

Design of the Stampede Preventing Monitoring and Early Warning System Based on a Quad Rotor UAV

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ABSTRACT: In order to explore the new method for monitoring the flow of people, improve the safety management level of the crowd decentralization, and prevent the occurrence of stampede accident, we have designed this system. In this paper, the real-time video transmission and computer technology are combined to develop the monitoring equipment of the crowd, and constitute a stampede preventing monitoring and early warning system with the quadrotor unmanned aerial vehicle (UAV) flight platform. Using a quadrotor UAV to acquire video data, put the flow of people density real-time transmit to the background. The data compared with the mathematical model of early warning that we make, early warning signal is automatically calculated. With green, yellow, red warning lights and alarm to realize alarm prompt, so as to provide the basis for site manager to make decision on the spot and guidance, make emergency plans in time.

Keywords- Quadrotor UAV, Monitor, Head recognition, OpenCV, Earlywarningmodel

I. INTRODUCTION

Timely and effective diversion is the most important ways to prevent the occurrence of stampede accident. According to the news reports data of every year, the global occur hundreds of stampede each year, lead to the death of thousands of people. On July 24, 2010, the western German city of Duisburg in held ‘the love parade’ techno music festival occurred groups stampede, killed 18 people, about 80 people were injured[1]. In November 22, 2010, the Kampuchea capital Phnom Penh diamond Island, a cable-stayed bridge in the water festival occurred serious stampede accident, resulted in the death of 347 people[2]. In July 29, 2014, the Guinea capital, Conakry, near a beach in a concert occurred stampede accident, the victims of the accident reached to 33 people. December 31, 2014 night at 23:35, the Bund of Shang Hai, in Chen Yi square occurred crowded stampede accident, resulted in 36 deaths, 47 people were injured. Stampede has nothing to do with culture and race. Whether developing countries or developed countries stampede is likely to occur all over the world. Stampede accident can be avoided, the result still be caused so much tragedy.

The stampede preventing monitoring and early warning system based on a quadrotor UAV is characterized by the flow of people density. Real-time monitoring the flow of people in a distributed point or area, using video recognition technology to process video image in the monitoring area, and get the flow of people density data information in the monitoring area. Real-time detect and identify the area of security, combined with a good early warning model to get the area of the flow density level, real-time make the judgment of the flow of people congestion level, and generate the corresponding warning level information and the corresponding emergency plan. So as to ensure the high efficiency and safety of the population distribution, reduce the incidence and severity of accident.

II. The stampede preventing monitoring and early warning system based on a quadrotor UAV

The UAV is a new airborne platform, especially the quadrotor UAV. In recent years, with the maturity of the technology, it has applied in meteorological sounding, disaster monitor, environmental sensing in many fields. The quadrotor UAV has main characteristics includes the purchase of low cost, low operating cost, easy to operate, flexible and so on. According to the field situation, the quadrotor UAV can adjust the operation scheme and load equipment. It is very suitable for outdoor or indoor artificial monitoring operation. This paper designs the flow monitoring and early warning model of the head automatic identification technology, together constitute the stampede preventing monitoring and early warning system based on the quadrotor UAV.

2.1 Analysis of the stampede accident

Almost all of the stampedes occurred in the stairs, and most of them were on the corner of the stairs. Stampede occurred in more events, rally, railway stations, and other community activities more. Once the

accident occurred, almost all caused the results of casualties, and the accident is often group casualties, great harm, bad influence, high social concern.

Through the wide range access to information, according to the domestic and foreign scholars to the scientific research and analysis, the stampede accident has been the following reasons:

1. more than the critical value of the people density. In 2004 the graduation thesis, Fu-Dan University postdoctoral Zhu Chun-Xia was combined with stampede studies both at home and abroad pointed out: indoor attractions to 1 square meters/person, outdoor reached 0.75 square meters/person is the critical value of the stampede occurred, so immediately launch the emergency plan[3].

2. From the macro level analysis, the existence of the Gauss singularity is caused. In a large range, the density of the local people depends on the density of each direction and the radius of your concern. The greater radius, the average density is more uniform. But in a small range, it will produce the density is much higher than per capita density. The density distribution in space is in accord with the Gauss probability. That is to say, because of the Gauss distribution, although the overall density of only 1.7 people per square meter, if there is a point of high density, then it is easy to form a reverse nuclear fission, the people will quickly go to the point caused stampede accident. For example, in shanghai bund event, the location of the "drop dollar" is likely to form the Gauss singularity. We have to set up a lot of partition, put the area of the crowd in a small piece of the area. With the reduction of each block area, the possibility of a high density singularity of individual members in the region will be significantly decreased.

