Magneto: Scale Standardization

Background

- The magneto project is an ongoing effort to fully digitize historical magnetograms
- Magnetograms are records of local magnetic field fluctuations where these fluctuations are measured in γ (*gamma*)
- Currently, only recent data is available for magnetograms, making long-term forecasts unreliable. Long-term forecasts of these fluctuations are useful for predicting geomagnetic storms which, when severe, can cause disruptions in services or even the collapse of an electrical power grid

Objective

- To create a method to measure the number of pixels that represent 1 millimeter on the original image. This method will use both a photo editor and RStudio to complete the objective

Purpose

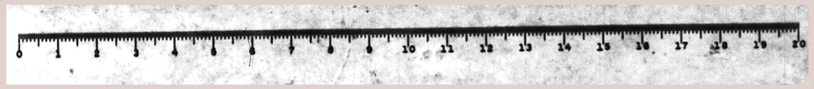
- As groups of magnetograms have corresponding rulers, we can use these measurements to properly scale digitized magnetograms as the conversion from millimeters to γ is known
- The method is intended to be incorporated into the **magneto** package which contains the Trace Identification by Separation (TIS) algorithm, designed to digitize magnetograms

Future Considerations

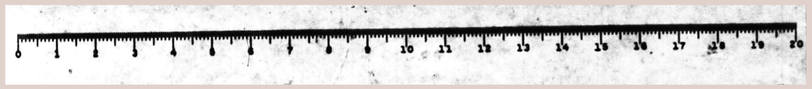
- Automation of choosing inputs for this method as well as providing diagnostic information to the user would be helpful for the large-scale processing that this is intended for
- This was tested on a clean, complete image but not all ruler scans are in this condition. Further work will allow for cases in which a portion of the ruler is available or there is a shadow on the image.

A Four Stage Method:

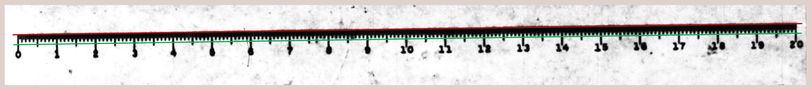
Stage 1:



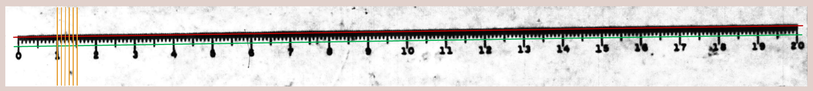
Stage 2:



Stage 3:



Stage 4:



Acknowledgement

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Stages

Stage 1:

- User is required to manually ensure that the image is complete and clear of any spots or shadows

Stage 2:

- Image must be preprocessed in a photo editor
- Contrast is increased to create a greater disparity between pixels that appear black or white to the human eye but do not have the exact associated value (0 and 1, respectively)

Stage 3:

- In R, the first pixel below a given threshold in each column is collected and a linear model is fitted to those points. The resulting line (in red) traces the top of the ruler.
- This line is then shifted downwards until it bisects only the 0.5 cm and the 1 cm ticks of the ruler (in green). The line will not shift down again after the difference in the 80% quantiles of the pixels in each line exceeds a user defined quantity.

Stage 4:

- The values (from 0 to 1) that the pixels in the shifted line have are then examined. When these values drop below a given threshold, it is determined that the pixel in question is part of a tick mark.
- Once the tick marks have been identified, an average is taken of the distances between each tick mark. This is the number of pixels in 0.5 cm and so to get the desired number, it is divided by five.
- This scale value separates the vertical orange lines. The image may be inspected to ensure the method was effective and provided a sensible value.