LOK-Viewer : Graphical Interface Application for Geomagnetic Data in Observatory Geomagnetic Lombok

Giri W. Wiriasto, Teti Zubaidah, Bulkis Kanata
Electrical Engineering Dept.
Mataram University
Lombok, Indonesia

Indira P. Kinasih
Mathematics Education Dept.
IKIP Mataram
Lombok, Indonesia

Abstract— **This paper is aimed to discuss the development process of an interactive application which able to display numerical, graphical and statistical profile of geomagnetic data for Lombok Observatory, named *LOK-Viewer*. LOK which is a codename for Geomagnetic Lombok Observatory, is being focused to obtain and measure data on the earth's magnetic field. LOK has taken that measurement since March' 2014. It is important to have a dynamic version of this data by visualize and display it continuously as an integrated system. This software is specific, because it is adapted from raw data files. It is mean that it is not associated with any particular program or application on operating systems. On the interface, we provide table view with *mean value, smallest and largest value, and standard deviation* are showed in statistical summary panel. This software interface is developed using GUI-Matlab and compiled build code with *executable* file using *Matlab Compiler Runtime*2012b. *LOK-Viewer Ver.2015a* has been developed and able to be run directly standalone. This application allows users to conduct visual observation by noticing earth's magnetic field graphical pattern shown on the interface with differentdaily data. It is also create a possibility of easiness and simplicity for users, since they do not need to collect a very large data manually in order to observe its characteristics.**

Keywords— LOK-Viewer; Lombok Geomagnetic Observatory; Geomagnetic data

I. INTRODUCTION

Geomagnetic Observatory Lombok (LOK*) located on Lombok Island at Latitude: 18.65 S; Longitude: 171.13 that refer to IGRF-11 for 2010. The LOK Observatory is run in co-operation of the Faculty of Engineering, Mataram University and the GFZ-Postdam since March' 2014. The geomagnetic field intensity and directions are continously recorded at the observatory[1]. Lombok Island has the highest intensity geomagnetic anomalies in Indonesia [2]. Therefore, its existence will give a crucial contribution in terms of filling the data void from the global geomagnetic equator region, especially Southeast Asia region.

Continuous and long-term observation to geomagnetic phenomenon is needed to be able to understand some changes in Earth's magnetic field, which is a life shields against solar storms and cosmic rays. Geomagnetic data are very useful for many practical purposes, including air and sea navigation, the search for natural resources, especially minerals and geothermal resources, as well as for the mitigation of natural disasters, including earthquake. To measure the Earth's magnetism in any place, we must measure the direction and intensity of the field. The Earth's magnetic field is described by seven parameters. These are declination (D), inclination (I), horizontal intensity (H), the north (X) and east (Y) components of the horizontal intensity, vertical intensity (Z), and total intensity (F) [3]. Five parameters of which we use is a component of X, Y, Z, F and delta-F. LOK Observatory use Three-axial fluxgate magnetometer FGE suspended deviceto measure the variation of magnetic field in three vector components. This tool generates log raw data as follows;

