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Model Diff Tool Framework: Efficient Simulink Model Comparison Tool Using MATLAB M-Scripts

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ABSTRACT: This paper introduces a novel differential analysis tool (Difftool) designed for Simulink models, leveraging MATLAB m-scripting to enhance the evaluation of system dynamics. Difftool automates the process of extracting, comparing, and analysing differential equations from Simulink models, providing a streamlined approach to model validation and performance assessment. The tool integrates seamlessly with the Simulink environment, utilizing m-scripting to facilitate parameter adjustments and simulate variations in model behaviour. Key features include automated extraction of system equations, visualization of state-space representations, and the ability to perform sensitivity analysis on key parameters. Through case studies involving various dynamic systems, we demonstrate the efficacy of Difftool in uncovering insights into system stability. The findings reveal that Difftool not only enhances the analytical capabilities of engineers and researchers but also promotes a deeper understanding of the intricate relationships within complex models. This work contributes to the field by providing a robust framework for differential analysis that can be easily adapted to a wide range of engineering applications.

KEYWORDS: Difftool, Simulink model, MATLAB M-scripting, software validation, model block parameter.

I. INTRODUCTION

A differential tool for Simulink models can be highly beneficial for a variety of purposes, especially in managing, analysing, and validating models in the context of engineering and simulation. Here are some common uses: Model Comparison, Version Control and Collaboration, Simulation Configuration Comparison, Model Optimization and Validation, Tracking Dependencies, Integration with Continuous Integration (CI) Systems, Bug Detection and Debugging and Refactoring Models. A Simulink model diff tool is essential for efficient model management, troubleshooting, collaboration, and ensuring that models remain accurate, up-to-date, and aligned with specifications.

Paper is organized as follows. Section II describes related works of model differential tool. The flow diagram represents the step of the algorithm. Proposed method of Difftool that is given in Section III. Section IV presents experimental results showing results of the model Difftool. Finally, Section V presents conclusion.

II. LITERATURE SURVEY

When working with Simulink models and managing their version history, you can use Simulink's built-in model history tracking along with version control tools like Git to compare different versions of the model. This will display a list of changes with associated metadata (timestamp, user, etc.), but it won't show detailed content differences between model versions [1]. In Simulink, history tracking must be enabled manually. You can do this by setting the History parameter to on for a model. This will allow Simulink to track all changes made to the model.

Git is highly recommended for more robust version control and history tracking. You can track changes to the Simulink model file (.slx or .mdl), commit changes to a repository, and use Git to compare versions of the model over time. Since Simulink models are binary files, git diff won't show human-readable differences. But this can help you track the evolution of the model by comparing commit histories [2]. You can use git diff to compare two different versions of the model by comparing specific commits or branches. Simulink models are stored as binary files (e.g., .slx), which Git can't diff as text, but Git can still manage these binary files. You can also use Git tools like GitHub, GitLab, or SourceTree to visually inspect the history of the model. These tools will show you the commit history, and you can view diffs for text-based files. For binary files like .slx, they won't provide a detailed diff, but the history and metadata of the commits will be visible.

For comparing specific versions of Simulink models based on their saved versions, you can programmatically use `simulink.diff` to compare two models [3]. This can be done by loading different versions of the model and comparing them. This will give you a summary of the structural differences between the two models, such as Differences in blocks, Changes in block parameters and Differences in the connections between blocks. This will produce a detailed report that you can refer to for model history and comparisons.

III. METHODOLOGY

This proposed system is used to find the difference between the old version and the new version of the SWC model and Highlights the changes of Added block in new model and deleted block in old model with red colour.

Why Model Diff Tool: while doing Unit testing/Regression Testing of any SWC Simulink model, will take more time to identify the model changes of previous vs current version of the model by visual inspection. Sometimes we will miss the minor changes by mistaken to mitigate this issue we are using Diff Tool.

What is Model Diff Tool: Highlights the changes of Added block in new model and deleted block in old model with red colour. Captures the screenshot of the Added and deleted block paths to the respective folders (Diff_Tool_images_added and Diff_Tool_images_deleted). Copies the model path into the excel sheet to the respective folders (Diff_Tool_images_added and Diff_Tool_images_deleted) to cross verify the changes.

WORK FLOW

Step 1: Selecting the files SWC model files.

1. Taking old and new model as input
2. Saving the old model with the name “diff_toolmodel_deleted”
3. Saving the new model with the name “diff_toolmodel_added”
4. Get the list of the blocks used in the old and new model.

