

COMPUTERIZED SIMULATION SYSTEM FOR ECM RADAR SYSTEM

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*This thesis is dedicated to father, mother and family.  
Your prayer helps a lot. Thank you.*

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Mohamad Sabri Salleh

## **ABSTRACT**

The purpose of this project is to develop a simulation system for Electronic Counter Measure (ECM) Radar System. The study of ECM system consist of basic principle of radar, jammer, ECM and Electronic Counter Counter Measure (ECCM). The principle of electromagnetic spectrum is the basic background for all calculation and simulation. It is user friendly for design and training purposes. The simulation system provides the application for user to design and learn about ECM Radar System. User will be able to appreciate the principle behind the operation of Electronic Warfare (EW).

This thesis documents the development of computerized simulation system by using principle of software engineering which is Object Oriented (OO) Methodology. The process started with requirement analysis on how the users wish the system to be. The user needs a system which is able to evaluate equipment and train personnel about EW theory. Then Unified Modeling Language (UML) was used as a tool to implement the OO methodology. Use case diagram were used, based on the requirement analysis. From the use case diagram, use case scenarios are created to view on how the system works. Next sequence diagrams were used to view the internal process within the simulation system. Finally before code generation, the flow chart of the simulation algorithm was used. The system is based on C++ Builder application; it has the capability of OO programming with the enhancement of Visual Component Library (VCL). OO methodology with the tools of UML has aided in the development of the system in a well structured manner.

## ABSTRAK

Projek ini adalah bertujuan untuk menghasilkan satu simulasi berkomputer bagi pengoperasian *Electronic Counter Measure (ECM) Radar System*. Kajian mengenai sistem ECM melibatkan teori radar, *jammer*, radar ECM dan *Electronic Counter Counter Measure (ECCM)*. Asas pengiraan spektrum elektromagnetik merupakan asas pengiraan bagi simulasi ini. Simulasi ini dapat membuatkan pengguna mempelajari dan menghayati teori penggunaan dan rekaan peperangan elektronik. Ia mempunyai pengantara yang mudah guna bagi tujuan rekaan dan pengoperasian.

Thesis ini adalah dokumen berkenaan pembinaan sistem simulasi berkomputer menggunakan prinsip *software engineering* iaitu *Object Oriented (OO) Methodology* khususnya. Proses bermula dengan pengumpulan data untuk *requirement analysis* yang mana untuk mendapatkan apa yang dikehendaki oleh pengguna terhadap sistem tersebut. Pengguna mengkehendaki satu sistem yang berupaya menguji keupayaan peralatan dan juga melatih anggota mengenai teori peperangan elektronik. Kemudian *Unified Modeling Language (UML)* telah digunakan sebagai alat bantu melaksanakan OO methodology ini. *Use case diagram* digunakan berdasarkan maklumat dari kehendak pengguna. Daripada *use case diagram* tersebut *use case scenario* telah direka untuk menggambarkan bagaimana sistem itu berfungsi. *Sequence diagram* kemudiannya digunakan untuk memaparkan proses demi proses dalam sistem tersebut. Akhir sekali carta aliran telah digunakan untuk membantu pembinaan kod. Sistem ini adalah berasaskan *C++Builder* yang mana mempunyai keupayaan pengaturcaraan OO dan dengan bantuan *Visual Component Library (VCL)*. OO methodology dengan bantuan UML telah memudahkan pembinaan pengaturcaraan dengan lebih sistematik.

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## **CHAPTER 1**

### **INTRODUCTION**

This chapter provides an overview of the project conducted on Computerized Simulation for Electronic Counter Measure (ECM) Radar System. The objectives and the motivation of the project are introduced. The overview of the Electronic Warfare is also presented.

