Nozzle Flow Analyzer Project

Testing Requirements

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INTRODUCTION:

This Test requirement doc describes the required testing functions of a Nozzle Flow analyzing system (NFA). In this system a flow path can be built from a list of set components, and the user can input data for calculating the properties of the flow. The user selects from a set number of conditions called flow nodes, referred to as such because each node can act independently of each other, with the exit conditions of one node acting as the inlet conditions of the next. For the system as a whole, isentropic flow relations are used with the exception of if a shock is detected. In essence this will be a basic CFD, computational fluid dynamics calculator.

BACKGROUND INFORMATION:

The majority of the values that this program calculates are tabulated in appendixes A-E, Farokhi, S. (2021). Aircraft Propulsion. John Wiley and Sons. To check for the flow properties through a nozzle Appendix A offers tabulated values when mach is entering a diverging nozzle at M=1, or leaving a converging nozzle at M=1 (converging nozzles are diverging nozzles but flipped). Appendix D offers the tabulated values for heat addition, and Appendix E offers the tabulated values for friction tubes. These problems must be checked by hand, as these tabulated values need to be matched with exit values in the tables for tabulation. If a normal shock occurs that problem must be checked by working it out by hand with the equations discussed in the Software design document.

REQUIREMENTS:

For the first deliverable the flow nodes are not working in sequence yet and the user has to pick one to test. For any of the pieces they must be checked against the tables for correct values, for project validity estimations are assumed.

Table 1: Requirement Specifications

ID	Requirement Specification
1	The program asks for the needed data matching with the selected flow piece. ATS12
	Heat tubes ask for heat added, friction tubes ask for length and friction coefficient R1
2	As a developer I want the program to have exception handling.
	Program will continue to run even if string is put instead of number… R2
3	As I developer I want the program to properly detect a shock and notify the user
	If a shock is detected the Program prints that a shock is detected. R3
4	As a developer I want the program to notify the user of choked flow
	Program prints that the flow is choked (not valid in diverging nozzle type) R4
5	As a developer I want the program to properly use normal shock relations
	If a shock is detected NormalShock.java is called and calculates ratios R5.
6	As a developer I want every output from a node to be a valid input for the next
	Mach, Pressure, stored as exit values in a node, Mach prints to user. R6
7	As a user I want the program to tell the exit condition of a diverging nozzle
	Program prints out the exit condition for a diverging nozzle. R7
8	As a developer I want isentropic values to be called, where the flow has constant P0 and T0 (not heat tubes, and not in shocks)
	When isentropic values are needed the program calls Isentropic.java and uses said ratios. R8
9	I want the program to determine flow through a diverging nozzle when Mach is >1 (hard)
	Program uses an iterative method of the A/A* equation to create a ratio between inlet and outlet machs. R9
10	As a user I want the program to place a shock in friction tubes, but not heat tubes
	If the L* value is reached in the equation a shock is placed, Mach after that point =1 and flow displays as choked. R10
11	As a user I want the program to Notify me of the exit condition on every node
	If the User runs a node, an exit condition is calculated. R11
12	As A user I want the Exiting properties of one node to be the entrance properties to the next.
	If the user has more than 1 node, the exiting properties of the first go into the 2nd. R12
13	As a user, if the program detects a shock, the program should display the shock
	If a user creates a node that has a shock a shock is graphed R13
14	As A user I want to place nodes in a graphical stetting
	If a user places a node it is displayed in the GUI R14
15	As A user I want to input the information of the Node in a graphical setting
	If the user creates a node, a get information popup occurs R15

16	As a User I wish to be informed of any inaccuracies in the code,
	If the exit Mach is greater than 5, the GUI prints a warning to the user. R16
17	As a user I whish to be able to save my data
	If the user selects the save data option, they are prompted to save their data as a a CSV, and all of their inputs are saved. R17
18	As a user I wish to open up previously saved data
	If the user selects a file saved by the program in a previous point the program will run with the data from it. R18
19	As a user I wish to know the assumptions made in each piece
	When the program is opened a console printout informs the user of all of the made assumptions. R 19
20	As a user I wish to know if my given conditions are invalid for a flow
	If the given conditions are invalid, the system informs the user of badflow/ invalid flow R20

[Shall be completed for user stories actively worked in the current sprint. Add rows as needed.]