3. Relevant early warning mechanism is not sound. For example, the people in front already overcrowded, had an accident, had been unable to move, people in droves don't know the scene, continue to push forward, so the stampede was occurred. If we quickly put the video to the scene on the big screen at this time, and then accompanied by radio, notify the site management personnel, so that the behind people fast enough to get information, and no longer to aggregate a point, and timely to take diversion means, the tragedy will not expand.

Based on the above analysis, in order to prevent the accident, to control the three important factors, and make timely emergency plan. The stampede preventing monitoring and early warning system based on a quadrotor UAV is able to complete the task.

2.2 The design of technical route and system structure

In order to achieve the above functions, use high-definition camera as a monitoring device. The video data is transmitted to the ground control station by wireless data link, and the number of the population is automatically detected by the head recognition technology in the image, and completes the people density calculation, display and alarm. At the same time, in order to provide the location of the stampede event occurrence, the quadrotor UAV has been configured the global positioning system (GPS).

The stampede preventing monitoring and early warning system based on a quadrotor UAV consists of four major part module includes a quadrotor UAV module, data acquisition and display module, alarm processing module and emergency module. The system structure is shown in figure 1.

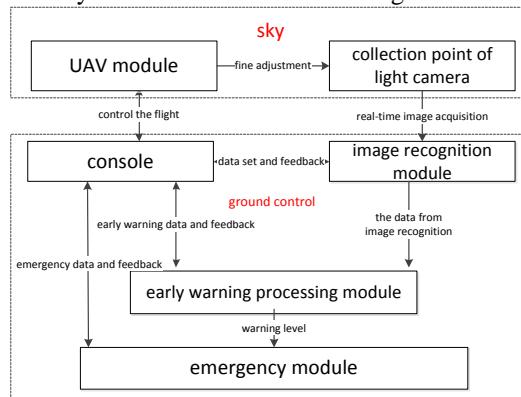


Figure 1 The structure diagram of stampede preventing monitoring and early warning system based on a quadrotor UAV

III. The realization of the quadrotor UAV monitoring and early warning system

3.1 The quadrotor UAV system

A quadrotor aircraft is a kind of "disc shaped" aircraft. It has attracted wide attention and has become a new research hotspot with novel structure layout, unique way of flight in the world [4]. The quadrotor UAV has the advantages of fixed-wing UAV is difficult to compare: the ability to adapt to all kinds of complex environment, the capability of automatic take-off and landing, the low requirements of take-off and landing place and highly intelligent, all kinds of flight attitude such as hover, fly front, side fly and inverted flight. These advantages determine the quadrotor UAV has a wider application prospect than the fixed wing UAV[5]. The biggest use of

the quadrotor UAV is to do reconnaissance, portable visible light equipment such as cameras, infrared equipment, radar equipment, etc. therefore, in the air photo and video applications, it can all be done. For example, forest fire monitoring, search and rescue, address exploration, the flow of people accident forensics, pipe line inspection/testing, filmshooting, aerial entertainment and so on. Of course, it is not a panacea, some equipment quadrotor aircraft is not brought up, and some applications quadrotor aircraft are difficult to meet the requirements of the flight radius. The flight time and load capacity limit the quadrotor aircraft market.

This system uses the Shenzhen DJquad rotor UAV as the main flight, the quad rotor UAV uses battery powered with flight stability, easy operation, long duration, can carry a portable camera, screen real-time transmission and other advantages. As shown in Figure 2.



Figure 2 Equipment figure of a quad rotor UAV

3.2 Data acquisition and display module

The module is mainly responsible for real-time image acquisition on flying area, and processing the image information collected by camera. This system is mainly based on Opencv head automatic identification software get the number of pedestrian in monitoring area, then automatically convert to real-time the flow of people density data information, and real-time display in the central console in time. The input of module is the flow of people digital image data in flying area. The output of module is critical parameters such as real-time the flow of people data, real-time the flow of people density.

A quad rotor UAV people data acquisition display module is mainly composed of airborne light HD camera and ground monitor. Airborne micro camera connected to the three-axis stabilized platform, three-axis stabilized platform and the quad rotor UAV body below fixedly connected, both flight attitude are the same. In support of the attitude sensor, it can control the stability of the pan micro camera always keep with the ground vertical axis. In the job flight, the ground station receives the video image of the airborne camera and the flight height, flight speed, GPS position and other parameters.

The function of the system includes the identification model of the image of the control room in the background, the center console of saving the UAV flight information and image data, and graphic display module that manage continuous video, abnormal flow imaging and flight parameters. In addition, the software system also includes a central console visualization of human machine interface and other basic components. The function realization of data acquisition and display module is shown in Figure 3.

