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Evaluation of Geometry and Parameters for Solid Propellant Grain

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Abstract - In missiles energy production or gas pressurization is achieved by a chemical substance called propellant. A propellant induces energy which subsequently used for the movement of the object or for the replacing the object from one position to another. Propellants majorly consist of jet fuel, gasoline, rocket fuel, oxidizer etc. This propellant containing fuel like substances are decomposed to produce the propellant gas. This produced propellant gas can be directed through a nozzle thereby producing thrust and exhaust parallelly. The exhaust is expelled through a nozzle with pressure which has been generated by a combusted gas or propellant gas. The gas from combustion exits through the throat and nozzle of rocket motor at a high velocity. The Solid propellants are used in the form of grains. Each grain has different size and shape which results burn time, amount of gas and rate produced from burning propellant. The main aim of the project is to generate the pattern-based parameters calculated at that particular instance of time at constant Burn Rate for a regression pattern using a software code. The system architecture and algorithm are explained to represent the entire system and code written.

***Key Words*:** Burn Rate, Propellant, Solid propellant, missiles, Regression patterns.

1.INTRODUCTION

The evolution of missiles and solid propellants are having a great impact on the technologies growing. Technologies are Developing to improvise the existing methods and also to overcome the drawbacks of the methods which had been used. Solid propellant rocketry is particularly complex to describe for a typical classification of divisions and sub-divisions where the division of labour is among rocket engineers, is on a wide variety. So, there also exists a large number of contributions to this field which makes it even more complex to understand and implement. Hence researches have been going on to identify the best outcomes of a software solution with huge security and with better features like efficiency, performance etc. In this project, a software code for an initial issue is addressed and resolved.

The vast exposure to this field has made researchers explore and add more contributions. Use of propellants: As stated propellants are one of the important factors in a missile. The growing technology gives a lot of troubles for cost, quality, weight etc., reducing weight has become a challenge to increase the speed of the missile to deliver the payload at the destination. The code implemented helps to track the missile at every stage. The parameters are also calculated and represented in the form of the top view. It helps for better performance as the information is traced at every instance and handled accordingly. The main applications are weather forecasting, data survey, satellite communication, mapping. The main aim of introducing code in the field of missiles is to ease the implementation and track the missile, also reduces the cost that is required to be invested. There are a lot of upcoming advantages which have been in the analysis stage will soon be implemented to overcome the existing disadvantages.

2. METHODOLOGY

2.1 History of Propellant

The first rockets were used in the 1750s which had a reach of targets up to a mile and a half away. The solid propellants are then induced by gun powders to generate energy and gases to produce high velocity and thrust. In 1942 modern castable composite rocket motors were invited and the history includes both ancient and recent evolution of propellants. Although solid propellants are the most important source of energy for rockets, missiles and war weapons. It is the key material to realize the firing range and damage effect of weapons.

2.2 Literature Survey

1. Giulio Telleschi, Andrea Caroni studied "Solid Rocket Motor handling, Assembly, Static testing and Evaluation" in 2019, The need to improve design performance and avoid rework in missile systems development has led researchers to set up an international team to identify a super-set of missile functionalities in any missile domain, ranging from air-to-air to anti-ship missiles. This work led to an open functional architecture that can be tailored for any project, with a generalization of functional elements.

2. M.S. Thesis studied about "Development of composite solid propellant" in 2010 at Purdue University, Solid propellants offer a lower hazards classification than their commonplace counterparts. Strand and motor burns were

conducted over a range of pressures to quantify the effect of Fe2O3 concentration on burning rate parameters and combustion efficiency

2.3 Working of Project

A UI interface is created by using front end development services by HMTL and CSS. Initially, a login page is displayed for taking the username and password with a submit to direct the user to the next page. It helps the user to connect to the actual form with identities for the validation of details entered in UI interface there is a code running behind in JS, JQUERY for checking whether the password details are matching all the eligibility criteria like size, the complexity of password etc. and then approves the user redirecting them to the actual form after clicking on the submit button, it is actioned to perform an event to direct to calculations page. After getting directed to the actual page instance is entered for tracking the status of the missile, which will be the time in seconds. After entering the time constant there is a button to generate the top view of the missile at that particular time instance. The perimeter of the regression pattern is calculated with an image representing the top view of a missile.

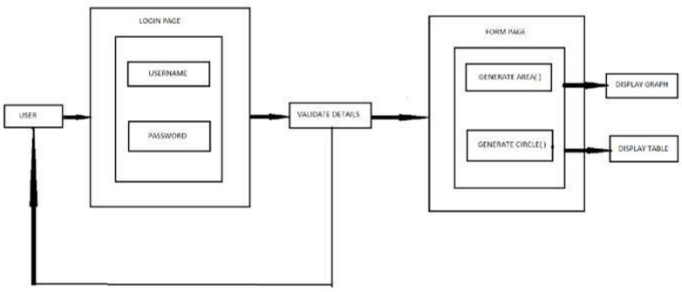

Fig -1: System Architecture

When all the combusted propellant gas gets exhausted the burn rate gets completely goes to zero. If the burn rate exceeds the given burn time (2.5sec here) it displays an alert box. When the areas of circles become zero it means that the propellant is combusted and is ready to get unlinked from the missile to reduce weight thereby increasing the speed of the missile. This improves efficiency. The values that are received at random instances are represented in a tabular view. A graph is also plotted between the area and time with the calculated values for a regression pattern using Plotly software which improves the ease of understanding.