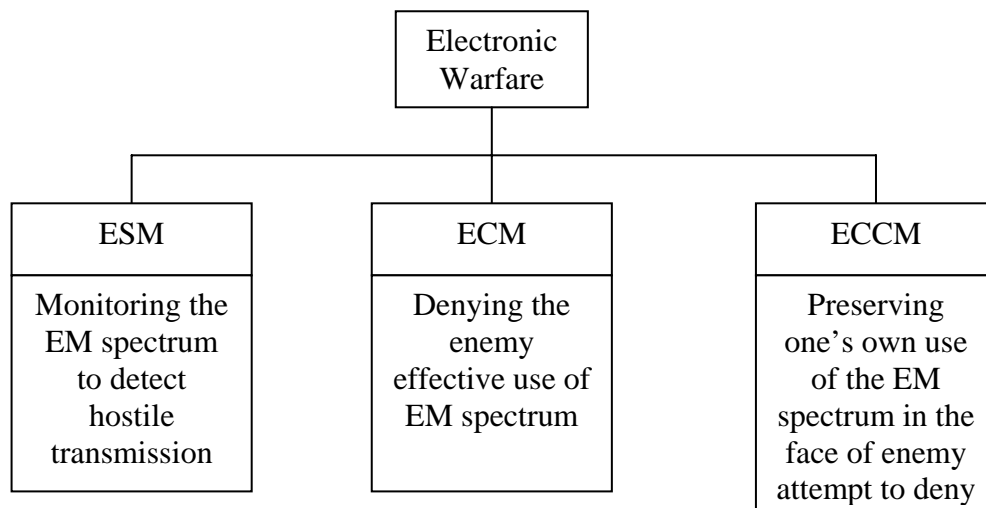
#### **1.1 Motivation for The Project**

Electronic Warfare (EW) is defined in the “DOD Dictionary for Military Terms” [1] as:

Electronic Warfare is a military actions involving the use of radio energy to determine, exploit, reduce, prevent or deny the hostile using electromagnetic spectrum. Electronic warfare consists of Electronic Support Measure (ESM), Electronic Counter Measure (ECM) and Electronic Counter Counter Measure (ECCM).

In other words, Electronic warfare is an action to win the war by using the medium of electromagnetic (EM) spectrum. The strengths and weaknesses about electromagnetic spectrum has open up ways to strategically win the war. The EW has evolved very fast and the technology becomes more complex. The exploration on environment behaviour, material, human factor and all other factor were considered to design equipment which strategically will help to win the war.

Basic principal of winning the war are to be invisible and to attack the defenceless opponent. In order to implement this, all the opponent sensors has to be destroyed before proceeding further attack. With the technology of fast attack equipment, knowledge about EW is vital to defend ourselves.



**Figure 1.1:** Electronic Warfare Overview

Source: David Adamy, EW 101 A First Course in Electronic Warfare, Artech House Inc., Norwood, 2001.

As everyone is thinking to defend their country by improving their equipment so that, it can work properly and deny any attack to blindfold them. There are ways to attack and to deny attack from enemy, the same idea should be realized as the enemy is also improving their equipment for the same purposes. Here the information warfare is very vital in order to defend ourselves.

Communication technology is very vital, as the operations are all depend on it to defend our country. The development of EW in Malaysia needs to be expedited in order to get better confidence level on national security. National security will contribute to positive development in all aspects.

Malaysian Armed Forces (MAF) has planned for the development of EW knowledge and skills to all their personnel. The use of computerized simulation system will help a lot in order to further develop the EW knowledge and skills.

Here, this project is to develop a simulation system on one of the field in EW. ECM Radar is considered as the main part of EW. The learning and evaluation on ECM Radar will help expedite the development of EW in MAF.

By having an evaluation simulation system, it helps to understand the operation of the equipment and to choose the right equipment for the country. The use of the simulation system also helps to expose our personnel to the operation of EW. Same concept like the development of pilot simulator, a lot of benefit can be achieved by having a good simulator system.

