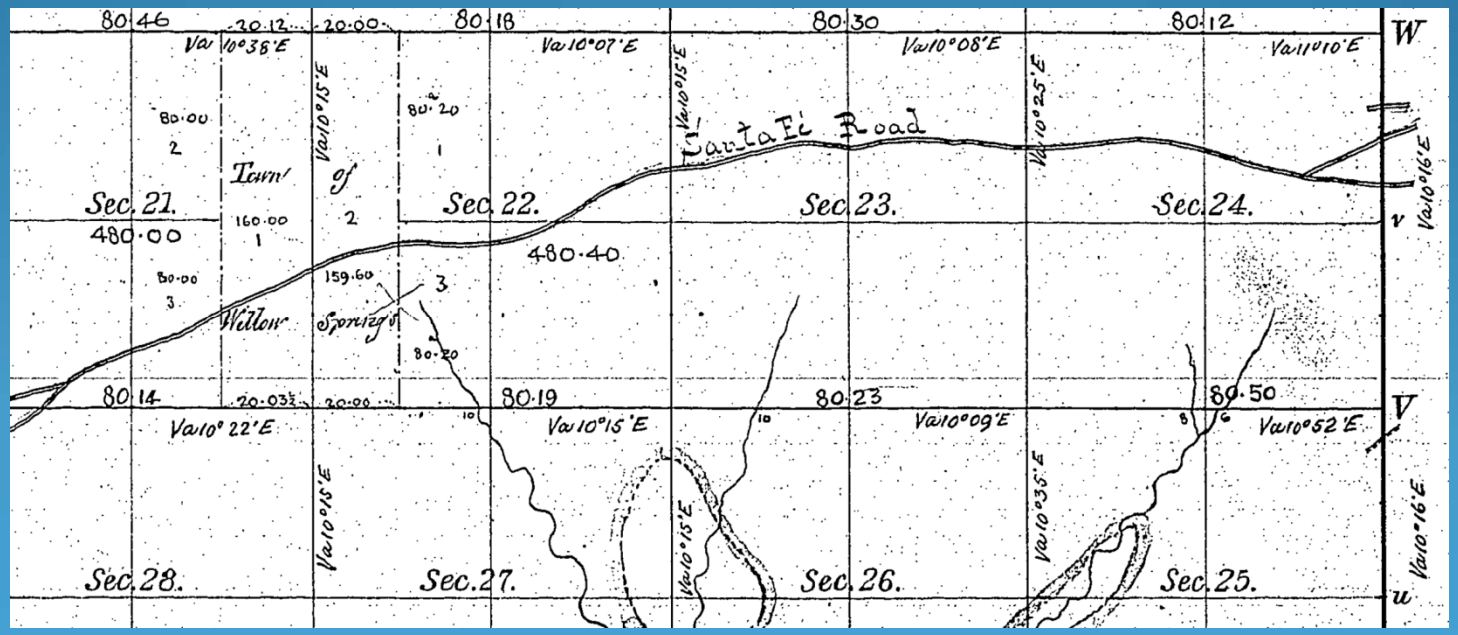
Automated Georeferencing of Kansas Historical Land Surveys

By : Ryan A. Surface



Background

• During the 1850's the U.S. General Land Office (GLO) conducted transect surveys along Public Land Survey System (PLSS) section lines

