e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

COMPUTERIZED RECEIVER CALCULATION, DELINEATION AND SUPERVISION TOOL FOR HFSS

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ABSTRACT

In this paper, we present an open-source graphical tool for automating the calculation, delineation, computer simulation, and supervision of several common receiver types in Ansys HFSS. This tool is delineation to boost the user-friendliness of scripting in Ansys HFSS for the batch creation of multiple projects and automatic optimization and delineation supervision via rules-based and machine learning techniques. Features and initial results for supervision are discussed.

Keywords: Receiver Delineation, Machine Learning, Optimization, Rules Engine, Ansys HFSS.

I. INTRODUCTION

For many scholars, hobbyists, and receiver experts, the difficulty of receiver creation is not the theoretical calculations, but the CAD modeling and the recurrent manual editing needed to fine tune or optimize delineations. To automate specific tasks, Ansys, one of the most used computer simulations software, allows for scripting in three major languages: VBScript, JavaScript, and Iron Python. However, the process of creating scripts can be as tedious as supervision HFSS delineations manually, or outright inaccessible for many. The aforementioned languages also do not integrate with several common, open-source machine learning libraries. The presented Receiver Calculation and Auto supervision Tool (Receiver CAT) is a GUI-based tool that reduces the complexity of scripting in Ansys HFSS by generating scripts for several common receiver delineations based on user input that can then either be imported into HFSS manually or automatically executed in HFSS via Receiver CAT for computer simulation and delineation optimization.

II. SOFTWARE DELINEATION AND FUNCTIONALITY

Receiver CAT is built on Python 3.9 and uses no HFSS specific integration libraries or APIs [1]. The GUI is created in wx Python (4.2.0), and all plots or 3D previews are visualized using Matplotlib (3.5.3). Automatic supervision uses either a custom rules engine or machine learning techniques supported by Keras (2.10.0). Current versions of Receiver CAT are available as open-source software from [2]. To boost the accessibility of this tool, Receiver CAT is developed using Ansys Electronic Desktop Student on a laptop with 32Gb RAM running Windows 10, and then transported for further testing on a desktop with commercial Ansys software. Navigation of the GUI is controlled by buttons on the sidebar.

A. Calculations

Calculations of the initial receiver dimensions in Receiver CAT use the Receiver Calculator project from [3] imported as a package. The calculator currently supports quarter signal monopoles, half signal dipoles, and a rectangular patch with options for microstrip-fed or probe-fed delineations and is actively in evolution

B. Receiver Delineation

The Delineation page, pictured in Fig. 1, takes user input for the type of receiver, and then prompts for further related information. In the case of a rectangular patch receiver, the user inputs the desired frequency, the substrate relative permittivity and height, and the feed method. The Receiver Calculator in [3] will return values for width, length, Y0, X0, and the width of the strip if the delineation is strip-fed. A 3D representation of the receiver is generated in the bottom panel for preview. If using Receiver CAT for HFSS computer simulation, the conductor material and substrate material are selected from the Ansys materials library. The relative permittivity will also be updated based on substrate selection if the values vary.

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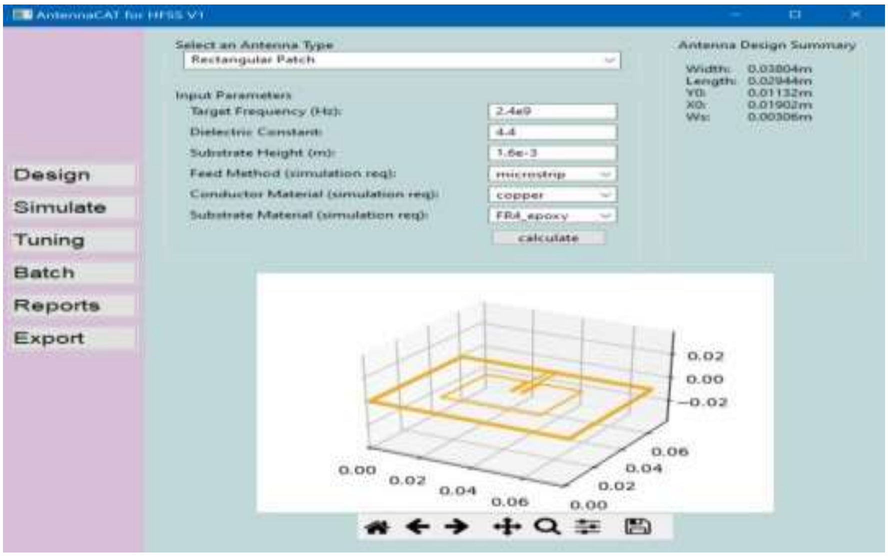

