CHAPTER 1
INTRODUCTION

This chapter explains the background, problem formulation, objectives, problem limitation, research methodology, and writing systematics.

1.1 Background

The air quality level changes continuously, this happen due to various reasons such as vehicle emissions, environment and climate changes [1]. To overcome this, creating an effective system to measure the quality of the air of the environment around us is a great solution. The current air quality measurement system is considered to be inaccurate, because it only measure at a certain points on the ground so it give inaccurate result that affected by various reasons. Measurement on the ground make an inaccessibility of certain regions that only the limited range of area can be measured.

Since the ground access is usually hindered and full of obstacles, the most feasible way to implement a mobile air quality monitoring robots is via Unmanned Aerial Vehicles (UAV) [2] . For that reason, we propose to create a Swarm-Internet of Things (IoT)-based Quadcopter UAV that consists of a group of small UAV that can work altogether. This UAV is expected to help us measure the level of air quality by flying it.

In addition to that, to make the work easier and efficient, this thesis propose an Automatic Take Off and Landing (ATOL) system for this UAV. The basic UAV have to remotedly piloted by an operator that requires a routine training to fly and land it because it controlled by a human. This basic system can cause an accidents which make a failure for the flight. As mentioned in, [3] the principal cause of the failure were classified as human error, technical failure, weather and sabotage. By applied the automatic take off and landing system, we can eliminate the human error failure in the percentages.

Nowadays, several companies produce ATOL systems for UAV with developed ground station software that being as a commercial use. One of the company that produce this is The UAS Europe. They provide a flight control system. This system fully allow autonomous flights, from take-off, mission to landing. The limitation of this solution is the cost. However with the recent increase in development of

UAV development, there are now many devoloped system that can be afford at a low budget.

Several papers have been published that propose the method of ATOL system for the UAV. In 2007, KARI (Korea Aerospace Research Institute) developed an autopilot design of a tilt-rotor UAV as a Smart UAV Development Program in Korea. This system using Particle Swarm Optimization (PSO) method. The objective was to create an automatic tool for control system design using the PSO method that being developed and applied to autopilot design of tilt-rotor. This project achieved a whole autopilot system includes several parts like state observer, state estimator, and flight controller [4] .

Other researchers focused on create a full vision-based landing system. It based on detachable markers without a GPS (Global Positioning System) . The proposed system enable UAV landing with just a speedometer, an Inertial Measurement Unit (IMU), and a camera. One of the noticeable works of this system were proposed by Kong et al [5] , that devided the landing of the UAV into landing on a known area and on an unknown area. The other researchers that proposed on vision based landing used marker detection techniques with pose estimation and pattern recognition such as [6] . In this system, vision servo control is being used.

Mentioning in [5] , there are four challenging points for the vision-based landing system. First, its difficult create imaging process algorithm. Because for on-ground system, the small target detection algorithm is the critical. Second, its difficult to control the altitude. Third, its difficult to control the rate of the descent. Lastly, its difficult to control the heading direction of the runway during the entire course of the landing process.

On the other hand, some researchers applied GPS to improve landing ability. In [7] , the researchers used the database with a high efficiency GPS to find known location of runways. The challenging point to use GPS or other sensors for positioning that mentioning in [8] is first the accuracy of GPS is usually not enough for guiding a UAV to narrow runway. Second, whatever type of GPS that used in the system there are still remaining problems for unknown ground. Such as acquiring accurate GPS map on ground. Third, the GPS-based systems would totally fail if a certain satellite systems are not available.

By looking at all of the problem, this thesis proposes to make an ATOL system that capable perform a fully autonomous mission, from the take-off to the landing process. This system use Pixhawk as the autopilot system, Mission Planner as the Ground Control Station (GCS) software, Global Positioning System (GPS) as the receiver, Telemetry as a two way datastream, and a computer as the control unit.

1.2 Problem Formulation

The problem of this thesis is the basic UAV had to be remotely piloted from the ground by an operator. This thesis needs to create an ATOL system for the Swarm-IoT UAV so when the UAV operating it barely need the human touch. This ATOL system can also reduce the risk of human errors, saving time because it barely require a human touch, and it can accurately precise the locations because they can be programmed and maneuvered.

1.3 Objective

From the problem that have been described, the purpose of this thesis are as follows:

1. Create an ATOL system for the UAV.
2. Maintain the GPS accuracy of the UAV in take-off and landing during the flight test.
3. Maintain the altitude accuracy on the flight test in order to obtain an accurate altitude based on the given input.

1.4 Scope of Problem

Related to the problem formulation, scope of problem can be identified as follows:

1. The flight test was carried out in the outdoor area.
2. The flight test was carried out at altitude of 3 and 5 m from the ground level.
3. At each altitude a delay is given to collect the data for air quality measurement.
4. The wind speed, air pressure, temperature and gravity level at each flight test are assumed to be the same.
5. There are no obstacles when the quadcopter did the flight mission.
6. The quadcopter didnt experience a crash when carrying out the flight mission.

1.5 Research Methodology

The research methodology carried out on this thesis are:

1. Literature Study, get data from jurnals, papers, and other thesis related to UAV, Quadcopter, GPS, and ATOL system.
2. Hardware and software design for the ATOL system.
3. Experimental flight test and collect the data to analyze include the GPS and altitude needed.
4. Analyzing the GPS and altitude data that can be compared.

1.6 Writing Systematics

The rest of this thesis is organized as follows:

- Chapter II BASIC CONCEPT
  This chapter contains the basic theory, tools, and application used to create the ATOL system for the UAV.
- Chapter III SYSTEM METHOD
  This chapter contains the workflow,experimental model diagram, and the method to create the ATOL system for the UAV.
- Chapter IV RESULT AND ANALYSIS
  This chapter contains calibration,the test performed, the result of the test, and analysis of the result of the test performed by the ATOL system for the UAV.
- Chapter V CONCLUSION AND SUGGESTION
  This chapter contains the conclusions for this thesis and suggestions for the research that can be carried out in the future.