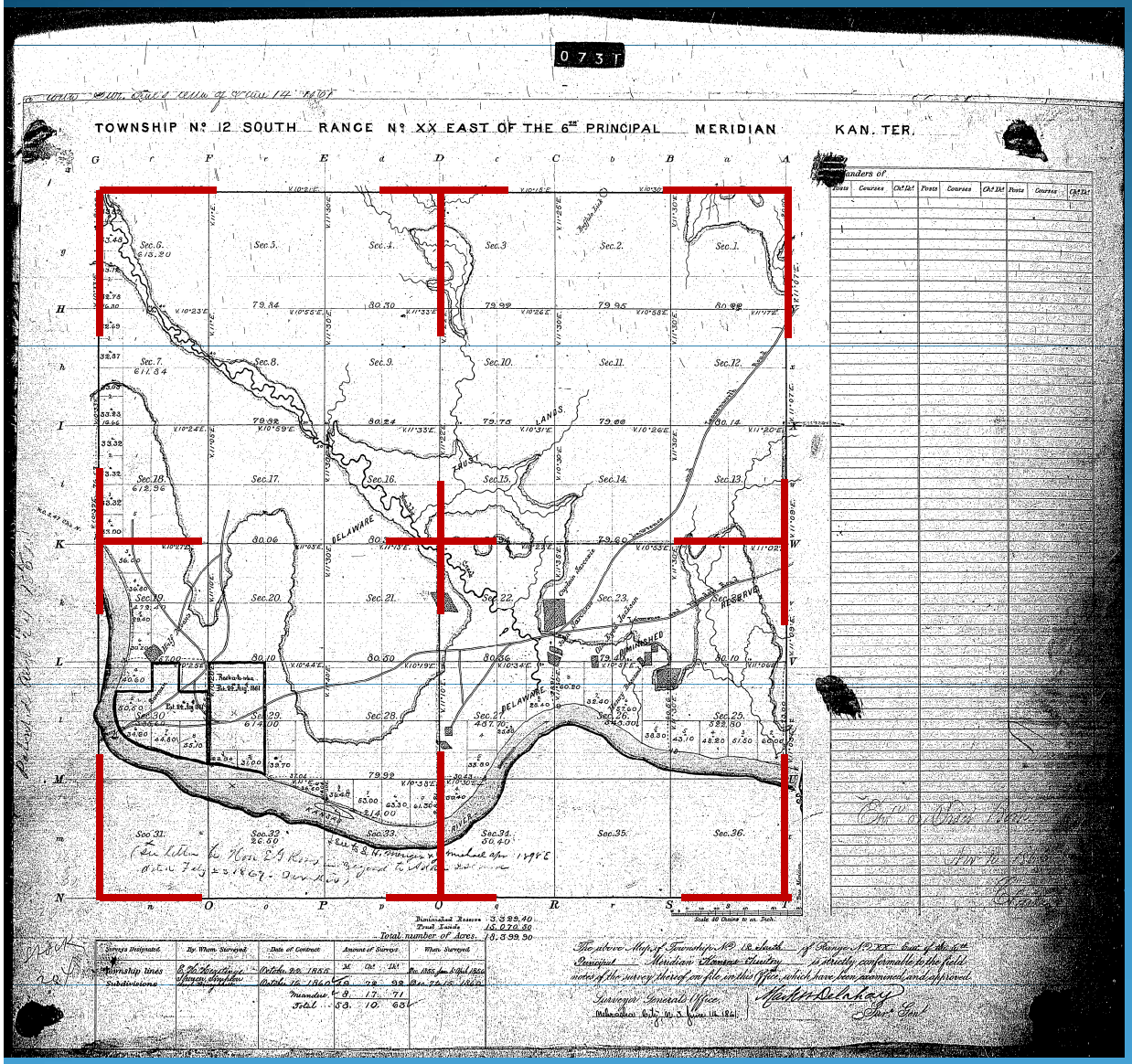
• Maps were produced for each of the 2300+ townships in Kansas

• Forest cover, streams, trails, and other significant features were included, along with field notes for each corresponding map.

•In 2002 the Kansas State Historical Society and Kansas Society of Land Surveyors transferred the microfilm maps and notes to .PDF files.

