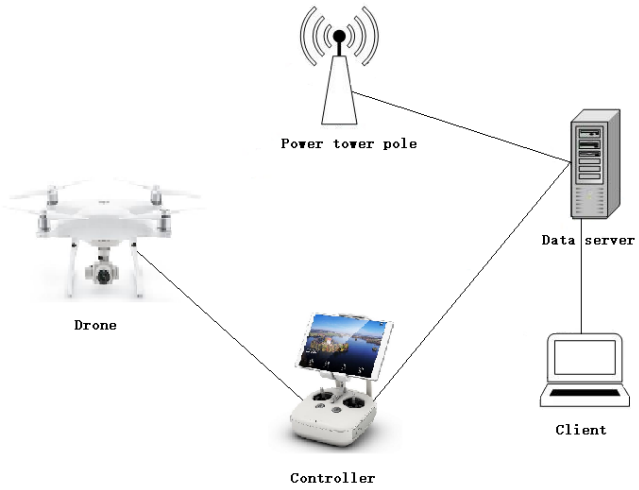

Figure1. Architecture diagram

As shown in Figure 1, various sensors (such as temperature and humidity meters) are installed on the tower poles to collect various detection status data. These data are transmitted to the data service through the NB-IoT network; because the number of towers nationwide is too large. Many, it is impossible to install sensors on every tower pole, and the cost of installing sensors on all tower poles is very high. Therefore, as an alternative, drones are used to assist inspections to understand the conditions of tower poles and power lines. UAV technicians arrive near the tower pole to fly the UAV, and control the UAV through the remote control. The UAV and the remote control realize real-time transmission of video images through 2.4G band wireless communication; the remote control is equipped with a mobile phone SIM Card, through the telecommunications network of the SIM card to transmit the real-time picture back to the server, the client obtains the real-time picture through the server, and the client can also communicate with the remote controller in real-time voice to direct the drone technicians to control the drone, such as requiring no one Move the camera to the left and right to perform close-up shooting in order to get a clearer picture.

4. SYSTEM DESIGN AND IMPLEMENTATION

This system mainly includes two aspects of data transmission, one is the transmission of the status information of the sensors installed in the tower pole, and the other is the transmission of the video stream taken by the camera carried by the drone.

(1) State information transmission, generally speaking, the sensor has a built-in network interface, which includes two transmission mechanisms: synchronous transmission and asynchronous transmission. This article uses asynchronous transmission, that is, first set the normal value range, server IP address, receiving port, and transmission bit rate on the sensor. If the value of the sensor exceeds the normal range, the data will be sent according to the machine indicated by the configured IP address, and after reaching the designated machine, it will be stored in the interface of AxFKREALSVRLib._DFKRealSvrEvents_OnReceiveGLogDataEvent, and then the data will be read in the asynchronous function. Some key codes are as follows Shown.

```
private void axFKRealSvr1_OnReceiveGLogData(object sender, AxFKREALSVRLib.
_DFKRealSvrEvents_OnReceiveGLogDataEvent e)
{
  // Database operation base class library
  DBHelp db = new DBHelp();
      //insert the state value into the database
  db.Insert(e.ClientIP,e.DeviceID,e.CurrentData,e.Datetime);
}
```

(2) For video streaming, this article uses the RSTP protocol to build an RSTP service on the data server side, and push the data to the server side on the remote control side, so it involves two parts of code implementation: client push and server reception. This article uses the industry's well-known open source component ONVIF ODM to develop, some of the key codes are shown below.

```
// The client's video stream push
private void SendData(object sender,Event e)
{
  String ad = “rtsp://211.101.*.*:554/livexxxx.sdp”;
  NetworkStream ns = new NetworkStream(ad);
  ns.getStream(getDevice());
  ns.Flush();
}
// The server receives the video stream
private void ReceiveData(object sender, AxODM_OnReceiveGLogDataEvent e)
{
  String path = “***”;
  File f = new File(path); // Set video stream storage path
  NetworkStream ns = new NetworkStream();
  ns = e.Stream; // Get the video stream
  f.SaveFromStream(ns); // Store video stream
}
```

5. CONCLUSION

Compared with the use of helicopter climbing robots, flying robots, etc., this paper proposes a design plan for a power tower inspection system based on UAV and NB-IOT technology. The sensor status is transmitted through NB-IOT and the UAV is used to Receive the real-time video stream and send it back to the data server through the RSTP protocol. Practice has proved that the scheme proposed in this paper greatly saves costs.

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