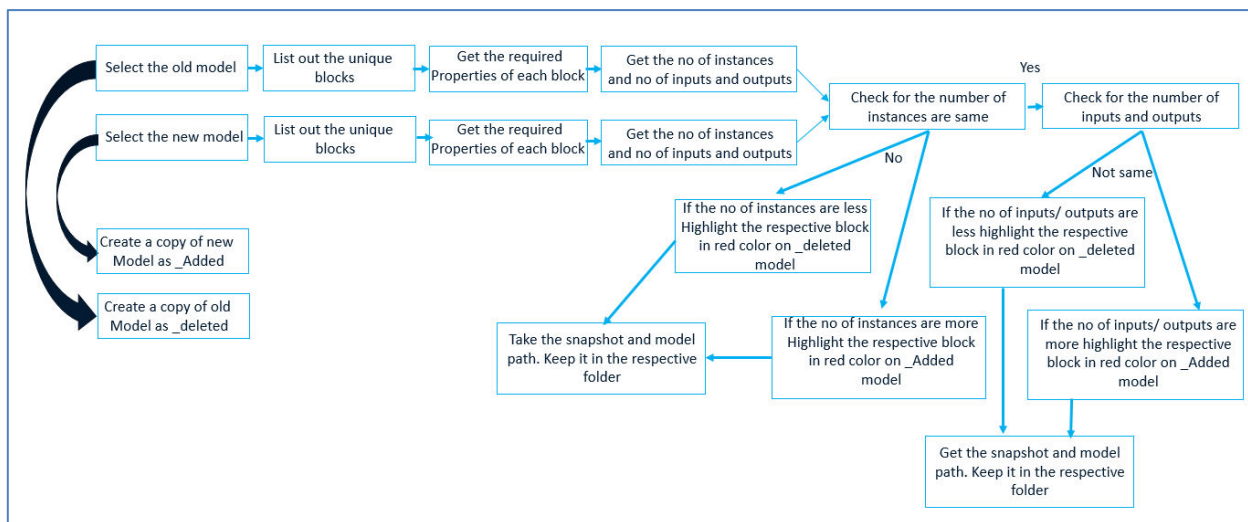


Fig. 1 Block diagram of proposed model diff tool framework

Step 2: List the unique block and it is properties

1. List the unique blocks
2. Create a cell array “blockInfo” to store the block name, number of instances of the block, path to the blocks and number of inputs and outputs to the blocks in the old model
3. Create a cell array “blockInfo1” to store the block name, number of instances of the block, path to the blocks and number of inputs and outputs to the blocks in the new model

4. Create cell array “summary_oldmodel” and “summary_modifiedmodel” to store “blockInfo” and “blockInfo1” respectively.

Step 3: Compare the model with unique block properties of old version and new version of the model

1. Store the common blocks which are in old model and new model in a variable.

If the block exists in the particular index in the blocklist of old and new model:

I. Check If the number of instances of the blocks are same

- a. Check if the paths of the blocks have been changed. If changed highlight the same.
- b. Obtaining the number of inputs and outputs for each instance.
- c. Checking if the number of inputs and outputs are same.
 - i. If number of inputs is same displaying the message
 - ii. Else storing the input path in a variable.
- d. Repeating the same for checking the outputs.

II. If the number of instances of the blocks is different

- a. Check if the paths of the blocks have been changed. If changed highlight the same.
- b. Obtaining the deleted paths from the model.
- c. Obtaining the number of inputs and outputs for each instance.
- d. Checking if the number of inputs and outputs are same.
 - i. If number of inputs is same displaying the message
 - ii. Else storing the input path in a variable.
- e. Storing the deleted inputs in a variable

Obtaining the block paths which are newly added and which are deleted. These are stored in 2 different variables.

Step 4: Highlight the changes, Capture the snapshot of Added and Deleted blocks in the respective model and save the path into the excel sheet.

1. Store the paths of differentiated blocks, inputs and outputs in a variable.
2. Check if the folders are available. If it is available, then delete and create 2 folders to store images from the new model and old model.

I. For new model Highlight the part of the model with red using the paths.

- i. Capture the screenshot of the subsystem.
- ii. Store the paths in the excel sheet.

1. If state chart is present, then capture the screenshot from the level up.

2. Save the images with the name ‘image’ with the number.

Move the excel file and images into the folder.

II. For old model Highlight the part of the model with red using the paths.

- i. Capture the screenshot of the subsystem.
- ii. Store the paths in the excel sheet.

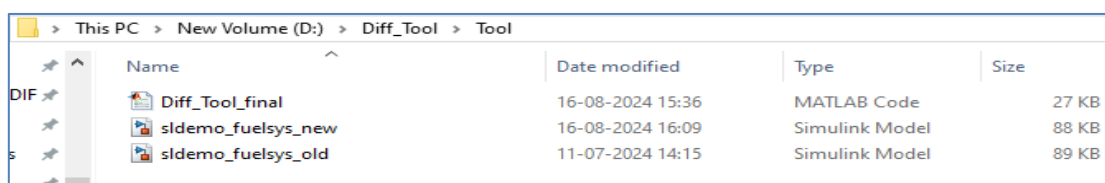
1. If state chart is present, then capture the screenshot from the level up.