•This data set is not yet available in a georeferenced format which hinders the usefulness of this valuable resource

Data



- 2300+ Townships
- Multiple map versions for each township
- The map is contained within the larger survey template

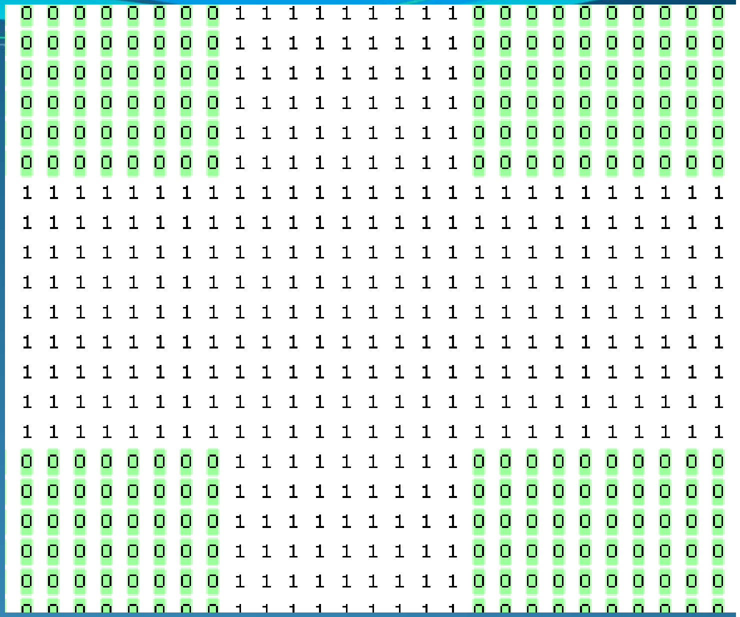
Method

- Exploit the consistent geometric properties of the templates , by finding pixel patterns
- Perform image processing and filtering to find Ground Control Points (GCPS's) for georeferencing

Filtering

- Focal filters are used to identify candidate pixels for GCP’s
- A pixel located in the left border of the Map will return a higher value using a left border filter than a cross filter
- Image processing is performed before the filtering process to increase accuracy

Cross Filter



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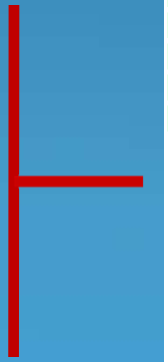
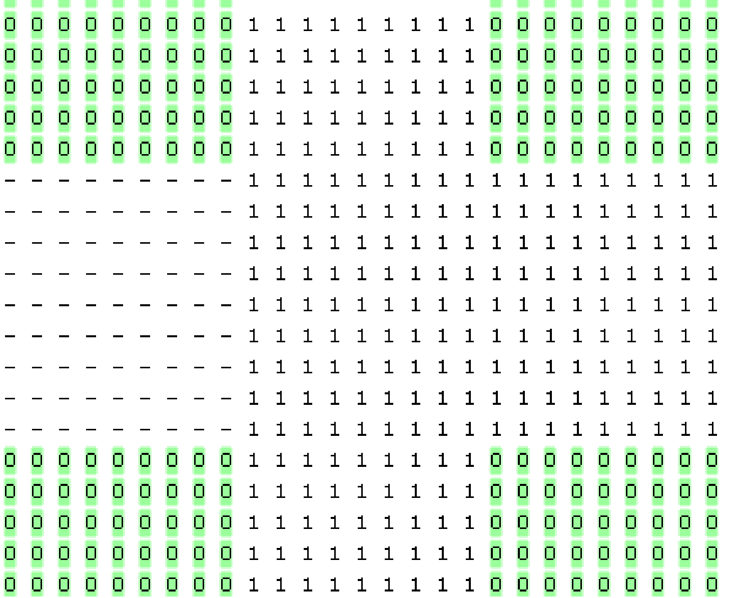


Left Border Filter



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Note: ‘-’ is used instead of ‘-1’

