Autonomous Aerial Power Plant Inspection in GPSdenied Environments

The University of Texas at El Paso Aerospace Center

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> Crosscutting - University Training & Research 2022 **Project Review Meeting**



A Giant Leap Forward research.utep.edu/cSETR



Outline

- Introduction
- Navigation in different environments
- Flight tests at El Paso Electric
 - Outdoors
 - Indoors
 - Outdoors near substation and communication antennas
- Publications
- Other Achievements

Introduction

- GPS-Denied
- Autonomous
- Close quarter inspection



Introduction



Figure 1. Methodology of the CAM/AM-based UAV inspection in a GPS-denied environment.

Autonomous Navigation in Different Environments:





2D LIDAR

• RGB-D

1st Flight Test at El Paso Electric



Tethered Flight Test

Flight requirements:

- Low altitude (20 ft max)
- Tethered UAS
- Flight mode: Position Mode (semiautonomous)
- Maximum wind speed allowed 10 Km/hr.

3D Map of the lower section of the stack generated using photogrammetry to aid in the design of the flight path







Test Pictures





Video 1. Preparation



Vertica flight



2nd flight at El Paso Electric



Tethered Flight test

Flight requirements:

- Low altitude (20 ft max)
- Tethered UAS
- Flight mode: Position Mode (semiautonomous) and possibly fully autonomous.
- Type of environment: Indoors, dark and dusty.

Recognizance, geometric characterization and sensor performance evaluation visit



UTEP's Aerospace Center Students inside the boiler's furnace with the UAS



Preliminary results from the mapping. Light conditions make it difficult. **Solution**. On-site lights will be placed before mapping.



Reconstruction using photogrammetry





Students at the entrance of the boiler.



Students inside the boiler's furnace with the UAS



Drone ready to take off.

Test Video





Normalized Thermal image



One of the flight trajectories

3nd flight at El Paso Electric

Drone Flight Notifications - UTEP will perform an aerial inspections on the Rio Grande Powerplant Old Brick Stacks

A Safety & Reliability Drone Flight Notifications - UTEP will perform..

Drone Flight Notification

UTEP will perform close quarter aerial inspections on the Rio Grande Powerplant Old Brick Stacks on April 22nd, 2022 from 6:30 A.M. - 8:00 AM .



Outage Center Drone Elight Notifications - UTEP 1

Rio Grande Powerplant Old Brick Stacks

Archive - Drone Flight Notifications Safety Reliability Information

- Near a substation and communication antennas.

Remote Pilot In Command - 107 license 4488921

Visual Observer

Mapping



3D model with parametric information in CAD software





Drone RGB and Thermal Images



Normalized thermal image of the old stack



RGB image of the old stack

Publications 2021-2022

<i>Robotica</i> (2022), 1–24 doi:10.1017/S0263574721001570			CAMBRIDGE UNIVERSITY PRESS		 ← → C △ ● ieeexplore.ieee.org/document/3 ◆ desi ● case ◇ decla IEEE.org IEEE Xplore IEEE SA IEEE Spe 	5551409	SUBSCRIE	옥 년 ☆ 😋 承 🖬 ጰ 🗄
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Autonomous aerial flight path inspection using advanced manufacturing techniques Mousumi Rizia, Julio A. Reyes-Munoz, Angel G. Ortega, Ahsan Choudhuri and Angel Flores-Abad*					All Conferences > 2021 IEEE 17th International Conferences > 2021 IEEE 17th International A MAV Platform for Indoors and Outdoors Autonomous Navigation in GPS-denied Environments Publisher: IEEE Cite This PDF Julio A. Reyes-Munoz ; Angel Flores-Abad All Authors			Q DSEARCH More Like This Navigation of mobile robot using Global Positioning System (GPS) and obstacle avoidance system with commanded loop daisy
ISA Transactions	• UPDATE MY INFORMATION • JC MANUSCRIPT • INSTRUCTIONS FO ions Being Proces Datal submissions)	DURNAL OVERVIEW R AUTHORS • POLICIES	Role: Author	Username: afloresaba	d@utep.edu	R	esults per page 10 🗸	
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View Submis View Referer	sion ice Checking Results	ISATRANS- D-22-00176	UAV Flight Path Generation using 3D CAD Models for Close Quarter Aerial Inspection	Jan 21 2022 2:21:53:687AM	Apr 1 2022 9:00:36:790AM	Under Review		22

Other Achievements: Student training.

• Two of the graduate students working in the project will perform an internship in NASA Ames Research Center to work in a project to perform autonomous aerial inspection in the largest wind tunnel in the world. The students will use a similar approach to the one used in this project.