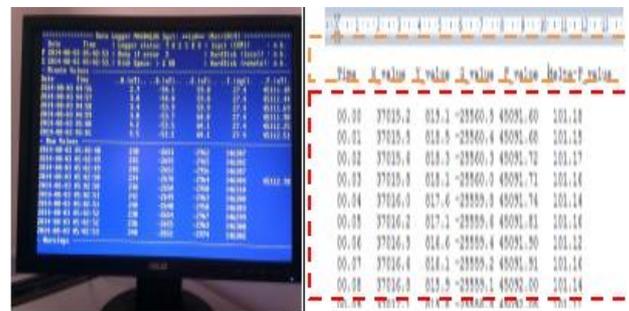Fig. 1. Show first columnmarked with orangedash box there is six variabel from raw data including'Time', 'X_value', 'Y_value', 'Z_value', 'F_value' and 'delta-F_value'. 2nd column which is marked by box markred dash present the raw data value. The name file of data has followed the naming standart, i.e'lo0_141001.dat'. 'lo0' is 'Lombok Observatory' and '141001' means local time data produce with format 'yy-mm-dd'
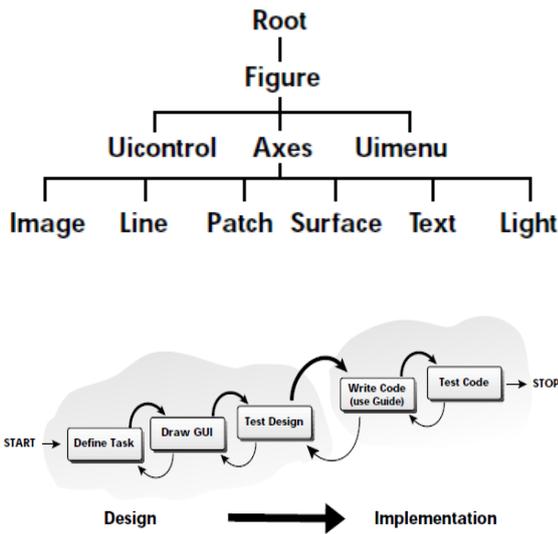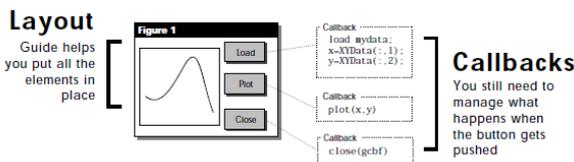
Fig. 2. GUI Design process

Fig. 3. sample GUI Layout

This template, modified in MS Word 2007 and saved as a "Word 97-2003 Document" for the PC, provides authors with most of the formatting specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) ease of use when formatting individual papers, (2) automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) conformity of style throughout a conference proceedings. Margins, column widths, line spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

II. METHOD

A. GUI Matlab

in a GUI Matlab one that easily recognizableas figure. Figure is component or object is called Handle Graphics. Each component or object on the screen has a unique identifier, called a handle. That Allows us to go back and modify the object at any time.

Generally there's no need to worry about the handles, but they're always there. Shown below is a diagram of the Handle Graphics object hierarchy. These are all the categories of object types in MATLAB. The Property Editor, one of the Guide tools, is extremely useful for navigating the Handle Graphics hierarchy. If you need to get or set any Handle Graphics property on any object, chances are you can do it most easily with the Property Editor[4]. *Figure 2* shown GUI design process approach. There are two importance general process, design and write code.

As shown in the illustration *figure 3*, even afteryou've used Guide to get the layout right, you still need to write the MATLAB language callbacks.Technical overview about the relation between GUI figure and callback function on LOK-Viewer can be seen on *figure 6*.
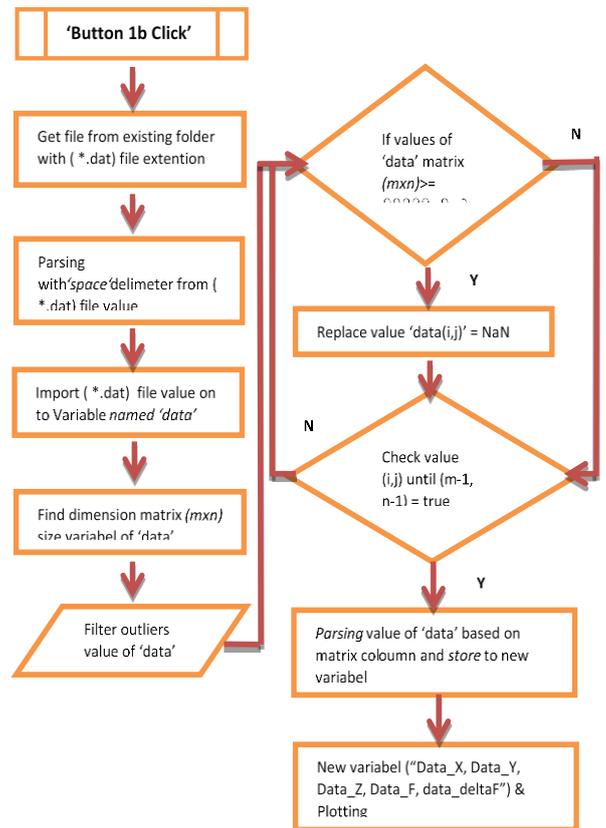
B. Flowchart Model

