Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF DRONE DETECTION SYSTEM USING ARDUINO FOR ENHANCE PRIVACY PURPOSE

MUHAMMAD ELWAN BIN MOHD ROSLAN

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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A project report submitted
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Disahkan oleh:

DR. AKM ZAKIR HOSSAIN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik
Universiti Teknikal Malaysia Melaka

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42, PERSIARAN HALAMAN AMPANG 9,
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DEDICATION

To my beloved mother, Salbiah Binti Nasir

and

To my dearest siblings Irfan, Aiman, Iman and Ain.

ABSTRACT

Today, we continue to see significant increases in the use of robots (airborne or non-airborne) in various aspects of our lives. Drones are common examples of unmanned airborne robots. Drones are not only used for military purposes; they are also used in the civilian sector. Some of these applications include logistical operations, reconnaissance, search-and-rescue, disaster assessment, and others. The Federal Aviation Administration (FAA) reports that over 1.5 million drones are registered in the United States. Twenty-eight percent of these registered drones are used for commercial purposes, while the rest are purchased for recreational purposes. Because there are numerous benign applications for drones and no strict regulations on who can buy and operate a drone, there is also an increase in safety and security concerns. The use of a drone to infiltrate a secured or restricted area is a common security concern. Extremist or terrorist groups can also use drones to deliver explosive payloads or chemicals to a specific location, putting public safety at risk. Radar has been widely used in the detection of drones and small aircraft. However, there are some restrictions. Radar, for example, cannot tell the difference between birds and drones. Several other detection methods, based on sensing mechanisms such as sound, video, thermal, and radio frequency, have been used in DDI systems (RF). There are various tradeoffs when using any of these approaches, and these tradeoffs influence system performance. Weather conditions can have a significant impact on the thermal approach. When there is a lot of noise around, the effectiveness and efficiency of a sound detection system suffers. Similarly, low light visibility and coverage are disadvantages for using video detection mechanisms.

ABSTRAK

Hari ini, kita terus melihat peningkatan ketara dalam penggunaan robot (bawaan udara atau bukan udara) dalam pelbagai aspek kehidupan kita. Dron adalah contoh biasa robot bawaan udara tanpa pemandu. Drone bukan sahaja digunakan untuk tujuan ketenteraan; ia juga digunakan dalam sektor awam. Beberapa aplikasi ini termasuk operasi logistik, peninjauan, mencari dan menyelamat, penilaian bencana dan lain-lain. Pentadbiran Penerbangan Persekutuan (FAA) melaporkan bahawa lebih 1.5 juta dron didaftarkan di Amerika Syarikat. Dua puluh lapan peratus daripada dron berdaftar ini digunakan untuk tujuan komersial, manakala selebihnya dibeli untuk tujuan rekreasi. Oleh kerana terdapat banyak aplikasi jinak untuk dron dan tiada peraturan ketat tentang siapa yang boleh membeli dan mengendalikan dron, terdapat juga peningkatan dalam kebimbangan keselamatan dan keselamatan. Penggunaan dron untuk menyusup ke kawasan yang selamat atau terhad adalah kebimbangan keselamatan yang biasa. Kumpulan pelampau atau pengganas juga boleh menggunakan dron untuk menghantar muatan bahan letupan atau bahan kimia ke lokasi tertentu, meletakkan keselamatan awam pada risiko. Radar telah digunakan secara meluas dalam pengesanan dron dan pesawat kecil. Walau bagaimanapun, terdapat beberapa sekatan. Radar, sebagai contoh, tidak dapat membezakan antara burung dan dron. Beberapa kaedah pengesanan lain, berdasarkan mekanisme penderiaan seperti bunyi, video, terma dan frekuensi radio, telah digunakan dalam sistem DDI (RF). Terdapat pelbagai pertukaran apabila menggunakan mana-mana pendekatan ini, dan pertukaran ini mempengaruhi prestasi sistem. Keadaan cuaca boleh memberi kesan yang ketara ke atas pendekatan terma. Apabila terdapat banyak bunyi di sekeliling, keberkesanan dan kecekapan sistem pengesanan bunyi terjejas. Begitu juga, keterlihatan dan liputan cahaya rendah adalah kelemahan untuk menggunakan mekanisme pengesanan video.

