Conducted Susceptibility Data Adaptation Tool

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Abstract

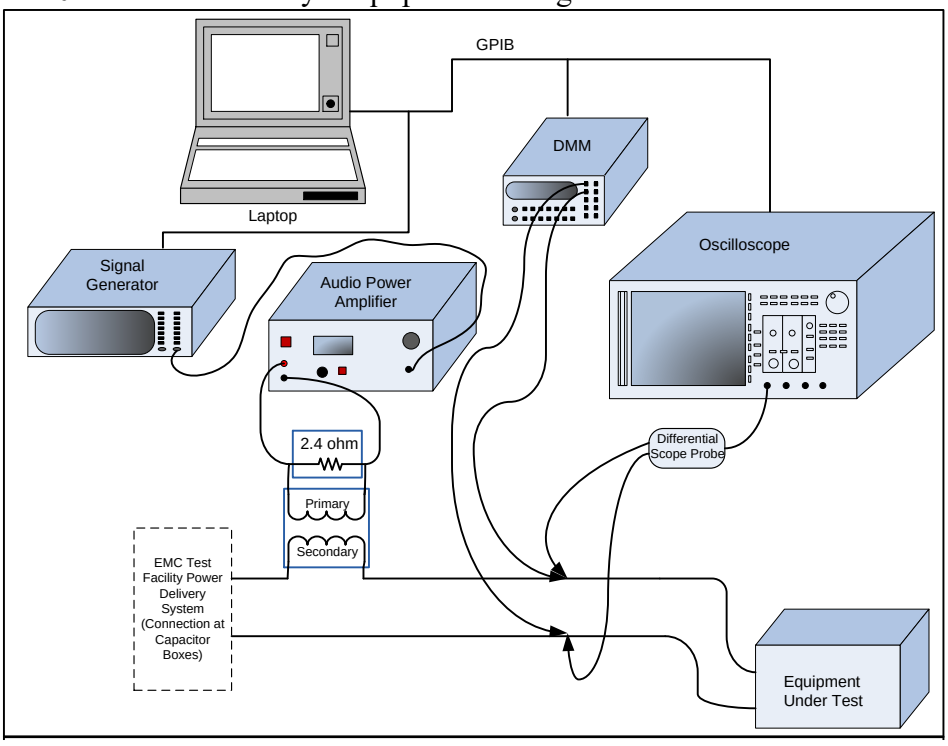
The purpose of this research project is to help NASA scientists increase effectivity in testing by reducing the amount of time required for data conversion from initial measurements to the analysis stage. This project resulted in a data conversion tool developed in python using the openpyxl library. When lab personnel perform the Conducted Susceptibility 101 (CS101) and Conducted Susceptibility 02 (CS02) tests in the Semi-anechoic Electromagnetic Compatibility Test Facility at NASA Langley Research Center, the driving code produces a text file under the .DAT extension. The data must be manually converted the .DAT file into an Excel file line by line for data analysis. The Conducted Susceptibility Data Adaptation Tool (CSDAT) uses python code to convert the .DAT files to spreadsheets automatically which saves lab personnel time which they could use for faster analysis as well as prevents possible human error such as leaving out a line of data in the manual conversion process.

Introduction:

Sensitive hardware requires verification before entering service. Electrical malfunctions in one component can result in failures throughout other systems. Electromagnetic compatibility (EMC) testing includes radiated emissions, conducted emissions, radiated susceptibility, and conducted susceptibility tests. Radiated and conducted emissions tests are performed to verify that the level of emissions produced by the equipment under test (EUT) meets the specified limits. Radiated and conducted susceptibility tests are performed to verify that the EUT will operate properly in the

expected electrical and radio frequency (RF) environment. As per MIL-STD-461G, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, the conducted susceptibility test from 30 Hz to 150 kHz (CS101) test "is used to verify the ability of the EUT to withstand signals coupled onto input power leads," (Department of Defense, 2015).

In the EMC Test Facility, the CS101 test setup consists of a laptop which uses LabView to automate the test and to record the data. This laptop is connected to a signal generator, a digital multimeter, and an oscilloscope using GPIB to communicate to the instruments. The signal generator provides an audio frequency sinewave signal to an audio power amplifier which increases the signal strength. The output of the audio amplifier is connected to the primary of a audio transformer. The secondary winding of the audio transformer is connected in the applicable EUT power lead in order to inject the test signal into the EUT power input. The LabView code is used to control the injected signals frequency steps and level to signal to the required strength during the automated test. The LabView code records the frequency, target injection level, actual injection level, calculated impedance, and the pass/fail decision. The figure below shows the CS101 EMC test facility's equipment configuration.



Summary of Research Project:

A. Approach

The focus for this research project was designing a tool to transfer data from the lab generated .DAT file to a Microsoft Excel spreadsheet quickly and without data loss.