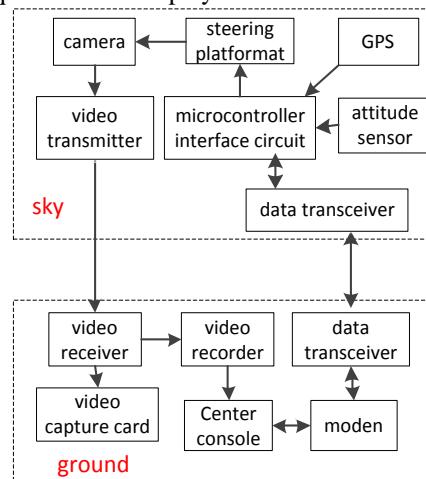


Figure 3 Realization of data acquisition and display module

3.3 Early warning processing module

The module is mainly responsible for the people data that input by the recognition and processing module comparing with the relevant data of people safety warning level, get real-time the flow of people safety state level and the corresponding early warning level. Then output the relevant warning information to the emergency module.

The flow of people density saturation early warning data: when the flow density is less than 0.5 people /m², do not need to alert, green light normally on background page. When the flow density is greater than 0.5 people /m², less than 1 people/m², need to alert, yellow light turns on in background monitoring page. When the flow density are greater than 1 people/m², less than 2 people/m², need to alert, the red light turns on and flash in the background. When the flow density are greater than 2 people/m², the red light flashing and sound alarm in the background. The upper and lower density of stream of people set by other research data, manually entered after the system starts. Detecting abnormal flow density images will be automatically recorded in the form of images, and the position of the video sync data also recorded, in order to further develop the work of identification, situation assessment, estimating the loss and improving the detection, etc. The work flow is shown in figure 4.

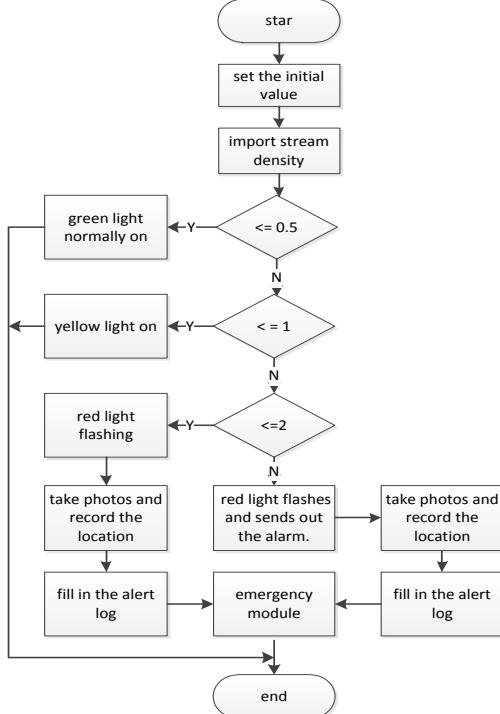


Figure 4 Work flow chart of early warning model

The input of the module includes the real-time people flow data in the reading recognition module, and the flow of people safety state level data. The output of the module is divided into early warning level information and the early warning log. Among them, the level information of early warning including specific level, the warning time, the area. The early warning log includes the time of occurrence, the dangerous area and the corresponding warning level.

The module requires the system to receive the real-time passenger flow data from the recognition module, which is a fast and accurate way to deal with the passenger flow and people density. To compare the results with the prior warning level data to generate the early warning level information and pass it to the emergency processing module.

3.4 Emergency module

The module is mainly responsible for the early warning information that according to the input from the early warning module, combined with the emergency level data input from the central console, real-time generate process strategy and notify the operator, and generate the emergency processing log.

The output of the module is divided into emergency operation instructions and emergency handling log. Among them, the emergency situation indicates that the operation personnel to take measures to eliminate the specific emergency situations, methods, etc. Emergency handling log: the document of the emergency handling information generated by the real-time recording system shall include information such as time, danger area, level of emergency information. The module is required to receive the information data of the early warning level, the data from the central console is read to match the data of the emergency response plan, and the emergency strategy is issued in time [6].

IV. Conclusion

The stampede preventing monitoring and early warning system based on a quadrotor UAV developed by using real-time video transmission and computer technology. It has small size, light weight, design

features independent and complete, a good adaptability. The use of automatic identification technology based on Opencv, the ground monitoring station can be processed to achieve real-time detection of UAV flying area. The test proved that the quadrotor UAV and monitoring equipment constitute the stampede preventing monitoring and early warning system can achieve a reduction of the occurrence of the stampede accident. With a good ability of population density detection, can detect regional anomalies and make alarm. Low running cost, simple operation, is a new security technology and equipment. Further improvement and popularization application of the system by light weight UAVpopulation monitoring will help to improve the automation level of China's monitoring, early warning and safety management of public places[7].

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