Image Processing

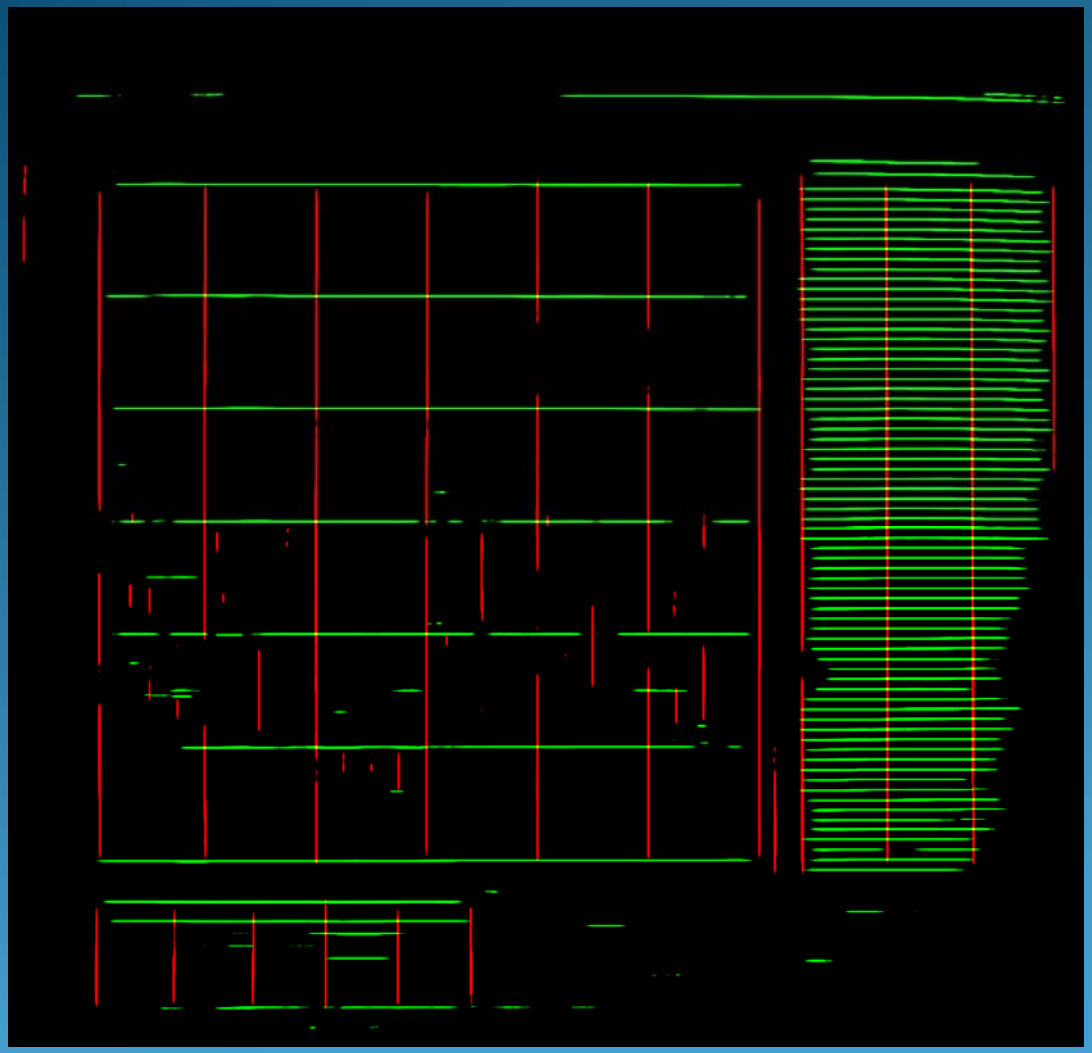
Noise Reduction

- Small image objects and scanning artifacts are removed
- Section lines are preserved because they are continuous large objects

Object Growing/Resizing

- Objects that meet the size criteria are thickened using a grow operation
- This corrects some discontinuous parts of the section grid