2. Save the images with the name ‘image_’ with the number.

Move the excel file and images into the folder.

IV. EXPERIMENTAL RESULTS

1. FiguresThe folder consists of the old and new version of the model placed alongside the Tool script.



Name	Date modified	Type	Size
Diff_Tool_final	16-08-2024 15:36	MATLAB Code	27 KB
sldemo_fuelsys_new	16-08-2024 16:09	Simulink Model	88 KB
sldemo_fuelsys_old	11-07-2024 14:15	Simulink Model	89 KB

Fig. 2 Current directory of the diff tool before executing the tool

2. Once the Tool is run, folder will open. Select the old version of the model and click Open as shown in Fig. 3

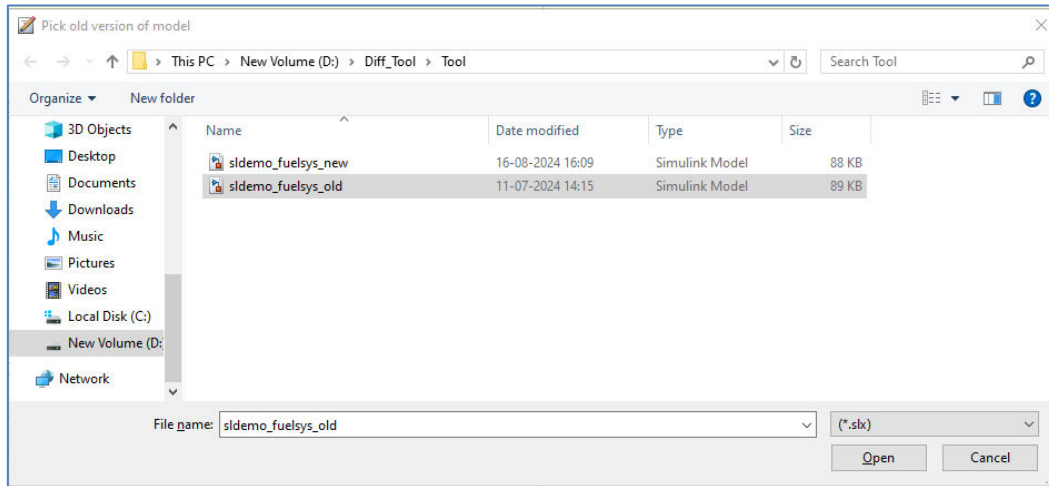


Fig. 3 selecting old version of SWC model

3. Next select the new version of the model and click Open as shown in Fig. 4

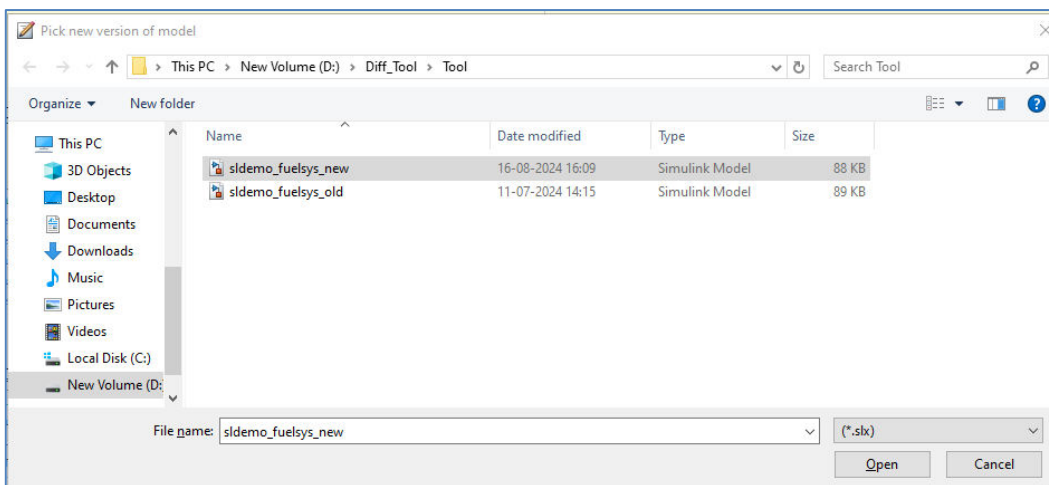


Fig. 4 selecting new version of SWC model

4. This is how the folder looks like after successful execution as shown in Fig. 5

“diff_toolmodel_added” has the added changes in the new version of the model as compared to the old version. “diff_toolmodel_deleted” has the deleted changes highlighted in the old version of the model as compared to the new version.

