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Design of Anti-collision APP System for Bridge Inspection UAV

Xinyu Huang[1], Yimin Yang[2], Juan Zhao and Yonghu Wang[3]

[1]School of Traffic and transportation, ChongQing Jiaotong University, Chongqing 40074, China

[2]School of Civil and Engineering, ChongQing Jiaotong University, Chongqing 40074, China

[3]College of Aeronautics, ChongQing Jiaotong University, Chongqing 40074, China

Abstract

Due to the special environment of wind field in bridge inspection and the complexity of bridge components affecting the normal flight of UAV, it increases the possibility of uav collision in bridge inspection. Therefore, this paper proposes an anti-collision APP for bridge detection UAV based on Android system with mobile phones as the media. Based on the genetic algorithm as the bridge detection path, numerical simulation software is used to simulate the wind field of the bridge, using finite element software, the safe flight parameters of different types of UAV in complex environment are analyzed, and environment construction and uav detection track planning are completed through Matlab,so as to improve the safety of bridge inspection UAV operation.

Keywords

Bridge Inspection; Crash Research; Path Planning.

1. Introduction

In the study of bridge inspection UAV, Jung Sung Wook [1] solved the problem of uav's limited use of GPS in harsh environment by using simultaneous positioning and mapping method based on hierarchical graph. Hidaka Kenta [2] constructed a single coordinate system through the combination of two camera images, and ensured that the UAV could be well controlled even when its own weight changed by using the adaptive control method. Sebastian Benders [3] took into account different wind conditions and flight conditions and proposed A path planning of fixed-wing UAVs based on line graph by using A* algorithm.

Through thinking, it is found that bridge detection UAV also has the following problems: 1) There is lack of further research on UAV protection, such as the influence of UAV on its safe flight in wind field environment. According to the data, one out of every three flight accidents caused by weather factors is caused by bad wind conditions [4], which increases the risk of using bridge inspection UAV. 2) The premise of using intelligent algorithm for UAV path planning is the setting of UAV safe flight parameters, so it is necessary to increase the research on uav collision in the case of out of control. Based on the above reasons, this paper proposes an Anti-collision APP for bridge detection UAV based on Android system. The safe flight parameters and optimal detection path of different types in complex environment are given to improve the possibility of applying bridge detection UAV to reality.

2. Design Functions of Bridge Detection UAV Anti-collision APP

The bridge inspection technology of quadrotor aircraft will be a trend of the development of bridge inspection technology in the future[5]. Coupled with the widely used mobile phone, it can simplify the bridge inspection work. The specific functions are as follows :

(1) The bridge detection UAV location: due to the weak GPS signal under the bridge, it is impossible to accurately locate the UAV, so when the UAV inspecting the bridge, using SLAM

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technology, to the UAV is equipped with sensors and high-definition cameras, realize the environment modeling and real time control of the UAV location positioning for operators.

(2) The bridge detection of UAV flight path planning: based on the safe flight parameters obtained by numerical simulation and UAV collision analysis, the intelligent algorithm is used to optimize and solve constraints and objective functions, and the optimized detection path is presented to users for confirmation

(3) Bridge inspection UAV collision analysis: UAV may collide due to unforeseeable factors, background management personnel needs analysis internal record data of the safety of the chip and unmanned aircraft airframe structure damage degree, in order to determine the parameters for the different type UAV flight safety, to ensure the safety of the bridge detection of UAV flight.

3. Design of Anti-collision APP System for Bridge Inspection UAV

3.1. Design of Physical Framework of Anti-Collision APP System for Bridge Detection UAV

The physical framework of the system is divided into two parts: client and server. The client is mainly used for users to query the weather, wind conditions, path selection and determine the specific location of uav. Through the network module transmission protocol, the Android client and the server are connected in series. The client initiates the request information, and the server processes the data, and feeds back the processing results.Android system through the network connection to the client and the server for data processing and feedback, by the user login interface, input basic information bridge and wind field data, the server will be on this basis, gives the bridge detection under complex environment map of UAV equivalent models, and UAV flight safety zone, the optimal path in the query interface, The server analyzes and computes the transmitted data and presents the final result to the user.

3.2. Design of Anti-collision APP System Framework for Bridge Inspection UAV

In the process of system data processing, through collection, transmission, analysis and processing, and finally feedback the results to users. The whole system consists of the following three modules: basic information module, external interface module and system management module. The specific function modules of the anti-collision APP system of bridge detection UAV see Fig. 1.

