

# Development of Graphical User Interface (GUI) in Determination Geomagnetic Parameters Using MAGDAS Data

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**Abstract**—The accuracy of prediction and monitoring the magnetic variation should be increased. The accuracy can be increased by analyzing the methods that are used for observation and execution of the raw data. The parameter of magnetic that produces most of the effect on prediction and introduces serious accuracy degradation into the system is Magnetic Data Acquisition System (MAGDAS). By modeling this MAGDAS parameter, the evaluation of the prediction error and the correction of these prediction errors for differential prediction can be done. Thus, the analysis using the single frequency method using the graphical user interface is an easy, simple, more efficient and accurate way of determining and analyzing this MAGDAS parameter.

**Keywords**— Magnetic Data Acquisition System (MAGDAS), Graphic User Interface (GUI)

## 1. INTRODUCTION

The Magnetic Data is represented in tesla (T) unit, which is the SI, derived from the unit of magnetic field (specifically magnetic flux density) [11]. The tesla is equal to one Weber per square metre and was defined in 1960 in honor of inventor, scientist and electrical engineer Nikola Tesla. The ambient magnetic field is expressed by horizontal (H), declination (D), and vertical (Z) components are digitized by using the field-canceling coils for the dynamic range of  $\pm 64,000\text{nT}/16\text{bit}$ . The total field ( $F+\delta F$ ) is estimated from the  $H+\delta H$ ,  $D+\delta D$ , and  $Z+\delta Z$  components [2].

MAGDAS (Magnetic Data Acquisition System) is a system of 50 real-time magnetometers that is being deployed by Kyushu Sangyo University of Fukuoka, Japan, as part of Japan's leading contribution to International Heliophysical Year of the United Nations [IHY] [9]. Ground observation is "a must" for meaningful study and exploration of outer space. MAGDAS system is now being deployed in order to carry out space weather studies since 2005 up till 2008. The ground analysis will use MAGDAS data to study the variation in the H component of earth's magnetic field.

MAGDAS (The magnetic Data Acquisition System) is being deployed to space for weather studies during the year 2005 to 2008 [3]. The system

will aid the study of dynamics of geospace plasma changes during magnetic storms and auroral sub storms, the electro-magnetic response of the ion-magnetosphere to various solar wind changes and the penetration and propagation mechanisms of DP2 channel-ultra low frequency (ULF) range disturbances from the solar wind region into the equatorial ionosphere [10]. With the help of MAGDAS data, one can conduct real-time monitoring and modeling of the global three-dimensional current system and the ambient plasma density for understanding the electromagnetic and plasma environmental changes in the geospace [5].

The magnetometer system consists of a 3-axial ring-core sensors, fluxgate-type magnetometer, data logging/transferring unit, and power supply. Magnetic field digital data ( $H+\delta H$ ,  $D+\delta D$ ,  $Z+\delta Z$ ,  $F+\delta F$ ) are obtained at the sampling rate of 1/16 seconds, and then the averaged data are transferred from overseas stations to SERC in near real time. The x, y and z are the earth magnetic field [8].

The three components of the earth's magnetic field along such axes are called X, Y and Z. It will then produce

$$F = \sqrt{x^2 + y^2 + z^2} \quad (1)$$

Where X is referred to the geographic northward value, Y is referred to the eastward value and Z is referred to the downward value. The H component defines the horizontal component of the total field intensity which can be measured using formula and

$$H = \sqrt{x^2 + y^2} \quad (2)$$

in which it will also include H as the horizontal component. In order to describe the field, in addition to the intensive components, we can also use angular elements.

A Graphical User Interface (GUI) is a *human-computer interface* that uses a combination of technologies and devices to provide a platform the user can interact with for the tasks of gathering and producing information. This makes it easier for

people with little computer skills to work with and use computer software [1].

A major advantage of GUI is much easier for a new user to move a file from one directory to another by dragging its icon with the mouse rather than by having to remember and type seemingly arcane commands to accomplish the same task.

## II. METHODOLOGY

The first stage for this project is developing GUI. This is where the MATLAB programming version R2007b will be used. The facilities 'GUIDE' in this software that have variety of equipment (TOOLS) which will be used in developing GUI. Guide initiates the GUI design environment (GUIDE) tools that allow creating or editing GUIs interactively. Guide opens the GUIDE Quick Start dialog where one can choose to open a previously created GUI or create a new one using one of the provided templates. The Help browser is used to search for and view documentation and demos for all Math Works products. There are several help functions that provide forms of help different than the Help browser documentation, or provide alternative ways to access the Help browser information [4].

The second stage is doing the performance test for GUI that was developed. That obtains how to browse data, checking the error of data, parameter chosen and the comparison of results that normally is retrieved from method extracting data.

This stage will be repeated if the performance test is in the state of error. The performance test will follow the step-by-step procedure to make it easy to detect the error of progress. The progress will continue with analysis if the performance test is not having problems or error.