Fig. 4. Flowchart diagram for Main Window interface from LOK-Viewer

Fig. 6. Diagram Block LOK-Viewer GUI Composition

In general, the algorithm applied to the GUI / interface Main window (page 1) application was designed using a flowchart diagram shown in figure 4. Based on this flowchart algorithm,we write a source code or program that fill in Callback Function. In this case, Callback Function is a function of object component 'Button 1b' named by 'push_ambildata_Callback'. We include The complete program later in another section of this paper.

Figure 4 shows flowchart that draw an overall idea of the main window. The second page's algorithm is not too different from the one in main window, it just needs to be adjusted slightly. Such as adjusting the command to specify data handling (*see rectangle second box in figure 4*).

III. DESIGN INTERFACES

A. *LOK-Viewer Design Interfaces*

The development of this interface we adjust to the data and needs. From some papers related to the development of GUI interface using Matlab also design an interface adapted to their respective problems[5][6][7]. Figure 5 shows LOK-Viewer's main window interface. It is contain load data button, exit button and dinamyc text box that indicate the existing file name (see *figure 5 on appendix*).

There are also four axes plot which able to display graphics drawn from original data, assisted by radio button that allow users to adjust that graphic will be displayed. Table display on the left side of main window will show numerical data after it is loaded with load data button. Main window also had a statistical summary table on the left-bottom side. It will ease user to gain a statistical inference related to geomagnetic data.

B. *LOK-Viewer GUI Composition*

Figure 6 shows the composition diagram block between objects/components in main window interface as shown on *figure 5*.

This GUI Composition shows that there are two main callback function inside the LOK-Viewer main function.

These two main callback function will take control all of the components and objects.

C. *LOK-Viewer GUI Matlab code*

This session will show us the main window LOK-Viewer's source codeas displayed on figure 5. These codes allow us to formulate data processing. We also enclose some detail commentsthat help reader to understand this program.

