iSafeUAS: An Unmanned Aerial System for Construction Safety Inspection

Introduction

- Unmanned Aerial Systems (UASs) have recently been utilized as an efficient safety inspection and monitoring tool on the construction job sites.
- However, UAS deployment could result in hazardous situations such as worker distraction or struck-by accidents.
- This study introduces iSafeUAS as an initial effort to develop and assess a platform designed for safety inspection purposes with customized features.

Research Background, Problem, and Aim

- Several limitations were identified in the literature that could affect the usage of UASs as safety monitoring and inspection tools on the construction job sites.

Stated UAS Deployment Limitations

- FAA Flight Regulations
- Low-Quality Visual Sensors
- Struck-by Accidents
- Workers Distraction
- Signal Interferences
- Short Battery Life
- Weather Conditions
- Jobsite Obstacles
- Pilot Skills and Training Requirements

Research Method

A three-step process was implemented in this study:

iSafeUAS Design, Development, and Programming

- Body
- Navigation and Communication System
- Recovery System
- Programming

iSafeUAS Technical Performance Assessment

- Free Flight Assessment
- Autotune Calibration
- Camera Assessment
- Recovery System Assessment

iSafeUAS Real-World Safety Monitoring Application

- 1X Zoom Level
- 10X Zoom Level
- 20X Zoom Level

Technical Performance Assessment

Test

Assessment Description

Assessment Aspect

#1: Free Flight Assessment
Flying the iSafeUAS using different flight modes to assess the platform’s stability and its maximum battery life.

- Platform stability
- Flight mode functionality (i.e., stabilize, loiter, and auto modes)

#2: Autotune Calibration Assessment
Balancing iSafeUAS flight characteristics to get better inflight stability.

- Platform stability adjustment (i.e., roll, pitch)

#3: Camera Assessment
Testing the camera response during pre-programmed flight missions.

- Functionality of the RGB Camera Sensor

Indoor Simulations

- Stabilize, loiter, and function in different flight modes
- Programmed in the automatic deployment condition of the Recovery System in a controlled environment.

- Manual Recovery System deployment

Design, Development, and Programming

- No prior research has explored the UAS design and development methods that could minimize any of the presented UAS implementation challenges and associated safety risks.
- To cover this gap, this study is an initial effort to develop and assess the iSafeUAS, a UAS platform designed for safety inspection purposes with customized features such as an RGB Camera Sensor with super 30x optical zoom capabilities and a Parachute Recovery System to ensure a safe yet accurate visual data acquisition without the need to fly over or near populated areas.

Real-World Safety Monitoring Application

- iSafeUAS could reduce the onsite UAS usage risks while offering an efficient jobsite safety inspection and monitoring.

Conclusion

- Technical performance tests showed that the developed iSafeUAS can accomplish stable flights, with the proper operation of flight modes, and an appropriate amount of battery while automatically capturing visual data.
- Indoor simulations results showed that the Parachute Recovery System was responsive, capable of being triggered under both deployment methods, and reducing the accident’s impact energy and the probability of fatality.
- Case study results revealed that the enhanced iSafeUAS zoom level capabilities enabled capturing very detailed visual data from a particular jobsite location without exposing anyone to any UAS-associated fall hazards. Moreover, such detailed visual data helped safety managers identify several types of hazards at outdoor and indoor building locations that could have been otherwise difficult or impossible to detect using visual datasets with lower zoom levels.

Figure 9. Potential safety hazards identified in the visual data captured with 20X zooming capability

Graph 1: Performance Assessment