UNMANNED AERIAL VEHICLE (UAV) MONITORING SURVEILLANCE SYSTEM

KHUSYAIRI BIN ABD AZIZ

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Specially……

To my beloved parents

To my kind brothers and sister

And to all my friends

For their Love, Encouragements, and Best Wishes

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ABSTRACT

This thesis presents the development of an Unmanned Aerial Vehicle (UAV) for Monitoring Surveillance Purpose where the video communication at the UAV is being focused. The measurements data for this project is obtained by conducting the signal strength (signal power) measurements of the UAV video signal. The resulting measurement data is used to calculate the signal power loss for 100 meters UAV video operation based on the average power loss value that is identified. The average power loss of the system is 3.63 dB per meter resulting in loss exponentially for 100 meter UAV operation.

ABSTRAK

Tesis ini membentangkan penghasilan sebuah Kenderaan Udara (pesawat) Tanpa Kendalian Manusia (UAV) untuk tujuan pengawasan visual dimana komunikasi video pada UAV diberi penekanan. Butir maklumat pengukuran untuk projek ini diambil dengan menjalankan pengukuran kekuatan isyarat (kuasa isyarat) untuk isyarat video UAV tersebut. Hasil butir maklumat dari pengukuran digunakan untuk mengira kehilangan kuasa isyarat untuk UAV beroperasi pada 100 meter, berdasarkan purata kehilangan kuasa yang dikenal pasti. Purata kehilangan kuasa untuk sistem adalah 3.63 dB untuk satu meter, memberikan pertumbuhan kehilangan kuasa untuk operasi UAV pada 100 meter.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CCD	-	Charged Coupled Devices
CCTV	-	Closed-circuit Television
GCS	-	Ground Control Station
IP	-	Internet Protocol
KM	-	Kilometers
QoP	-	Quality of Performance
R/C	-	Remote-Controlled
TV	-	Television
UAV	-	Unmanned Aerial Vehicle
VCR	-	Video Cassette Recorder
VSCQ	-	Visual Surveillance Coverage Quality
VTOL	-	Vertical Take-Off and Landing

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

This chapter covers the introduction of the project, background study regarding the project topic, project objective, the problem statement involves, the scope of work, and the methodology of this project.

1.1 Project Background

Unmanned Aerial Vehicle also familiarly called as UAV, Drone, and Remotely Piloted Vehicle is unpiloted aircraft including airplanes and helicopters. UAVs can be remote controlled from a certain distances or fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. It is a system consists of three main systems, which are the aircraft, the Ground Control Station (GSC) and the operator. There are many types of UAV which are varies in shapes, size, configurations, and characteristics. This UAV type depends on what operation it must execute on or its purpose. [1]

This project is to study the existing UAV types, configurations, and applications in order to develop a portable aerial surveillance system. Man operated type UAV will be used. The surveillance system that will be develops will focus on video surveillance system using a low power wireless type camera.

The information signal transmit by the wireless camera will be receive by its radio AV receiver. The output from the receiver will be connected to a monitor which is a television or a computer for monitoring purpose.

1.2 Project Objective

The objective of this project is to develop an Unmanned Aerial Vehicle (UAV) Monitoring for Surveillance System.

1.3 Problem Statement

The production of UAV is been towards military used since its existence. A programmable UAV usually used by them where many circuits and sensors are needed. This does not seem practical to be applied in civil application. A monitoring purpose UAV can be included in a civil application of UAV. Some monitoring purpose UAV has been developed but for monitoring large area for example traffic. For surveillance purpose, only some area will be covered. Basic type of UAV can be applied for this application.

Aside of this, video surveillance system existences are more towards wired type connection. This can be support by the CCTV existence, where the video capture gadgets (camera) normally in fixed position and cannot be change. A portable video surveillance is more practical and can be applied anywhere.

Considering the information and problem stated, an Unmanned Aerial Vehicle (UAV) monitoring surveillance system will be developed. A portable camera will be equipped to an R/C Helicopter in order to provide an aerial visual for monitoring an area.