GUI-CallBack Function Script Main Window (Page-1).

```matlab
% Last Modified by GUIDE v2.5 05-Jun-2015 08:50:31
% -----------------Main_Function----------------------------%
functionvarargout = LOKViewer_V03(varargin)
% LOKVIEWER_V03 M-file for LOKViewer_V03.fig

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',      mfilename, ...
'gui_Singleton',  gui_Singleton, ...
'gui_OpeningFcn', @LOKViewer_V03_OpeningFcn, ...
'gui_OutputFcn',  @LOKViewer_V03_OutputFcn, ...
'gui_LayoutFcn',  [] , ...
'gui_Callback',   []);
ifnargin&&ischar(varargin{1})
gui_State.gui_Callback = str2func(varargin{1});
end
 ifnargout
   [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT OF MAIN FUNCTION %

%-----Initially Sub-Function from Component Object----------%
% --- Executes just before LOKViewer_V03 is made visible.
function LOKViewer_V03_OpeningFcn(hObject, eventdata, handles,
varargin)

% Choose default command line output for LOKViewer_V03
handles.output = hObject;

% Update handles structure
guidata(hObject, handles);

% -- Outputs from this function are returned to the command line.
functionvarargout = LOKViewer_V03_OutputFcn(hObject, eventdata,
handles)

% Get default command line output from handles structure
varargout{1} = handles.output;

% -- Executes on button press in push_ambildata. (Get file from
exissting folder – see block diagram)
functionpush_ambildata_Callback(hObject, eventdata, handles)
%---This is block part of Read / import File
filename1=0;                      %Reset  value file

%-- Opening dialog box  to getting file as variabel  filename1
filename1 = uigetfile('*.dat');

%--- Used for exeption handler dialog box
ifisequal(filename1,0)
return
end

%--- Used for getting  filename1  to  text1 box
```

```
set(handles.text1,'String',filename1);
%--- Used for read *.DAT file and store to 'data' variabel '
delimiterIn = ' ';              %Parsing text with Delimeter 'space'
headerlinesIn =0;
A = importdata(filename1,delimiterIn,headerlinesIn);
data = A;                       %Used for rename new variabel

%getting Matrix Dimension for 'data' variabel
SizeData=size(data);
Nrows=SizeData(1);
Ncols=SizeData(2);

%filtering Outlier data --------------------
for i=1:Nrows
for j=1:Ncols
if data(i,j)>=99999.9 ;
        data (i,j)=NaN;         %replace data with 'NaN'
end
end
end
% used for Parsing 'data' variabel based on  Column Element and
store to new variabel
dataX=data(:,1);   % Vector Variabel for time / X-coordinate
dataY1=data(:,2);  % Vector Variabel for Y1 (data_X / Y1-coordinate)
dataY2=data(:,3);  % Vector Variabel for Y2 (data_Y / Y2-coordinate)
dataY3=data(:,4);  % Vector Variabel for Y3 (data_Z / Y3-coordinate)
dataY4=data(:,5);  % Vector Variabel for Y4 (data_F/ Y4-coordinate)
dataY5=data(:,6); % Vector Variabel for Y5 (data_deltaF / Y5-coord)

% STATISTICS BLOCK

[Ndata] = [size(dataY1,1) size(dataY2,1) size(dataY3,1)
size(dataY4,1) size(dataY5,1)]     % Number of 'data' rows
[MINdata] = [min(dataY1) min(dataY2) min(dataY3) min(dataY4)
min(dataY5)];                   % min 'data' value
[MAXdata] = [max(dataY1) max(dataY2) max(dataY3) max(dataY4)
max(dataY5)];                   % max 'data' value
[MEANdata] = [mean(dataY1) mean(dataY2) mean(dataY3)
mean(dataY4) mean(dataY5)]; )] % mean  'data'  value
[STDdata] = [std(dataY1) std(dataY2) std(dataY3) std(dataY4)
std(dataY5)]; )];               % std.dev  'data'  value
stat = cat(1, Ndata, MINdata, MAXdata, MEANdata, STDdata);

%-----------Plot data-------------
x =dataX;                  % 'X' coordinate
y1=dataY1;                 %'Y1' or 'X_value' coordinate
y2=dataY2;                 %'Y2' or 'Y_value' coordinate
y3=dataY3;                 %'Y3' or 'Z_value' coordinate
y5=dataY5;                 %'Y5' or 'delta-F_value' coordinate

% Plotting  'X_value' on axes1
plot(handles.axes1,x,y1,'-rs','LineWidth',2,...
'MarkerEdgeColor','k',...
'MarkerFaceColor','g',...
'MarkerSize',1)
%Setting graphical layout
set(handles.axes1,'XGrid','on','YGrid','on','XTick',0:23)
xlabel(handles.axes1,'Time(hr)');
ylabel(handles.axes1,'(X/dt)nT');
% Plotting  'Y_value' on axes2
plot(handles.axes2,x,y2,'-rs','LineWidth',2,...
'MarkerEdgeColor','k',...
'MarkerFaceColor','g',...
'MarkerSize',1)
set(handles.axes2,'XGrid','on','YGrid','on','XTick',0:23)
xlabel(handles.axes2,'Time(hr)');
ylabel(handles.axes2,'(Y/dt)nT');
% Plotting  'Z_value' on axes3
plot(handles.axes3,x,y3,'-rs','LineWidth',2,...
```

```
'MarkerEdgeColor','k',...
'MarkerFaceColor','g',...
'MarkerSize',1)
set(handles.axes3,'XGrid','on','YGrid','on','XTick',0:23)
xlabel(handles.axes3,'Time(hr)');
ylabel(handles.axes3,'(Z/dt)nT');
% Plotting  'delta-F_value' on axes3
plot(handles.axes4,x,y5,'-rs','LineWidth',1,...
'MarkerEdgeColor','k',...
'MarkerFaceColor','g',...
'MarkerSize',0.5)
set(handles.axes4,'XGrid','on','YGrid','on','XTick',0:23)
xlabel(handles.axes4,'Time(hr)');
ylabel(handles.axes4,'(delta-F/dt)nT');

%Calling 'data' variabel to display on Table  Component object
myform = guidata(gcbo);
datatabel = data;
set(myform.tbldata,'data',datatabel);

% Calling 'data' variabel to display on Table Statistic Comp.object
myform2 = guidata(gcbo);
datatabel2 = stat;
set(myform2.tblstat,'data',datatabel2);

% --- Executes on button press in Exit.
functionKeluar_Callback(hObject, eventdata, handles)
% ---- Customized as follows ----
close(ancestor(hObject,'figure'))
%----------END_of_Main&Sub_Function-----------%
```
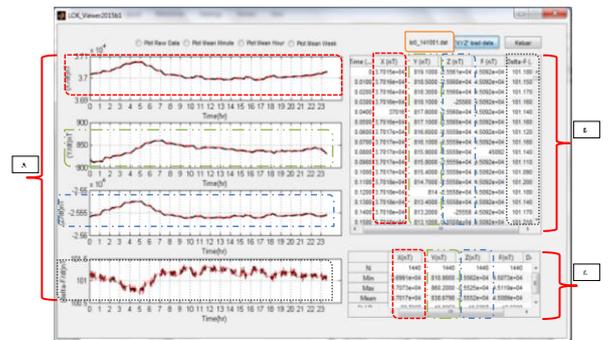