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m	-	meter
s	-	seconds

LIST OF ABBREVIATIONS

UAV	-	unmanned aerial vehicle
RF	-	radio frequency
GPS	-	global positioning system
DOA	-	direction of arrival
RCS	-	radar cross-section
FMCW	-	frequency-modulated continuous-wave
MIMO	-	multiple-input multiple-output
MDR	-	motion detection radar
SDR	-	Software-defined radio
FPV	-	First-Person View
OUI	-	Organizationally Unique Identifier
3D	-	Three dimentional
COTS	-	commercially available off-the-shelf
LOS	-	line of sight
FOV	-	field of view
NLOS	-	non-line of sight
RSS	-	received signal strength
LBP	-	local binary pattern
DPM	-	deformable parts model
GFD	-	generic Fourier descriptor
SIFT	-	scale-invariant feature transform
HOG	-	histogram of oriented gradients
SSD	-	single shot detector
YOLO	-	you only look once
KCF	-	kernelized correlation filter
CNN	-	convolutional neural network
CRNN	-	Convolutional Recurrent Neural Network
RNN	-	Recurrent Neural Network
GAN	-	Generative Adversarial Network
DSP	-	digital signal processing
SVM	-	Support Vector Machine
PIL	-	Plotted Image Learning
K-NN	-	K-Nearest Neighbour
SfM	-	structure from the motion
BA	-	bundle adjustment
GMM	-	Gaussian Mixture Models
KF	-	Kalman Filter
GSM	-	Global System for Mobiles

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CHAPTER 1

INTRODUCTION

1.1 Background

Over the past few years, we have seen drones have become very popular among all ages of people. We can see them being sold in all kinds of places whether it is a department stores, online, or even at the convenience store. Nowadays, it came at all sizes and prices. You can get a drone that has the same size as an apple and with a price that everyone can afford. The drone also can be referred to as an unmanned aerial vehicle (UAV). A drone is a flying robot that may be commanded remotely or fly autonomously by using a radio frequency (RF) controller or software-controlled flight plans that connect with onboard sensors and a global positioning system (GPS)[1]. A drone most commonly refers to a multirotor, which has three or more propellers and may hover or fly in any direction. A quadcopter is the most common type, with four propellers[2]. Drones have so many cool features that make them so popular. Many drones include cameras that allow you to observe the world through the eyes of the drone. You may also make videos with the camera to share your flying experiences with others. A flight controller is embedded into every drone to keep it stable. If it tips over due to a gust of wind, the flight controller will immediately alter the propeller speeds to level it out[3]. This makes learning to fly easier for novices. A full-sized airplane or helicopter was formerly necessary for aerial flight. Drones can now perform many of the same tasks at a fraction of the cost. Drones require a power source, such as a battery or fuel, to fly. Rotors, propellers, and a frame are all included. To save weight and improve manoeuvrability, drone frames are often composed of lightweight composite materials[4]. Drones need a controller, which enables the user

to use remote controls to launch, navigate, and land the drone. Controllers communicate with the drone via radio waves such as Wi-Fi.

1.2 Problem Statement

Drones that master the art of data collection efficiently are now part of the current inspection standard[2]. UAV technology has prompted various businesses to adopt new methods. However, all of the benefits come with a few drawbacks. Even while Drones strive toward perfection, they aren't perfect. When a new technology is introduced, some new problems will come with it. The most common problem that everyone has with a drone is a breach of privacy[5]. Drones give users the ability to position a flying camera practically anywhere they choose, including on other people or property. Even though there are rules governing where drones can fly, some users disregard them. The drone is easily manipulated and can invade the privacy of a group or individual. While many people want to use drones to keep themselves safe, doing so could violate a variety of individual liberties for the sake of public safety[2]. Drones are frequently used by criminals to target their victims and keep track of them[6]. The loud propeller noises are no longer a problem because they are unnoticed, allowing attackers to breach someone's privacy. Many drones equipped with thermal and night sensors detect vital signs and efficiently target people the spy is now interested in[7]. Because UAVs can collect reliable data, they can track routine habits and detect suspicious activity without requiring authorization.