The generated spreadsheet had to match a pre-existing format to maintain test data continuity. CSDAT began in excel as a base python program with no additional libraries. However, after much research, the program was found to require the openpyxl library. The program started by declaring a workbook object with the file path hard coded. This approach was flawed and quickly evolved into using tkinter, a GUI library for python. The program then used a tkinter dialogue box to determine a user inputted file path to a pre existing .DAT file. The .DAT file entered into a list in the program line by line to store the data for use later. Initially, this program only converted CS101 data and utilized a linear progression from file input to excel output with little need for user interaction, but upon the scope broadening to encompassCS02 data, the existing structure no longer proved effective. The CS02 test is another conducted susceptibility test performed in the EMC test facility that determines verifies the EUT's susceptibility to injected RF signals from 50 kHz to 50 MHz. Due to a different number of data point classifications, the original code would not accurately or fully plot the test data for CS02. Openpyxl utilizes a grid system to determine where data should be plotted which meant the linear program required more variability. This variability required a conversion from the linear approach to a class-based approach. All the original methods became class based methods and the excel size parameters, originally part of the main method became instance variables initialized to zero.

```
CHR
10/31/2019  2:20 PM  CS010379.DAT
PARAMETERS:
0.030
50.000
5.0
120.000 (Custom)
3.0
120V OP POS
DATE & TIME:  10/31/2019  2:20 PM
    Pt    Freq.   Target  Actual     Z  Observation
          (kHz)   (Vrms)  (Vrms)   (V/A)
!    1,  0.0300,  5.000,  5.026,   49.54, Pass
!    1,  0.0300,  5.000,  5.078,   49.49, Pass
!    2,  0.0315,  5.000,  5.059,   47.87, Pass
!    3,  0.0331,  5.000,  5.074,   46.69, Pass
!    4,  0.0347,  5.000,  5.039,   45.26, Pass
!    5,  0.0365,  5.000,  5.054,   43.37, Pass
!    6,  0.0383,  5.000,  5.080,   41.93, Pass
```

The image above is an example of a raw .DAT file from a CS101 test. The program then sorted the data file into three categories: the parameters, the type of data such as frequency or target, and the values. This program had to handle both CS101 and CS02 data files which differ in format. The initial parameters section is nearly identical in each both in number of lines and the data contained within which allowed a single method's compatibility with both test file types. The previously created list entered a parameter reading method which stored the initial parameter values in a list called params. Next, the program needed the data types.

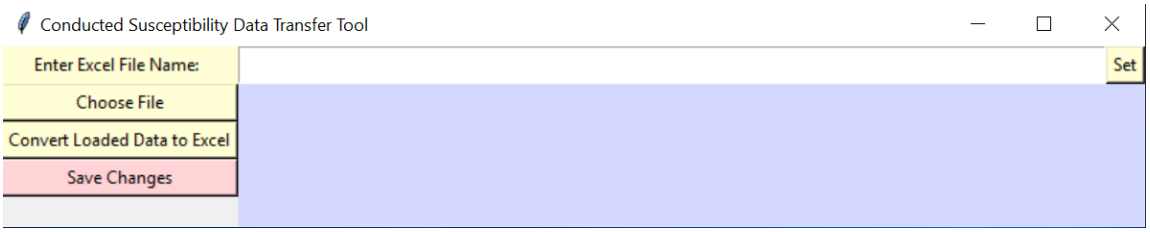
```
CHR
11/1/2019  12:46 PM  CS020388.DAT
PARAMETERS:
0.050
50.000
1.0
1.000 (Custom)
3.0
120V OP POS
DATE & TIME:  11/1/2019  12:46 PM
   Pt     Freq.   SGLvl   Target  Actual  2Monitor  Observation
          (MHz)   (dBm)   (Vrms)  (Vrms)  (Vrms)
!    1,    0.0500, -10.60,  1.000,  1.004,  0.883, Pass
!    1,    0.0500, -10.38,  1.000,  1.018,  0.905, Pass
!    2,    0.0525, -10.88,  1.000,  1.018,  0.899, Pass
!    3,    0.0551, -11.38,  1.000,  1.004,  0.891, Pass
!    4,    0.0579, -11.76,  1.000,  1.018,  0.895, Pass
!    5,    0.0608, -12.05,  1.000,  1.018,  0.912, Pass
!    6,    0.0638, -12.66,  1.000,  1.004,  0.891, Pass
```

As noted above, the CS02 test data contains a greater number of data categories with different classifications. To handle this difference, the program read in the data classifications and split the plaintext lines with a whitespace delimiter. It counted the number of elements in this split section and adjusted the instance variable governing the excel grid size accordingly. Finally, CSDAT read in the values from the test, excluding the first repeated value, and adjusted the excel parameter governing length. The program committed the changes to a user defined spreadsheet and completed.

B. Results/Conclusion

Conclusion

This project successfully resulted in a tool for data conversion. CSDAT will save significant time in data conversion and eliminate any human error. The program will allow for simpler integration with new lab personnel and streamlines CS101 and CS02 testing. The program was very effective in data transfer with no loss. Shown below is an image of the user interface and a side by side comparison between a valid test Excel sheet and a CSDAT generated Excel sheet.



CHR					
10/31/2019 2:20 PM CS010379.DAT					
PARAMETERS:					
0.03					
50					
5					
120.000 (Custom)					
3					
120V OP POS					
DATE & TIME: 10/31/2019 2:20 PM					
	Freq. (kHz)	Target (Vrms)	Actual (Vrms)	Z (V/A)	Observation
	0.03	5	5.026	49.54	Pass
	0.03	5	5.078	49.49	Pass
	0.0315	5	5.059	47.87	Pass
	0.0331	5	5.074	46.69	Pass
	0.0347	5	5.039	45.26	Pass
	0.0365	5	5.054	43.37	Pass

(Original CS101 Data)

CHR					
10/31/2019 2:20 PM CS010379.DAT					
PARAMETERS:					
0.030					
50.000					
5.0					
120.000 (Custom)					
3.0					
120V OP POS					
DATE & TIME: 10/31/2019 2:20 PM					
Pt	Freq. (kHz)	Target (Vrms)	Actual (Vrms)	Z (V/A)	Observation
1	0.0300	5.000	5.078	49.49	Pass
2	0.0315	5.000	5.059	47.87	Pass
3	0.0331	5.000	5.074	46.69	Pass
4	0.0347	5.000	5.039	45.26	Pass
5	0.0365	5.000	5.054	43.37	Pass

(CSDAT Generated Data)

References

Department of Defense. (2015). *MIL-STD-461G.* DOD.