Fig. 7. The main window : display application Interface of main window (Page-1) consist of geomagnetic daily data. Colour legend component object data relation between data Plot (*box 'A'*) and data Table Component (*box 'B', 'C'*) object:

(red dash line)	----------	*(blue dash line)*	– · – · – · –
: variabel (X/dt)nT		: variabel (Z/dt)nT	
(green dash line)	— · · — · · —	*(black dash line)*	....
: variabel (Y/dt)nT		: variabel (delta-F/dt)nT	

IV. RESULTS

A. LOK-Viewer GUI Interface and Data Representation

We may notice from the running result on *figure 7*, that LOK-Viewer is able to perform its role as raw data loader and also display each graphic on main window graphical interface

(see box A), numerical table (see box B and box C). The displayed data were taken from one sample with attribute 'lo0_141001.dat' with 'Time' as x-axes from 00.00 to 24.00.

B. Reading Geomagnetic Signal

It appears that the data on the day of Oct '1 2014 is complete and there is no longer an outlier value or missing value. The graph shows geomagnetic signal from 00.00 to 23:59 local time. Based on another related studies, signal sampling can be done based on the best data (data at certain times) with minimum noise. We can take a look this signal closer to be able to observe the Ultra Low Frequency (ULF) data phenomenon.

C. Statistical Result

In the left-bottom side of figure 7 we can observe a statistical summary for each data series. It is important for users to have this information so that they can gather some statistical inference which support data analysis. Still associated with the raw data on figure 1, to know there are some outliers the data recorded by the sensor device due to external factors. We encountered a data outlier worth 99999.9 and henceforth we filter the data of the outlier. 'N' is the total time series of data; 'Nmin' is the Minimum Value of every element geomagnetic variation; 'Nmax' is a maximum value of every element geomagnetic variation; 'Mean' is the mean value of every element geomagnetic variation; 'Std-Dev' is the value of every element Std.Deviation geomagnetic variation; From these data the following values in a row : each N = 1440; Nmin for X(nT) = 3.6991e+04; Nmin for Y(nT) = 810.90000; Nmin for Z(nT) = -2.5562e+04; Nmin for F(nT) = 4.5073e+04; delta-F(nT) = 100.6900; Nmax for X(nT) = 3.7073e+04; Nmax for Y(nT) = 860.20000; Nmax for Z(nT) = -2.5525e+04; Nmax for F(nT) = 4.5119e+04; Nmax for delta-F(nT) = 101.3700; Mean for X(nT) = 3.7017e+04; Mean for Y(nT) = 838.6798; Mean for Z(nT) = -2.5552e+04; Mean for F(nT) = 4.5089e+04; Mean for delta-F(nT) = 101.1216; Std.Dev for X(nT) = 22.7337; Std.Dev for Y(nT) = 10.8352; Std.Dev for Z(nT) = 10.5297; Std.Dev for F(nT) = 12.9238; Std.Dev for delta-F(nT) = 0.1339.