The last stage in this project is doing analysis for GUI. It focuses more to comparison with the result that is retrieved from conventional method. It obtains the correct data that is executed, error of reading data, and result of reading data shown by graph.

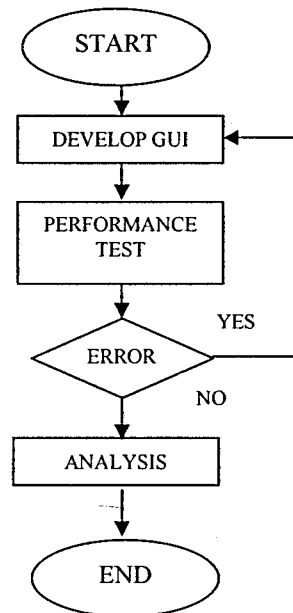


Figure 1: Flowchart of project

## III. RESULTS AND DISCUSSION

This GUI contains eleven toolboxes. Those boxes are front page and main menu. One can choose the boxes in the main menu. There is a function of loading new data where it will load a raw data, while old data will load the stored data that was extracted. The other toolboxes are browse data, checking data, choose parameter and graph. All the toolboxes are arranged for easier usage where users can see the 'help' function that can be used for assisting them.

This GUI was tested and the successfully executed MAGDAS data showed the correct results. The program started with selecting between load a new data or old data. After that, data will browse for checking error before load. The error data cannot be processed in this GUI. Those who have chosen both for user will get the results they wanted. The first one is subplot graph and single graph. For the subplot, it will appear in graph form with all the parameter in one toolbox and the single graph will appear two graph forms and only one parameter in one time where user can choose in the parameter toolbox.

Equation 3 is for leveling graph where using function polynomial evaluation and 'a' and 'b' is the linear coefficient, one day is equals to twenty-four hours, t is current time and x is the time at the peak data [6].

$$Y = b \cos(2\pi/24)(t-x) + a \quad (3)$$

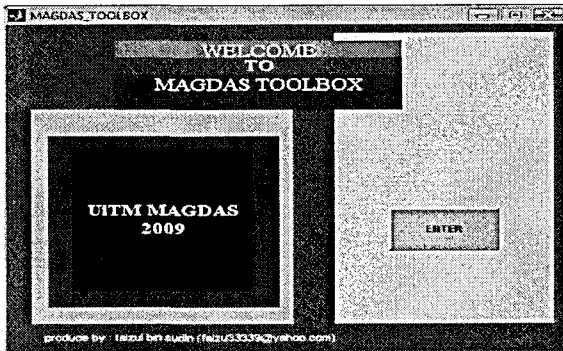


Figure 2: The Interface MAGDAS Toolbox.

This is interface toolbox for this MAGDAS GUI. User just click the button ENTER for go to main menu in this GUI.

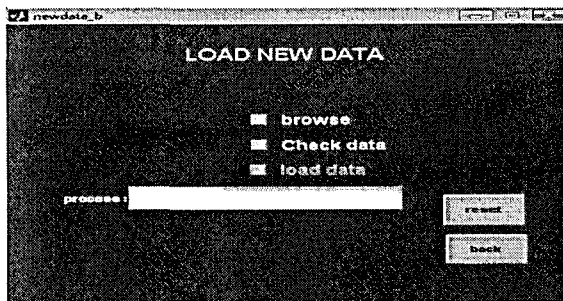


Figure 3: New Data Toolbox.

This toolbox appears when users choose the new data at the welcome toolbox. User can browse the raw data by tick at browse menu. It can browse anywhere the data stored. Check menu is for check the data have error or not. Only when the data is not error will be load for executed. Reset button is clear all the data and back is for go to toolbox before.

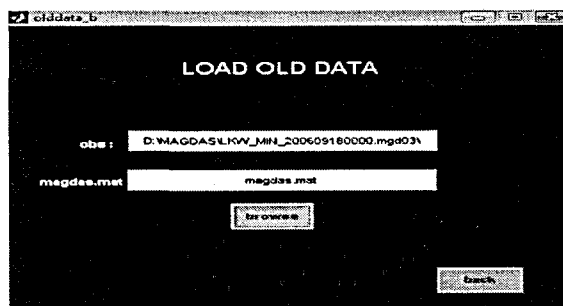


Figure 4: Old data toolbox.

This toolbox appear when user choose for reload the old data . At the old-data toolbox, users only need to browse data where they are already extracted and stored.

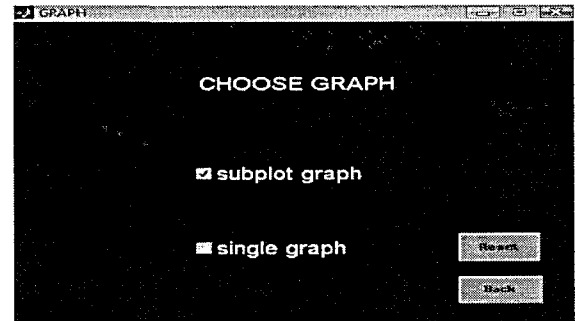


Figure 5: Choose Graph Toolbox.

