

Internal Ballistics Simulation Based on Object Oriented Programming

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Abstract—The knowledge of internal ballistics simulation is quite obscure due to security reason related to rocket implementation for national defense. Internal ballistics simulation involves complex calculation of thrust profile generated by burning solid propellant mass. The design of appropriate solid propellant mass for desired thrust profile requires visualization of propellant mass and overlook how it burns from the start to the end. Object-oriented programming has been used as a tool for simulation of complex mathematic algorithms in many fields. This paper introduced object-oriented programming framework and software architecture for solving complex calculation of thrust profile and visualization of burning solid propellant. JAVA programming language is chosen to implement a test program for proving objected-oriented programming based internal ballistics simulation. The result shows the reasonable trend of thrust profile according to the real behavior of thrust generated by solid propellant. This paper give intuitive idea of implementing simulation tool for designing of solid propellant mass in rocket application.

I. INTRODUCTION

Rocket has been used in defense technology in many countries. However, the art of rocket design has been kept as a classified information. Only a few rocket designing tool has been released to the public, and they are just for educational purpose. Rocket may refer to missile, spacecraft, aircraft, or other vehicle that contains a rocket engine for pushing rocket forward. There are many types of rocket, and they serve different purposes. Due to there are many different types of rockets, each rocket requires different thrust profile for different purposes. A thrust of a rocket engine is entirely formed by exhausive propellants. Designing of rocket propellant is necessary in order to archive suitable thrust profile for each type of rockets. Unlike amateur rockets, military rockets generate high thrust and cause severe damage. This is a complex task and very dangerous to test the real rockets. Therefore, a simulation software is necessary as a tool to design a complex and high-power rocket propellant. In many country, researches have been conducted on developing an internal ballistics simulation software. However, this kind of software affects the national security and cannot be released outside their countries. Thereby research on this topic would be valuable in term of economic and security of country developing its own rocket for national defense.

The paper in [1] presents the use of computer program to design rocket propellant. However the program is limited to design rocket propellant of only 2 layers. In addition it lacks of capability to visualize the rocket propellant design. The geometry of rocket propellant has to be designed in external CAD programs. Object Oriented Programming (OOP) is a programming language model organized around objects rather than actions and data rather than logic [2]. Hence we can model each layer of rocket propellant as object in OOP which make complex calculation of thrust profile easier.

In the next section, we discuss background information and previous studies related to Internal Ballistics simulation. Section II explains the OOP design and implementation of the Internal Ballistics. Section IV presents result of the pilot program to prove our propose concept, and discussed in section V. Section VI concludes and presents future improvements.

II. BACKGROUND AND RELATED WORKS

Inside Rocket Motor stored propellant mass, which drive the rocket forward. The combustion process proceeds throughout the length of the chamber and generate hot gases flow through the nozzle at high speed. Hence, thrust force is produced at the nozzle end.

Solid-propellant rocket is the simplest of all rocket design. Unlike liquid-propellant engines, solid-propellant motors cant be shut down. Once ignited, they burn until all the propellant is exhausted [3], we cant control the thrust force so designing of rocket propellant is necessary in order to archive suitable thrust profiles. Mostly propellants are designed with difference shapes of inner port. Calculating cross section area is important to design rocket propellant efficiently.

There are many types of propellant such as solid propellant, Double-Base propellant consist mainly of fibrous nitro-cellulose and a gelatiniser, or plasticiser, such as nitro-glycerine or a similar compound (ethylene glycol dinitrate), each containing oxygen and fuel in the same compound [4]. Composite propellant are solid particles of oxidizer and fuel suspended in a binder. The binder is liquid when cast into the rocket chamber and sets up or cures to form a rubbery compound [5]. The simulation program proposed in this paper only consider Composite propellant.