Image Processing

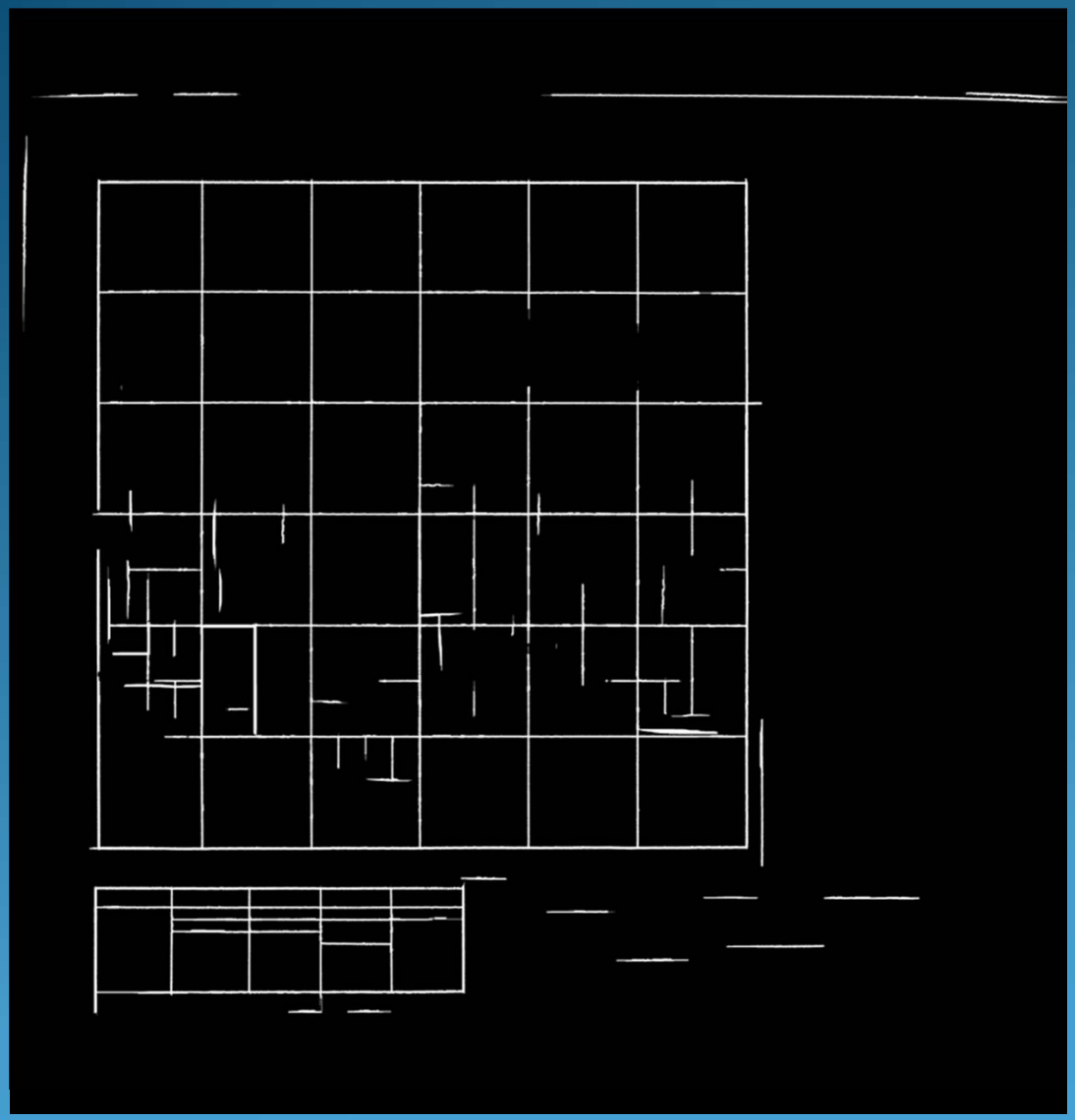


Line Extraction

- Ecognition's line extraction algorithm is used to extract vertical and horizontal lines