TEST CASES:

Table 2: Test Cases and Results

Req't ID	Test Case ID	Initial Conditions And Input	Expected Behavior Or Output	Actual Behavior Or Output	Pass Fail
R1	1	User inputs 1 for diverging nozzle	Program asks for Area1, area2, Pressure in, atmospheric pressure, temperature, and initial mach	Program does Expected Behavior	Pass
R2	2	User inputs a string for one of the flow properties	System informs user of bad inputs and program continues	System informs user of bad inputs and program conitinues	Pass
R3	3	(example values for shock) User selects diverging noz and puts in, Area ratio = 4 Pressure in = 15 Atmospheric P = 1 Temp = 300, Mach in = 1 Or open R3test.csv	Program displays a shock	Program displays a shock	Pass
R4	4	User selects a heat tube and puts in: Area 1 = 1 Mach in = 3 Pressure in = 15 Atmospheric P = 1 T = 600 Heat added = 3000000	Program informs the user of a choked exit flow	Program informs the user of a choked exit flow	Pass
R5	5	User Makes a friction tube with a friction coefficient of .15, length of 30, and inlet mach of 3	System displays a shock in the friction tube	System displays a shock in the friction tube	Pass

R6	6	User runs a modules (Any module) And inputs all data	System outputs an exit mach.	System has an output Mach value	pass
R7	7	User runs a diverging nozzle, runs any input	System outputs an exit condition.	System outputs an exit condition	Pass
R8	8	User runs a diverging nozzle	System calls on the isentropic values for the entrance mach	System calls on the isentropic values	Pass
R9	9	User runs a diverging nozzle, inputs a Mach in greater than 1, other values can be anything	System computes an exit mach, and runs normally, as if it would have if Min was 1 or <1	System has an output, using ratios of areas, and runs normally as it would have if Mach in was <1	Pass
R10	10	User runs a heat tube, Set friction = .005, And length equal to 60	Program prints an exit mach of 1	Program Prints choked flow	Pass
R11	11	User runs any node at with any conditions	An exit value is printed	An exit value is printed	Pass
R12	12	User has 2 nodes	2nd node inherits the exit conditions of the first	2nd node inherits the exit conditions of the first	Pass
R13	13	User creates a shock at exit	Shock is graphed	Shock is graphed	Pass
R14	14	User places a node in the gui	Node is displayed in gui	Node is displayed in gui	Pass
R15	15	User places a node in the gui	Popup asks for information	Popup asks for information	Pass
R16	16	User places a heat tube, Heat added of -20.22 Mach in of 3, gamma = 1.4 P in of 70, T in of 170, Atmospheric p =1	GUI says that the program has a mach 5 inaccuracy	GUI says that the program has a mach 5 inaccuracy	Pass
R17	17	After running the program, the user, selects save	Popup asks user to set name and save data and data is exported as a csv file	Popup asks user to set name and save data and data is exported as a csv file	Pass

R18	18	In a blank workspace user selects open, and selects a file from the swing explorer	CSV is opened and program runs with the data	CSV is opened and program runs with the data	Pass
R19	19	User runs the program	The console prints out the assumptions used for each node type	The console prints out the assumptions used for each nodetype	pass
R20	20	User runs a diverging nozzle with an atmospheric pressure greater than the inlet pressure	User is informed of bad flow at top of page	User is informed of bad flow at top of page	Pass

REFERENCES:

Farokhi, S. (2021). Aircraft Propulsion. John Wiley and Sons.

APPENDICES:

Appendices Blank For Now Will be Updated as Project Progresses