This the third stage in this GUI where user can choose whether want analyze the all parameter in one graph or single parameter in one graph. User only need tick anyone menu at the one time.

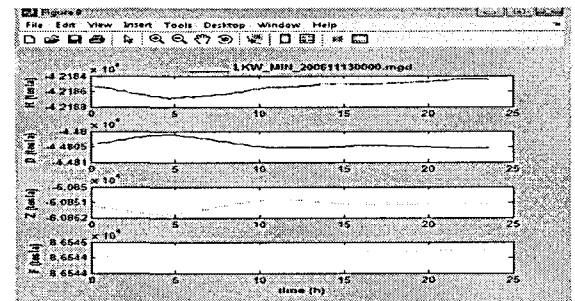


Figure 6: Example of Subplot Graph.

Graph in figure 6 is shown the all parameters for MAGDAS data parameter. User can compare the all parameter using this graph. This graph also shows the H parameter is most significant to determine the geomagnetic storm even occur in space.

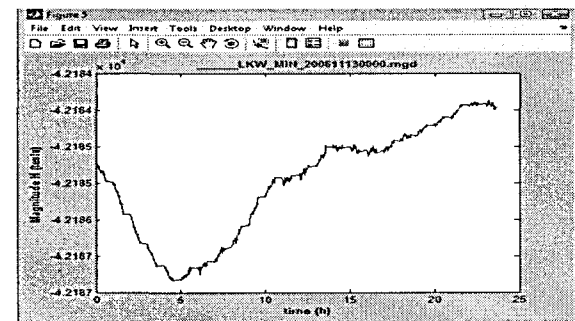


Figure 7: Example of Graph for H Parameter (13/11/2006) Langkawi's station.

This graph is original H parameter where shows the more complex wave. It will transpose to leveling graph where show in figure 8.

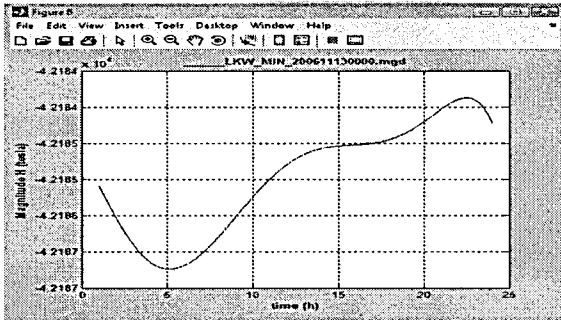


Figure 8: leveling graph that based on single graph.

Figure 8 shows the leveling graphs where this will advantage to user for analyze the graph. This more easy to state the magnitude for each time.

Table 1 is comparison tempo for extract MAGDAS data between conventional way and GUI. It shows that the time taken to extract MAGDAS data using GUI is more efficient compare than conventional way.

Process	Conventional		GUI	
	Single	Subplot	Single	Subplot
Browse data (min)	< 5	< 5	< 1	< 1
Load data (min)	< 3	< 3	< 1	< 1
Store data (min)	< 7	< 10	< 1	< 1
Output (min)	< 3	< 5	< 2	< 3

Table 1: Differences Tempo in Extract MAGDAS Data

For running this MAGDAS GUI need some specialization for MATLAB version and data format. This is limitations for using GUI where they have analyzed from analysis that was done:

- a) MATLAB version : R2007b and latest

- b) Data format: .MGD ( MAGDAS format)

This GUI has been chosen in two forms; those are new MAGDAS data for raw data and old MAGDAS data for executed data. Each toolbox has guide and *help* that will assist and show the step that need to be done. The advantages for this GUI are it can store data system, browse data, load data and also plotting graph. Store and load data will take just a few minutes for one data. This system will make it easier for users to execute data without repeating the process for executing data [7].

Process	Tempo
Checking data	< 1 minute
Appear graph	< 2 minute

Table 2: Process and Tempo

However, GUI has a few disadvantages. First, this GUI only can execute the MGD format data. Second, GUI also can load data only to obtain it for a limited time of 24hours only. Hence, users cannot do analysis for two days or 48 hour data in a row. Next, users need to load the data twice and make analysis manually. Then, specific equipments or requirements are needed to run the GUI, making it certain that not any computers can run the GUI program. Lastly, the MATLAB's version R2007b is one of the latest versions and many users are still using the old version. This makes users feel like being forced to run GUI [6].

#### IV. CONCLUSION

GUI (Graphical User Interface) is complete and well developed where it is an advantage for users to execute the MAGDAS data. There is no need to repeat the execute process anymore. The equipment in the MATLAB programming is very helpful in completing this project. Results from operating GUI are the same with the result from conventional way. These mean that GUI is error-free and ready for the use of any users or organizations related.

However, GUI is still improving for future use to cater to the situation and the users' needs. The current GUI will become a platform for programmers in developing a more modernized GUI that might be used to execute the MAGDAS data in the most convenient way.

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