Unmanned Aircraft Systems (UAS) are already widely used, yet because it is a new technology in the market, the legislation is continually evolving[8]. Specific rules for small drones apply to commercial and recreational users as well but are still ambiguous in various ways. Drone movement regulation and property protection from airborne trespassing are still

in the works, therefore UAV technology operates in a legal grey area. There are several conflicts between federal standards and any state or local laws governing aerial property rights, which can lead to drone pilots breaking statutes they are unaware of[9]. Drones' rapid acceptance over the last decade has aroused privacy, security, and safety concerns. Drones are used by voyageurs and paparazzi to photograph people in their homes and other formerly private locales. Drones are often employed in dangerous regions like cities and near airports[3]. Increased commercial and personal drone use has raised the risk of mid-air crashes and drone control loss. Concerns about drones flying too close to commercial planes have led to calls for regulation. UAV rules have been created in many nations. Laws are constantly changing as drone use becomes more widespread[8]. Drone pilots, both personal and commercial, must familiarise themselves with the rules of the country and region in which they are flying the devices. Drones pose a threat to large planes and helicopters, and they can obstruct firefighting and rescue efforts. Wildfires have grown deeper in certain cases because a drone hovered nearby, preventing firefighting planes and helicopters from reaching the blaze. So it has become part of airspace issues.

1.3 Project Objective

The primary goal of this research is to present a functional and methodical progress approach. The following are the specific objectives:

a) To design and simulate an efficient system for detecting drones.

b) To fabricate the proposed prototype for detecting drones.

c) To benchmark and compare the result with the current trend and industry.

1.4 Scope of Project

For this project, the scope is to design a system that can be used in detecting the unknown drone and prevent it from trespassing the private property. The way that the drone can be detected is by using the radio frequency (RF) signal of the drone. A camera also will be used to feed the live footage of the intruder. Both the inputs that are being used will be controlled by Arduino which can also be the brain of this system. The range of frequency of the signal that can be detected is around 2.4GHz and the distance is around 100 meters.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Small unmanned aerial vehicles (UAV) or drones have become increasingly popular nowadays. People are using drones for recreational use or as a hobby[10]. There is also a company that replaces their staff with drones such as food delivery. Drones are becoming a necessity in our daily lives. However, as technology improves, it becomes easier to spy on people in otherwise private places, such as a person's home, posing a greater risk to privacy[10]. Anybody nowadays can buy a drone and fly it over someone's fences without having difficulty climbing over the fence to get the inside view. The best solution for this situation is to equip ourselves with something that can detect and counter the personal drones that invade our private property[10]. Unfortunately, the existing product of drone detection systems are inaccessible to the general public because they require specialized equipment and costly deployment procedures.

The creation of an automatic drone detection system has become necessary in every home to have[6]. But the market for drone detection only targeting the industrial uses or bigger, that can cover a large area, so the product they offer are not affordable for civilian[10]. The manufacturer of this drone detector comes in many types of sensors implements inside the system depending on the needs of the users, so that it can become more flexible based on the situation of the area they are implementing it on[8]. But for the use of household properties they doesn't need so many types of sensors just one or two and also it only need to cover a small space enough to cover their house and yard.

In this report, I am going to present a type of drone detection that doesn't require a complicated setup to configure and only cost less than the industrial kind of product. The hardware and equipment we will be using are also off the shelves equipment and component. This system will only detect the drone that invade the privacy of home owner but also include the way to counter the intruder drone. Drones may carry out operations using a variety of technologies[6]. As a result, drone detection systems must be comprehensive enough to detect any type of drone. Current technologies, on the other hand, usually fail to recognise the many types of drones with harmful missions[8]. But in this system, it will detect all types of drones but it will leave the decision whether the drone are malicious or safe on the user hands.

2.2 Introduction to Drone detection System

The purpose of distribution feeder (cable or line) is to provide path for energy flow from GSS all the way to the distribution customer. Traditional distribution feeders (without DER) are usually operated in radial configurations - the energy flows uni-directionally from the GSS to the load. The feeders are typically categorized by its: (i) voltage level, (ii) conductor material, (iii) conductor size (cross sectional area), (iv) insulation type and (v) no of phases. These feeders scattered all over different supply zones. Hence, they are extensive and large in numbers.

2.3 Methods of Drone Detection

There are many ways to detect and track drone. There are five methods that are mostly used by the drone detection manufacturer which is Video-based detection, sound- based detection, radar-based detection, radio-based detection and Wi-fi based detection[14].

These five methods require their own types of sensors in order for the system to operate and detecting the drone.