Existing system: The manual calculations existing to implement were time taking and are typical to understand. It is not time efficient which can be overcome by implementing a software code.

Proposed system: There are other formats of representation which may be complex to implement but here we are using an initial software code to calculate the parameters for a regression pattern at a constant Burn Rate to track the missile is used which also displays the top view and calculates initial parameters.

2.4 Algorithm

An algorithm is used here to state a step-by-step procedure to display how the project runs.

Step 1: Start

Step 2: Open the login page and enter your login credentials

Step 3: Entered details are validated

Step 4: Enter time instance where you would like to track the status

Step 5: Generates an image containing a top view of a missile along with calculating the parameter's value like area, radius, diameter etc., for a regression pattern

Step 6: An alert box is displayed if the entered instance exceeds the burnout time (here 2.5 sec)

Step 7: Random instant values are taken and plotted a graph

Step 8: Stop

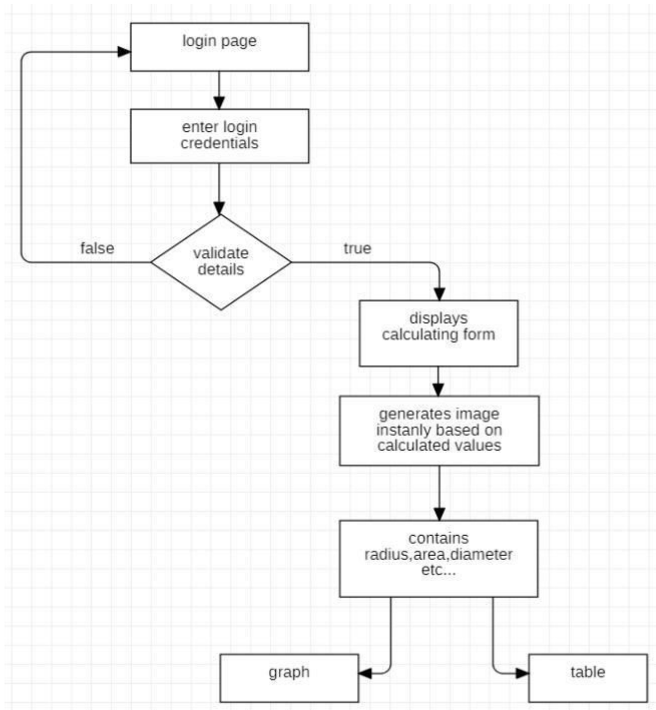

Fig -2: Flow chart describing the whole process of running code

2.5 Tabular Parameters

Burn Rate: Burn Rate is the rate at which decomposed gases are generated from the burning or igniting the propellant which in turn decides the rate of flow through the throat and nozzle pushing the object in the opposite direction. It is also known as the rate of regression.

Specifying the parameters: Solid propellants in missiles have many parameters which determine the status of the missile from source to destination. To track the parameters, the parameters are to be calculated and updated at every instance. Here the basic parameters like radius, area etc. are calculated.

Table -1: Tabulation of Calculated values

S. No	Time (sec)	Area (mm^2)
1	0	78.5
2	0.5	1962.5
3	1	6358.5
4	1.5	13266.5
5	2	22686.5
6	2.5	34618.5

3. RESULT

A graph is plotted between the values of time and area. The behaviour of time and area are directly proportional to each other.

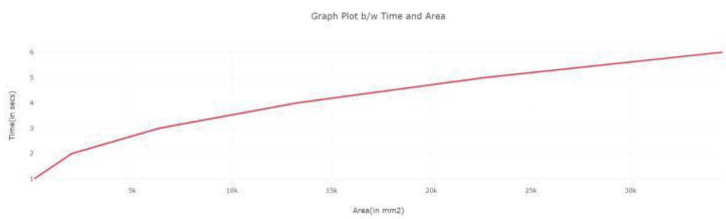

Fig -3: Plot between Time and Area

Future Enhancements: A further study can be done and development can be made to enhance the proposed system to improve efficiency. As solid propellants play a major role in the movement of a missile, there can be many types of research done in this field.

4. CONCLUSIONS

This paper consists of calculating parameters for a regression pattern at every instance of time. As the tracking of status cuts time and helps for a better output. The behavior of parameters at constant Burn rate is stated. The initial status of missile tracking stays important as technology gets updated day by day cost-cutting becomes a huge concern. However, the conclusions are derived from each of its components with specific methods of calculation for effectiveness.

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