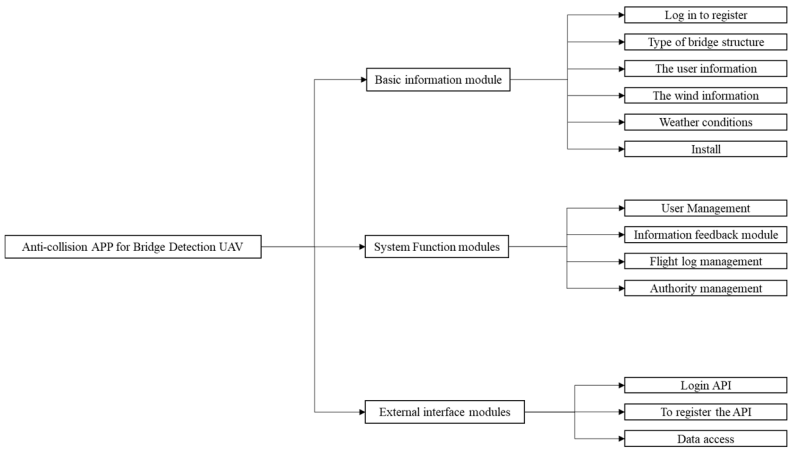

Fig 1. System structure drawing

3.3. Bridge Detection UAV Anti-collision APP System Operation Process

In this paper, the design of bridge detection UAV anti-collision APP system is as follows: According to the weather conditions to determine whether suitable for bridge detection task,

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select drone aircraft, the structure of the bridge type, input wind conditions and temperature information, the server database on the basis of given scale of wind field and the safety of UAV flight parameters, the related Bridges equivalent model is set up, and show the optimal testing path back to the mobile terminal, after waiting for the user to confirm correct can begin testing, Otherwise recalculate,see Fig. 2.

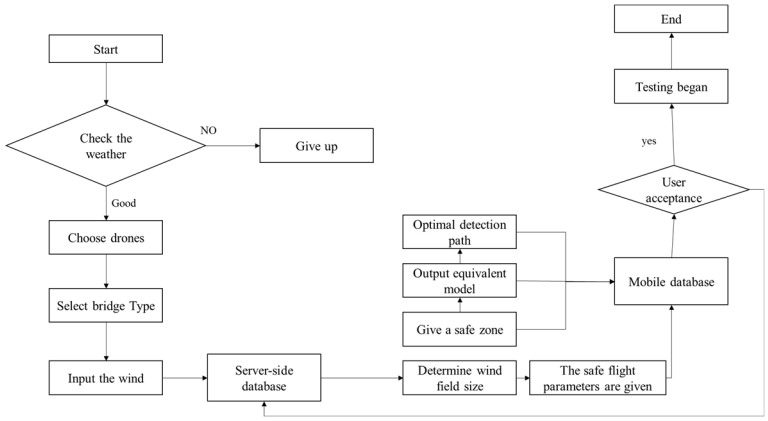

Fig 2. Mobile client operation flowchart

4. Anti-collision APP Algorithm and Simulation Analysis of Bridge Inspection UAV

4.1. Path Planning and Design of Bridge Inspection UAV based on Genetic Algorithm

The core of genetic algorithm is the selection of fitness function. Appropriate fitness function can enable individuals to evolve to a higher level population faster, that is, to choose safe path nodes faster. On the basis of considering the safe flight of UAV, the distance between nodes is minimized to obtain the optimal detection path. Therefore, the shortest path distance is taken as the fitness function in this paper. The higher the fitness value is, the shorter the distance is and the closer it is to the optimal path.

$$fitness = 1/\sum_{i=1}^{n}\sqrt{(x_{i+1}-x_i)^2+(y_{i+1}-y_i)^2+(z_{i+1}-z_i)^2} \quad (1)$$

Where, $(x_{i+1}, y_{i+1}, z_{i+1})and(x_i, y_i, z_i)$ are coordinate values of two path nodes. The fitness value is obtained by calculating the sum of distances between all nodes in a population and inverting them. After population selection, crossover and mutation, the new population is obtained and compared with the original population, and the one with high fitness value is selected until the end of iteration to obtain the optimal solution.

4.2. Analysis of UAV Collision Simulation based on IS-DYNA Finite Element Analysis

Is-dyna finite element software Is mainly used for explicit nonlinear dynamic analysis software, widely used in metal forming, impact, impact and other research, can simulate the physical characteristics of most two-dimensional and three-dimensional structures. The software can analyze the optimal safe flight parameters of different aircraft in the complex real environment. This APP mainly determines the influence of wind speed, flight speed, Angle and height on different UAV models in the case of collision, and analyzes accordingly to obtain the maximum wind speed, maximum flight height and Angle that corresponding UAV models can withstand in different environments.

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5. Conclusion

The use of UAV for bridge inspection is a trend of the development of bridge inspection technology in the future, and how to improve the flight safety of bridge inspection UAV is the key. In this paper, aiming at the shortcomings of the existing bridge inspection UAV research, the bridge inspection UAV anti-collision APP is designed. Compared with the traditional uav detection method, While shortening the bridge inspection cycle and cost, it also improves the safety and convenience of UAV inspection.

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