1.4 Scope of work

These are the main things and areas identified to be considered to the project.

a) UAV Types

   Suitable type UAV must be identified for surveillance system monitoring purpose. The payloads, size, signal strength, characteristics needed to suites to its purpose.

b) Camera Types

   Wireless type of camera needed to be used to fit UAV's requirement such that it used a wireless connection. The picture quality came from the camera also needed to be identified to suite a surveillance system.

c) Signal Strength and Loss Analysis

   This project is focusing on the communication between the video transmitter of UAV and the receiver. The signal strength is the main consideration thus some experiments are conducted to determine the signal lost based on the distance travel by the UAV.

d) Video Monitoring and Recording Method

   To fulfill a surveillance system, video received must be recorded for further usage. Ways of recording this video will be using other circuits or method depending on the recording system used.

1.5 Project Methodology

There are several major parts of methods in order to complete this project. These including:

a) Project planning
b) Literature review and related theory
c) Lab test and measurement
d) Field test

e) Full scale test

The main focused of this project is the communication between the UAV monitoring mechanism (camera) and its receiver. The power loss and gain is the main consideration in developing this UAV. Signal strength test is conducted in order to get the data for analyzing.

CHAPTER 2

LITERATURE REVIEW

This chapter discusses precisely about the information and theory relates to this project also the overview of major component involved. Factors that should be consider while developing this project also will be covered. The literature review will start with reviewing the UAV types, classifications and systems. The design consideration is also being strained. Further on, surveillance system will be reviewed based on its types, system, and requirements. This includes the types of camera that can be used. The project system that will be used will be stated at the end of this chapter.

2.1 Unmanned Aerial Vehicle (UAV)

UAVs are semi-autonomous or fully autonomous aircrafts that can carry various types of payloads including camera, sensors and communication system. Semi autonomous refers to man-operated UAVs while the fully autonomous is the program-controlled UAVs. Although UAVs application has been conquered by military since its existence but this past ten years, the number of its application in civil application is been increasing. [1] - [4]

2.1.1 UAV System

As being said earlier, UAV can be controlled by an operator or it can operate itself using preprogrammed controlled. UAVs system covers three main features which are as follows: [1] [4]

(a) The aircrafts - refers to the UAV itself and its types
(b) Ground control station - monitoring and UAV system control
(c) The operator - controls UAV movement

2.1.2 UAV Classification

There are many classifications of UAVs being made. Basically it being categorized based on its performance, operating range and capabilities. Based on The European Vehicle Association, UAVs is been identified to five main categories as shown below [5]. This category is identified based on UAV capability to operate at longer distances.

(a) Close Range

This includes aerial vehicles that can fly in range of less than 25 km; usually these airborne are extremely light and can be launched by hand [1].

(b) Short range

It is down to platforms that operate within the range of 25 to 100 km. Such systems are designed for operations within a limited area [1].

(c) Medium range

These are UAVs that can fly within 100 to 200 km of range. Aircrafts of this category are defined by a more advanced aerodynamic design and control systems due to their higher operational performance [1].

(d) Long range

These categories of UAVs can operate in range of 200 to 500 km. As in the previous category such systems are required to use more advanced technology to carry out complex missions or jobs. Also the need a satellite link (or another platform act as a relay) in order to overcome the communication problem between the GCS and the aircraft created by the curvature of the earth [1].

(e) Endurance

Aircrafts able to operate in the longest range which is more than 500 km, or it also can be said that the aircrafts can stay operate in air for more than 20 hours. These are considered to be the most sophisticated of the UAV family since it has high capabilities. It can be distinguished from the other system by their large dimensions and their high capability [1].

Among the first three categories above, there is a Vertical Take-Off and Landing (VTOL) type of UAVs. This aerial type platform has the ability to take off and land vertically, as well as to hover around the ground, but lacks in range capability [6]. Also, a new category of UAV has been emerged which is the Micro Air Vehicles. It's being categorized by its tiny size of no more than 15 cm wing wide span and length [1].