D. Data Representation (LOK-Viewer Page 2)

Figure 8 shows graphical display for LOK Observatory data throughout the January to December 2014. There are red signal in April, August, September, October and November. There is also an empty signal, which means that the sensor has not been able record the daily data caused by external factors. We still continue to work so that the signal can be recorded properly so that the missing data can be minimized.
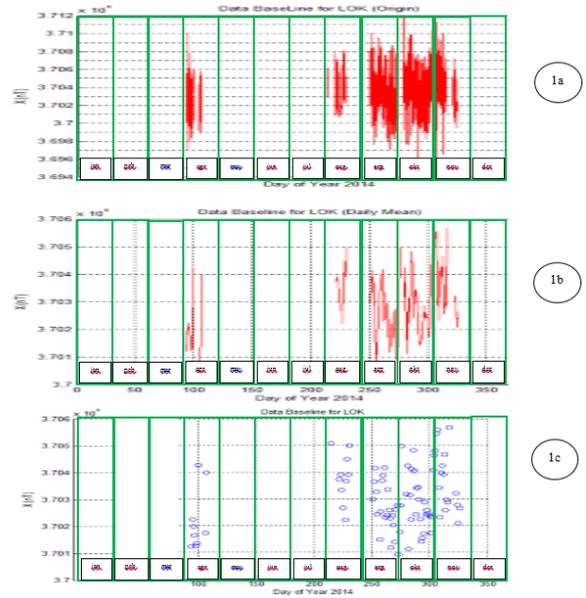

Fig. 8. Expose of geomagnetic signal variation of variabel X(nT), base line graphical from january to decemberin year 2014 with different view (1a),(1b),(1c) where (1a) is origin (raw) data ; (1b) is daily mean from origin data ; (1c) is daily mean with scatter view. For complete signal variation of Variabel Y(nT), Z(nT) and deltaF(nT) can be seen on Appendix 1.

V. Conclusion And Discussion

This software interface is developed using GUI-Matlab and compiled build code with executable (*.exe) file using Matlab Compiler Runtime2012b. LOK-ViewerVer.2015a has been developed andable to be run directly standalone. This application allows users to conduct visual observation by noticing earth's magnetic field graphical pattern shown on the interface with different daily data. It is also create a possibility of easiness and simplicity for users, since they do not need to collect a very large data manually in order to observe its characteristics. This application will be developed further by adding some features for digital signal processing.

References

[1] http://www.gfz-potsdam.de/en/section/earths-magnetic-field/infrastructure/observatories/lombok/ . Last Access on Sept 2015.

[2] T. Zubaidah, M. Korte, M. Mandea, Y. Quesnel, B. Kanata. Geomagnetic field anomalies over the Lombok Island region: an attempt to understand the local tectonic changes.Int. J. Earth Sci. (Geol. Rundsch.), 99 (5):1123–1132, doi:10.1007/s00531-009-0450-4. 2010.

[3] J. Iankowski and C. Sucksdorff, "IAGA - Guide For Magnetic Measurements And Oiservaiory Practice". Published by: International

Association of Geomagnetism and Aeronomy   ISBN:0-9650686-2-5. 1996.

[4]   The Language of technical Computing,MATLAB December 1996

[5]   J. M. Yadav, A. S. Reddy , "Development of GUI Based Programme For Thermal Characterisation And Life Expectancy of Transformer Using Matlab", IOSR Journal of Electrical & Electronics Engineering e-ISSN:2278-1676,p-ISSN:2320-3331, Vol.6 Issue 1. 2013.

[6]   J. Zhou, X. Zhang, and C. Xiu, " A MATLAB-Based Numerical and GUI Implementation of Cross-Gradients Joint Inversion of Gravity and Magnetic Data", Journal of Software Engineering and Application - Published   Online   February   2015   in   SciRes. http://www.scirp.org/journal/jsea. 2015.