

TECHNICAL UNIVERSITY OF CRETE

DIPLOMA THESIS

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# Design and Implementation of a Low Cost Embedded System for Localization of Drones Flying in Swarms

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*A thesis submitted in fulfillment of the requirements  
for the diploma of Electrical and Computer Engineer  
in the*

School of Electrical and Computer Engineering  
Microprocessor and Hardware Laboratory

November 25, 2020



TECHNICAL UNIVERSITY OF CRETE

# *Abstract*

School of Electrical and Computer Engineering

Electrical and Computer Engineer

**Design and Implementation of a Low Cost Embedded System for  
Localization of Drones Flying in Swarms**

by Christos SPYRIDAKIS

TODO: English . . .



ΠΟΛΥΤΕΧΝΕΙΟ ΚΡΗΤΗΣ

## Περίληψη

Σχολή Ηλεκτρολόγων Μηχανικών και Μηχανικών Υπολογιστών

Ηλεκτρολόγος Μηχανικός και Μηχανικός Υπολογιστών

Σχεδίαση και Υλοποίηση Ενσωματωμένου Συστήματος Χαμηλού  
Κόστους για Εύρεση Θέσης μη Επανδρωμένων Αεροσκαφών που  
Πετούν σε Σχηματισμό

από τον Χρήστο ΣΠΤΡΙΔΑΚΗ

TODO: Ελληνικά ...



# *Acknowledgements*

TODO: Add Acknowledgements





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# List of Algorithms





# Physical Constants

Speed of Light  $c_0 = 2.997\,924\,58 \times 10^8 \text{ m s}^{-1}$  (exact)



# List of Symbols

|          |                   |     |
|----------|-------------------|-----|
| $a$      | distance          | m   |
| $\omega$ | angular frequency | rad |



# List of Abbreviations

|             |  |
|-------------|--|
| <b>MCU</b>  | <b>Micro Controller Unit</b>   |
| <b>MPU</b>  | <b>Micro Processor Unit</b>  |
| <b>UAV</b>  | <b>Unmanned Aerial Vehicle</b>   |
| <b>VTOL</b> | <b>V</b> ertically <b>H</b> over, <b>T</b> ake-off, and <b>L</b> and   |
| <b>ESC</b>  | <b>E</b> lectronic <b>S</b> peed <b>C</b> ontrol                       |
| <b>IMU</b>  | <b>I</b> ntertial <b>M</b> easurement <b>U</b> nit                     |
| <b>GPS</b>  | <b>G</b> lobal <b>P</b> ositioning <b>S</b> ystem                      |
| <b>FPV</b>  | <b>F</b> irst <b>P</b> erson <b>V</b> iew                              |
| <b>WSN</b>  | <b>W</b> ireless <b>S</b> ensor <b>N</b> etworks                       |
| <b>UGV</b>  | <b>U</b> nmanned <b>G</b> round <b>V</b> ehicle                        |
| <b>MAV</b>  | <b>M</b> icro <b>A</b> erial <b>V</b> ehicle                           |
| <b>USV</b>  | <b>U</b> nmanned <b>S</b> urface <b>V</b> ehicle                       |
| <b>UAS</b>  | <b>U</b> nmanned <b>A</b> ircraft <b>S</b> ystems                      |
| <b>ISR</b>  | <b>I</b> ntelligence, <b>S</b> urveillance, and <b>R</b> econnaissance |
| <b>UCAV</b> | <b>U</b> nmanned <b>C</b> ombat <b>A</b> erial <b>V</b> ehicle         |



*Dedicated to those people who have helped me be the  
person I am today...*





# Chapter 1

## Introduction

Κατά το τέλος του έτους 2019 μόνο στις Ηνωμένες Πολιτείες της Αμερικής υπήρχαν πάνω από 990 χιλιάδες εγγεγραμμένοι χειριστές drone με πάνω από 1.32 εκατομμύρια drone ψυχαγωγικού χαρακτήρα να χρησιμοποιούνται [1]. Ενώ μέχρι το 2025 υπολογίζεται ότι το μέγεθος αγοράς των υπηρεσιών drone θα κοστολογείται 63.6 εκατομμύρια δολάρια [2].

### 1.1 UAVs and Swarm

### 1.2 Motivation

### 1.3 Scientific Goals and Contributions

### 1.4 Thesis Outline

- Chapter 2 - Theoretical Background:
- Chapter 3 - Related Work:
- Chapter 4 - Design Features and Implementation:
- Chapter 5 - Applications and Usage Examples:
- Chapter 6 - Experiments and Results:
- Chapter 7 - Conclusions and Future Work:



## Chapter 2

# Theoretical Background

"Let no one ignorant of  
geometry enter"

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*Plato*



## Chapter 3

# Related Work

“This is where technology is  
now, imagine where we can go  
in the future”

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*Timothy Chung*

### 3.1 Thesis Approach

This should be the last section



## Chapter 4

# Design Features and Implementation

”

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## Chapter 5

# Applications and Usage Examples



## Chapter 6

# Experiments and Results



## Chapter 7

# Conclusions and Future Work



## External Links

- [1] Matt Satell. *Ultimate List of Drone Stats for 2020*. July 2020. URL: <https://www.phillybyair.com/blog/drone-stats/> (visited on 11/2020).
- [2] Business Insider Intelligence. *Drone market outlook: industry growth trends, market stats and forecast*. Mar. 2020. URL: <https://www.businessinsider.com/drone-industry-analysis-market-trends-growth-forecasts> (visited on 11/2020).