- Parameters include
  - Angle
  - Thickness
  - Length

Image Processing



Remove Extraneous Information

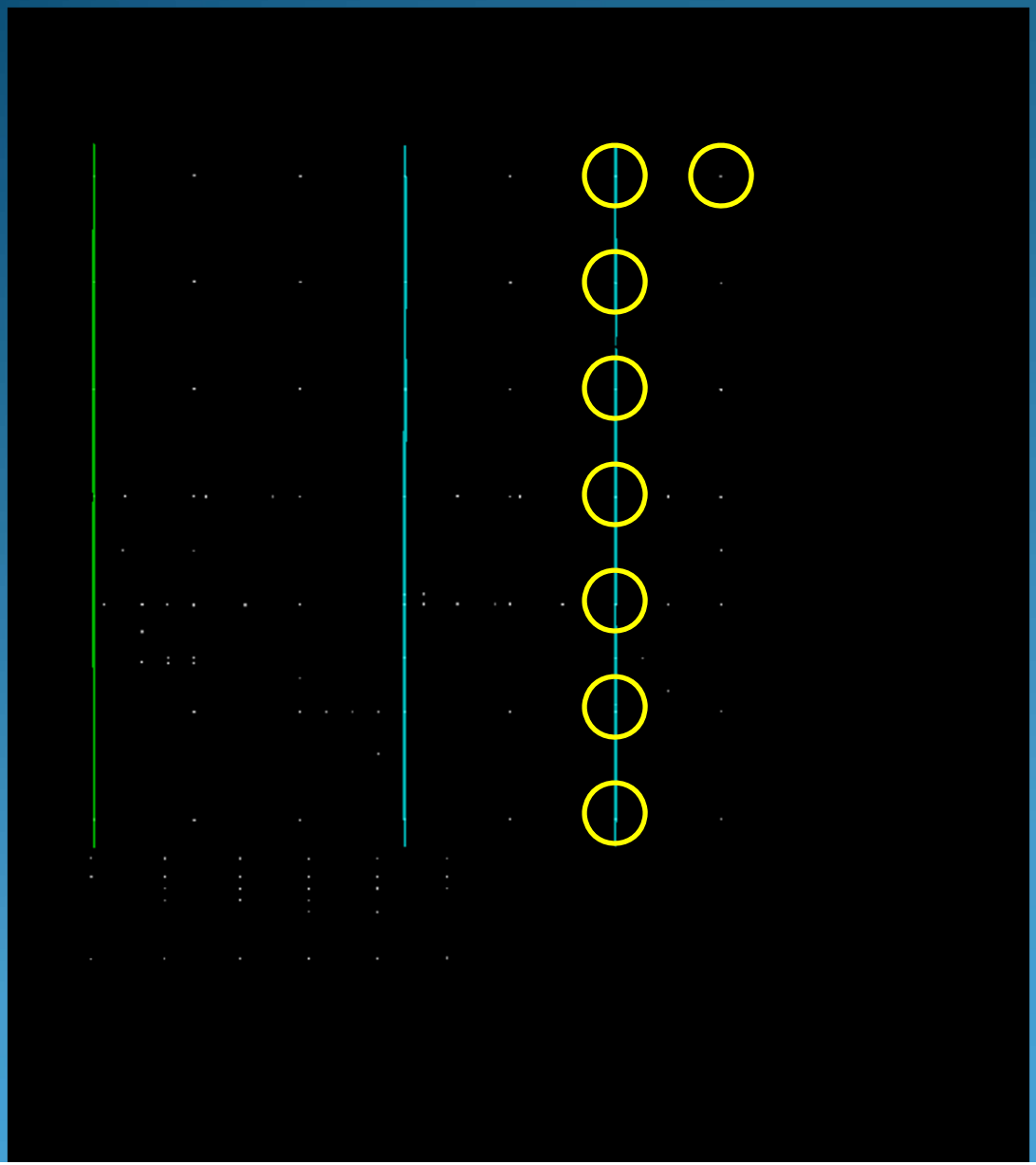
• Various rules are created to remove unwanted pixels

Remove Note Box

- The “note box” can be distinguished by vertical lines that have a high frequency of horizontal lines intersecting them