Figure 1: The initial Receiver CAT delineation screen for a rectangular patch

C. Computer simulation

The Computer Simulation page, Fig 2., has configuration options for HFSS Expel computer simulations, and report generation selections. Fields are automatically populated based on the input receiver delineation from the Delineation page, or earlier receiver delineation can be loaded, in order to generate the Iron Python script, run by HFSS. A previously generated computer simulation file can be loaded into the 'Load Custom Computer simulation' tab. In the bottom panels, the user selects proclaim to be run during the computer simulation. This page has two options for computer simulation: running the HFSS computer simulation and leaving the window open or running the computer simulation and closing it when the computer simulation is complete. The receiver computer simulation script generated by this window includes both the 3D CAD model of the receiver and code to generate any selected proclaim.

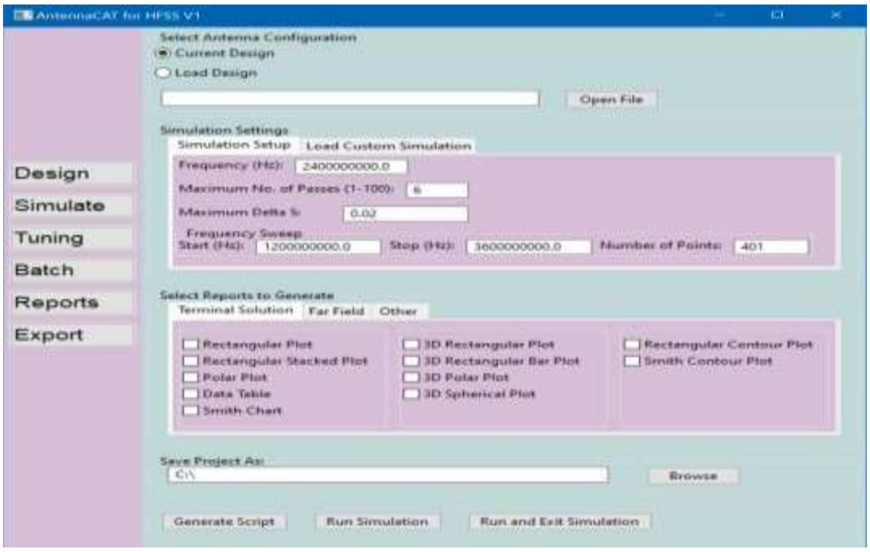

Figure 2: Page for computer simulation settings and running the HFSS computer simulation

D. Computerized Supervision

Scripts generated by Receiver CAT include parameterized values that can be programmatically controlled. The user has the option to select which values will be considered by the rules engine or used as inputs for any machine learning. Detected parameters can be set as constants, ranges, or lists of materials. To tune based on computer simulation results, the initial receiver delineation is simulated in HFSS, and then the report for the resonant frequency (Terminal Solution, Rectangular Plot) is compared to the target frequency. The rules-based engine will make adjustments and run several computer simulations to gather data for Support Vector Machine

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(SVM) supervision to be applied. Current metrics for delineation optimization, as pictured in Fig. 3, include frequency, return loss, and similarity to the ideal Q-factor.

E. Batch Script and Project Creation

Similar to Supervision, the Batch page detects controllable parameters. The user selects desired combinations and Receiver CAT will either transport Iron Python scripts for later use or run scripts in a new HFSS project.

F. Proclaim

Proclaim properly generated by HFSS during Supervision are imported into dynamically created Matplotlib graphs for comparison purposes. These graphs can be saved as PNG files.