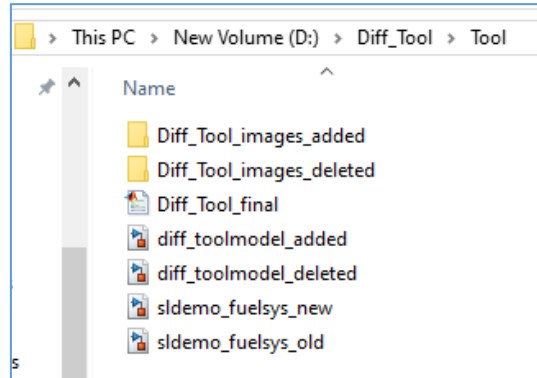


Fig. 5 Current directory of the diff tool after executing the tool

The folder “Diff_Tool_images_added” has the images of the highlighted portions in the new model along with the path to the changes stored in the .xlsx file as shown in Fig. 6

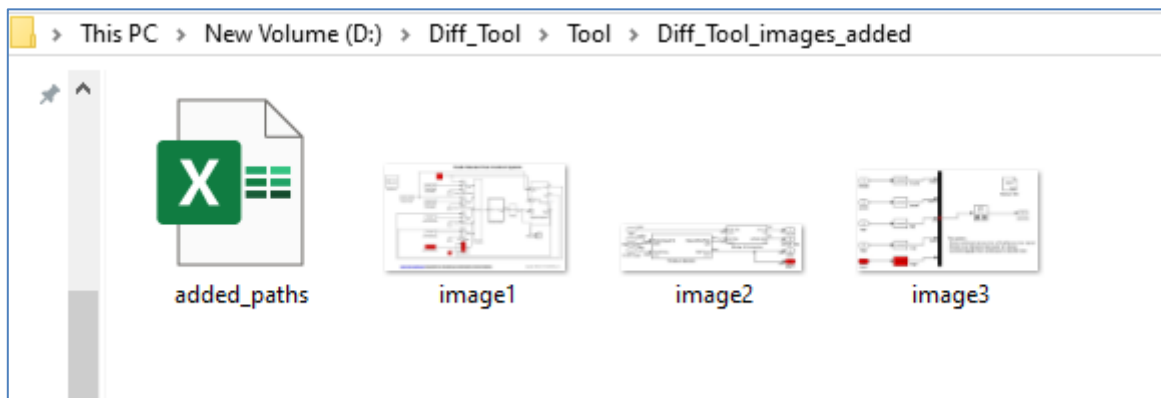


Fig. 6 Diff tool outcome of Added/modified portion of the model

The folder “Diff_Tool_images_deleted” has the images of the highlighted portions of the old model along with the path to the changes stored in the .xlsx file as shown in Fig. 7

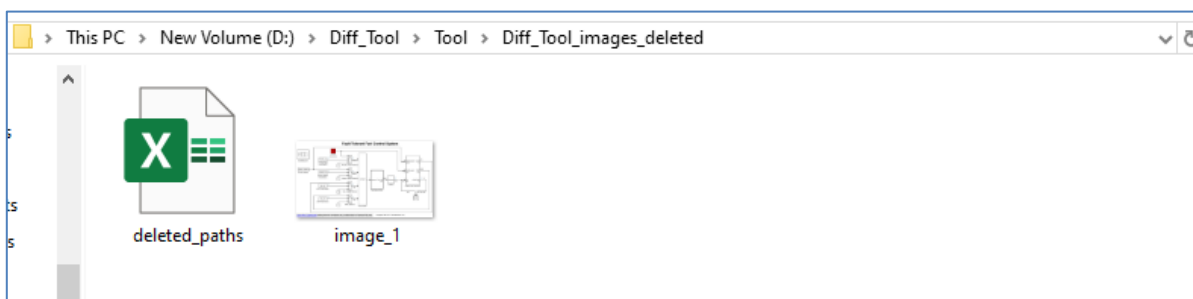


Fig. 7 Diff tool outcome of deleted portion of the model

V. CONCLUSION

The proposed Simulink model diff tool is a powerful asset for engineers and teams working with complex models in the Simulink environment. It provides essential functionalities for comparing different versions of models, detecting

discrepancies, and tracking changes, which is particularly useful in collaborative, version-controlled, and regulated environments. By highlighting modifications in model components, simulation settings, and parameters, it streamlines the process of debugging, validating, and optimizing models.

Moreover, the tool aids in maintaining consistency and quality throughout the model development lifecycle, ensuring that changes do not inadvertently introduce errors. It enhances collaboration, automates validation, and integrates well into continuous integration and testing workflows. Overall, the use of a diff tool significantly improves productivity, model integrity, and traceability, contributing to the successful development and deployment of Simulink models in diverse industries.

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- [3] 3. Comparison Tool, Diff and merge changes between Simulink models <https://www.mathworks.com/help/simulink/slref/comparisontool.html>



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