2.1.3 UAV Design Consideration

There are some major characteristics or element need to be look first before developing an UAV. Generally elements that needed to be considered are based on the applications type that the UAV will be carrying [1]. The major factors needed to be considered are as follows: [1] [6] [7] [8]

(a) Degree of autonomy
(b) Endurance
(c) Communication Bandwidth
(d) Payloads (Weight Burden and limitation)

2.1.3.1 Degree of Autonomy

Autonomy refers to the ability of a subject or an object to make decision without human intervention. This means that this element is to teach the machine makes its own decision. This means that a pre-programmed controlled needed to be applied to the UAV system. The pre-programmed usually develops using software and coding techniques. The technological development in the field of autonomy mostly follows bottoms-up approach such as Hierarchical Control System. [1] [7] [8]

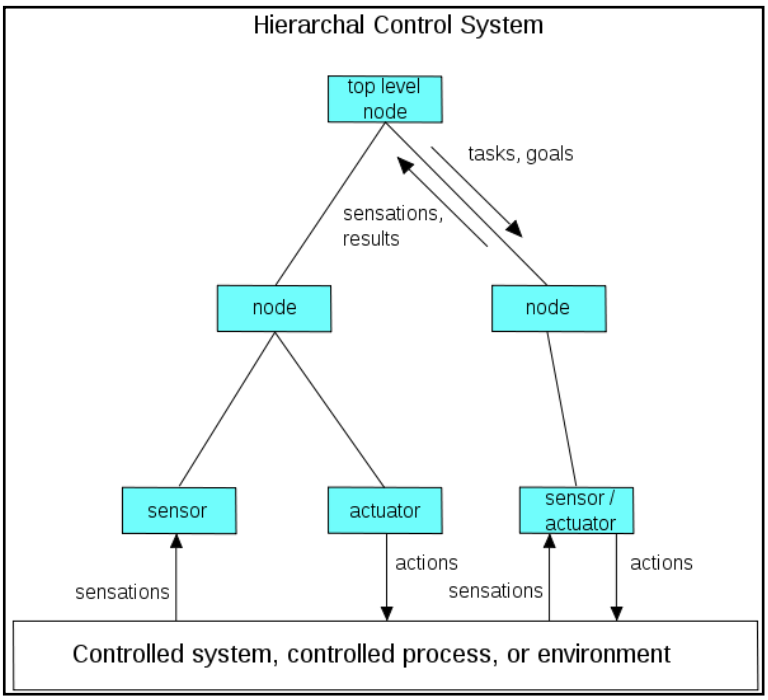

Figure 2.1 Hierarchal control systems

Based on this autonomy perspective, most early develop UAVs are not autonomous. But this is not the problem because this degree actually depends on the UAV application. These are autonomy technology involving UAV development: [6]

(a) Sensor function - combines information from different sensors
(b) Communications - handling communications and coordination between multiple agents

(c) Path planning - movements of UAV including obstacle and energy consumption
(d) Trajectory generation - motion planning (path needed to take)
(e) Trajectory regulation - specific control strategic/system
(f) Task allocation and scheduling - optimal distribution of tasks
(g) Cooperative tactics - Formulating an optimal sequence and spatial distribution of activities between agents in order to maximize chance of success in any given mission scenario

2.1.3.2 Endurance

It is known that UAVs is an unpiloted aircrafts which brings to less physiological limitations. Thus it can be designed as maximized on-station times. Endurance element is referring to the ability of an UAV to operate in certain amount of time. The maximum flight time for an UAV is varies widely depending on what mission or application its carry. This brings to its energy consumption where for engine operated UAV depends strongly on percentage of fuel burned as fraction to total weight. [1]

Another type of UAVs energy supplied is by battery pack. Some designs equip a solar panel to operate the UAV. Usually, UAV equipped with type of energy source is lacks in endurance capability because it cannot flight in longer duration. This UAV is only among the short and maybe medium range categories. [7]

Endurance element brings to high power and energy consumption since it must be operate in long duration of time and maybe in longer distances. Regarding this, the system that the UAV carry also must be takes to consideration as they also used energy. Table 2.1 shows a list of some latest endurance UAVs developed [7].