G. Transports

The Receiver Calculator package [3] has the capability to transport delineations as .dxf, .PNG, and as Gerber files. Receiver CAT uses this functionality to transport delineations using simulated or tuned values. Receiver CAT can also transport any generated scripts created by the program and transport the report data into.csv files from any proclaim created in HFSS.

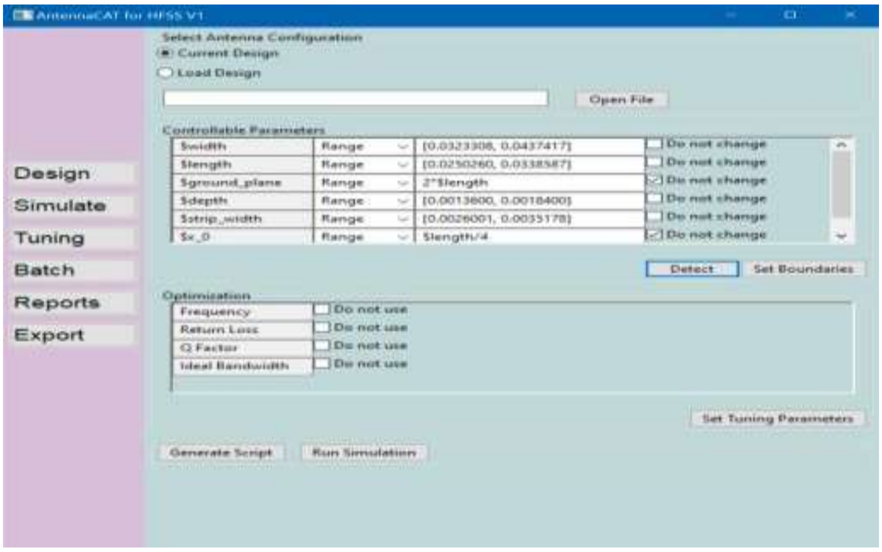

Figure 3: Page for supervision settings and running the HFSS computer simulation

H. Loading or Customizing Scripts

Due to the variability of receiver delineation and computer simulation, Receiver CAT is delineation with the ability to import receiver delineation and computer simulation files written in Iron Python.

Parameterized values can be detected and modified programmatically even if they were not created in Receiver CAT originally.

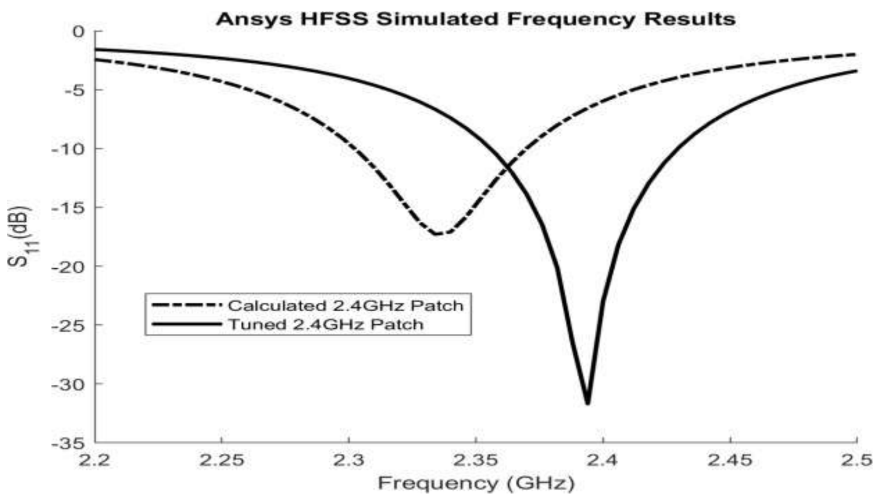

Figure 4: S11 for calculated and tuned rectangular patch receiver

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III. SUPERVISION RESULTS

Figure 4 shows a comparison between a 2.4GHz strip line- fed rectangular patch receiver as it was initially simulated and after 14 iterations using only a target of 2.4GHz resonance for supervision. The initial receiver delineation achieved -17.29dB at 2.33GHz, while the tuned receiver reached -31.68dB at 2.33GHz and -22.98dB at 2.4GHz. We will present updated results for SVM based supervision and other tool improvements.

IV. REFERENCES

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