Documentation User Plot

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1 Introduction

The final output of the code will consist of three plots: two telescope plots and one hop sequence plots. The code for user plot is to be integrated with the user interface, refer that for the complete coding.

2 Parsing the database

`ra_in,dec_in,fov,fov_finder_scope,m_lim` are the right ascension of the target, declination of the target, field of view of eye piece, field of view off finder scope and limiting magnitude of the telescope respectively. These values are either directly entered by the user or calculated from the parameters user enters. For convenience these are directly initialised in the code. `v_mag` is the visual magnitude limit of 6.

The data of constellation borders, Tycho-1 stars and Messier objects are read into file `data_cb`, `data_m`, `file` respectively. Since the plotting is to be done in celestial coordinates the right ascension values of the entire data that lies between 0 degree and 360 degree is to be converted to celestial coordinates that is 0 degree to 18 degree towards West and 0 degree to -180 degree towards East. This is done through following code for each datasets.
`ra=[(360-i)if i>=180 else (-i)for i in ra]`

The Messier objects are seaparated based on their types into globular clusters, open clusters, galaxies, nebula and supernova remnant, and other messiers. Each of these are plotted with different markers on the plot.

The csv file `Tycho-1.csv` have the details of stars upto the magnitude of 10.5 these are divided into two datasets `data_2` and `data_1`. The dataset `data_2` contains all the stars lying below the limiting magnitude of the telescope which would be used for showing the telescope plots and the dataset `data_1` contains all the stars lying below the visual magnitude which would be used for plotting the hop sequence. `ell` is the ellipse marker to be used for plotting galaxies from messier object.

3 Telescope plot

The function `telescope(fov,a)` is used to plot both of the plots one seen through the eye piece and another one through the finder scope. `fov` is the field of view of the plot and `a` is a constant passed to differentiate between the two plot. `m` is the basemap class instance declared with following values:

- `llcrnrlat` lower left cornet latitude
- `llcrnrlon` lower left corner longitude
- `urcrnrlat` upper right corner latitude
- `urcrnrlon` upper right corner longitude
- `lat_0` latitude value of central point on the plot
- `lon_0` longitude value of central point on the plot
- `celestial` Set as True to get the map on celestial coordinates.
- `fix_aspect` Set as False to avoid the plot's aspect to be fixed by basemap by default. This helps to overcome the problem of narrowing down of plots as we approach the poles.

The functions `drawparallels() drawmeridians()` are used to draw the circles of right ascension and declination.After showing the telescope plot a red dotted patch circle is added to show the exact field of view through eye piece and finder scope. The variables `s1` and `s2` are used to calculate the radius of the circle based on the declination of target. A direct approach with radius of the circle equal to field of view is not possible because the distance between two points separated by the the same degrees is different based on the declination. This happens because of the aggregation of right ascension circles as we approach the poles. For the cases where the `if` condition is not satisfied the telescope plots giving the exact field of view is not possible. For such cases a plot of general area of sky is shown centered at the target.

The messier objects are plotted with markers based on their types. The markers are made to resemble the markers used in IAU sky charts. The stars are scatter plotted with their size proportional to their magnitude. The value of the varibale `star_constant` can be changed to increase or decrease the sizes of the stars proportionally.

4 Hop Sequence Plot

The function `hop_sequence_plot(lon,lat)` is used to plot the hopping sequence. `lon` and `lat` are the arrays of right ascension and declination of

the hops made from the editor interface. `n` is basemap class instance created based on the given `width` `height` in map coordinates.The stars are scatter plotted as white dots, green dots represent the constellation borders and the messier objects are plotted based on their type as different markers.The function `drawgreatcircle()` is used to connect the points of hops as straight lines, this could be modified to show fancy arrows or any other visual methods that can best suit the need. The value of `name_lim` limits the number of names of prominent stars displayed on the plot. This value can be changed to include more star names in the plot though that is not recommended since that will just crowd the plot.

While adding the names of stars and messier id steps to ensure the name doesnt overlay on the markers is taken. This is done by adding text not exactly at the coordinates of target `(x,y)` but at `(x,y+10000)` where 10000 is the distance in the map coordinates. Such an approach suits the naming but an isuue is raised if at all the maps are to be zoomed because in such a condition while zooming the distance between the marker and names will also increasse because of the additional `y+10000` used. Naming of the constellation is not straight forward as it was for the stars and Messier objects, since a common method to find cooridnate to add text for all the constellation could not be found. Thus for the constellation names, arrays of `ra_const` and `dec_const` are the manually found coordinates for naming the constellation.

The datasets are not directly scatter plotted on the projection a conversion from the Ra, Dec values in celestial coordinates to the map coordinates is required. This is why throughout the cide we scatter plot `x,y` rather than `ra,dec`. The conversion is done by `x,y=m(ra,dec)` where `m` is the basemap class instance. Finally before showing the plots the y axis with right ascension is inverted in order to resemble the sky as seen from Earth otherwise the constellations could be seen in the plot as their mirror images.