## **1.2 Project Objective**

The objective of this project is to build a simulation system which consists of evaluation and training element for Electronic Counter Measure (ECM) Radar. The evaluation simulation is to measure the capability of ECM Radar against jammer. Base on this evaluation helps personnel to plan for further action. It can be used for tactical plan and strategic plan. Personnel also can use the simulation to measure the capability of other jammer. This project is also to build training module, which will demonstrate the calculation on EW operation. The personnel can compare the result manually calculated versus result from the simulation. From there, they can learn and appreciate the theory behind the EW operation. This simulation system is very beneficial to proceed on other EW element.

### **1.2.1 Simulation for Evaluation**

To evaluate the equipment, a user needs to explore the specification of the equipment under evaluation. To evaluate the said specification we need to go through all the calculation, based on EW theory and principle. The calculation and analysis can prove the capability of the equipment as stated in the specification sheet. As well known, most of the EW equipment is very expensive, so the verification and

validation on the equipment specification are extremely vital. By having a thorough exploration on the equipment capability we can help to convince our management on the return of investment on that equipment.

David L. Adamy [2] has discussed about simulation for equipment evaluation, he said that:

Simulation for equipment Test and Evaluation (T & E) involves making a piece of equipment think it is doing the job for which it was designed. This can be as simple as generating a signal with the characteristics a sensor is designed to detect. It can be as complex as generating a realistic signal environment containing all of the signals a full system will experience as it moves through a lengthy engagement scenario. Further, that environment may vary in response to a preprogrammed or operator-selected sequence of control and movement actions by the system being tested. It is distinguished from training simulation in that its purpose is to determine how well the equipment works rather than to impart skills to operators.

This can help in choosing the right equipment, in procuring process. This also can help in planning for the equipment life cycle cost. Other than that, the evaluation result can be used as a reference for strategic and tactical planning. The strategic planning based on the evaluation result also can help in predicting the performance of the equipment. For the tactical planning the data's are used for references to know the performance and capability of the equipment.

### **1.2.2 Simulation for Training**

David L. Adamy [2] also has discussed about simulation for training, he said that:

It exposes student to experiences (in a safe and controlled way) that allow personnel to learn or practice various types of skills. In EW training, this most often involves the experiencing of enemy signals in



the way they would be encountered if the trainee were at an operating position in a military situation. EW simulation is often combined with other types of simulation to provide a full training experience. For example, a cockpit simulation for a particular aircraft may include EW display that reacts as though the aircraft were flying through a hostile electronic environment. Training how the personnel respond. Sometimes, the instructor can play back the situation and responses as part of the debriefing after a training exercise, which considered a powerful learning experience.

The trainees become more intimate to the EW field as they can experience the operation base on the simulation. By having these two capabilities of the simulation, it helps to expedite the development of EW in Malaysia. EW is very vital in any war strategies, as nowadays communication becomes common and everybody is involved in those communications.

### **1.3 Scope of Project**

Base on the project objectives, the scope of this project is to build evaluation module on burnthrough range between ECM radar and jammer, training module on burnthrough range and training module on cross eye jamming.

Evaluation on burnthrough range between ECM radar and jammer provides list of ECM radar and jammer, which will be chosen by the user. Then selected equipment will be evaluated on burnthrough range parameter. The parameter will be displayed for user to perform manual calculation. The module also will give a brief analysis on the burnthrough range result. Other than evaluation on that equipment, it also works as database on the characteristic of ECM radar and jammer.

Training module consist of burnthrough range and cross eye jamming calculation. Users are able to change any parameter and observed the result automatically. These give the user chance to appreciate the effect of each parameter

and relate to the theory of EW and electromagnetic waves. For the burnthrough range training module, user able to change the parameter value by key in the value or using the sliding bar. The simulation also displays bar graph which represents the value of burnthrough range. This is to give user chance to observe immediately whether the result are increasing or decreasing. For cross eye jamming training module, it has parameter to be changed by the user. It displays the result on configuration of the jammer versus the characteristic of the target radar.