- This stripped down image can now be used to find GCP’s via focal filtering

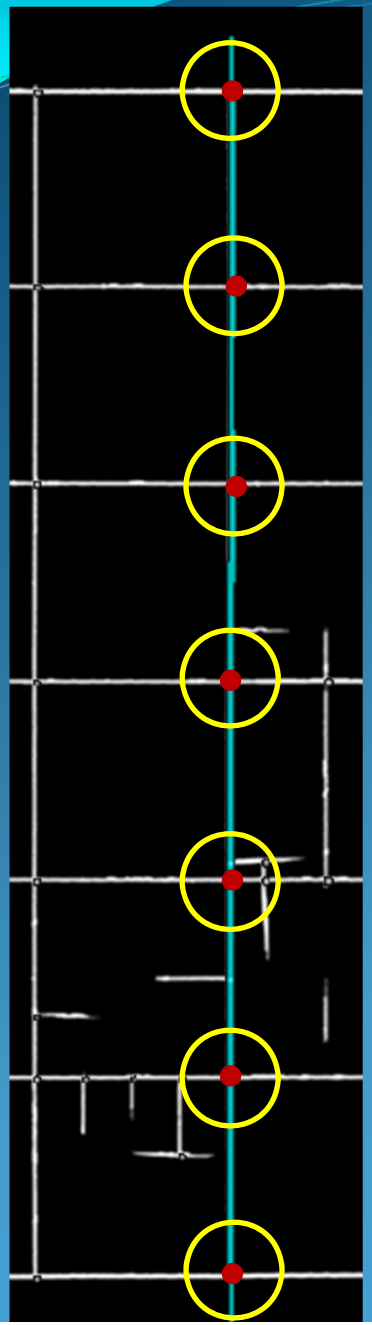
Object Based Analysis

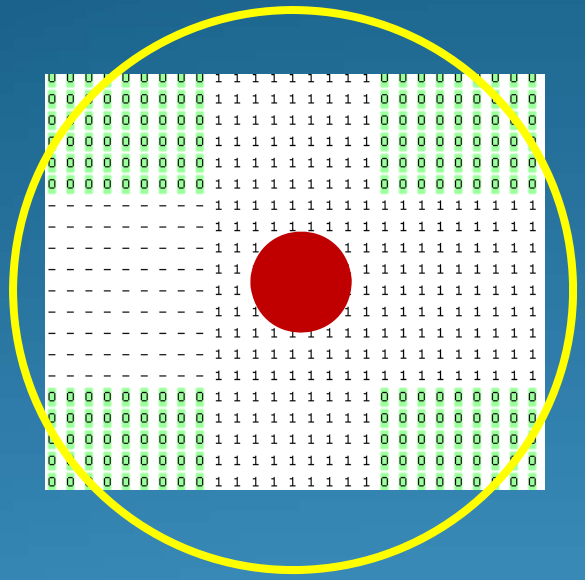


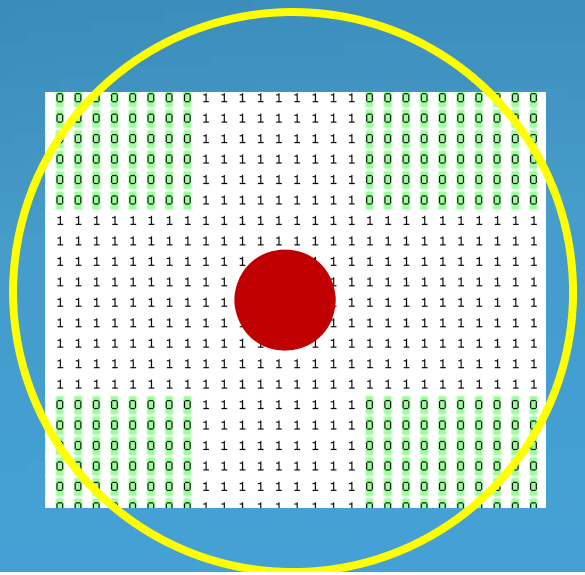
Identifying Objects

- Vertical and Horizontal intersections are displayed as white dots
- Each line is an object
- Intersections are converted to sub objects of their corresponding line

Object Based Analysis







Object Filtering

•Inside each sub object (red circles) are the pixels that will be filtered, these are potential GCP's

•The yellow circle represents the extent of the filter area

•Statistics for a line's sub objects for a given filter can be calculated and compared

Georeferencing

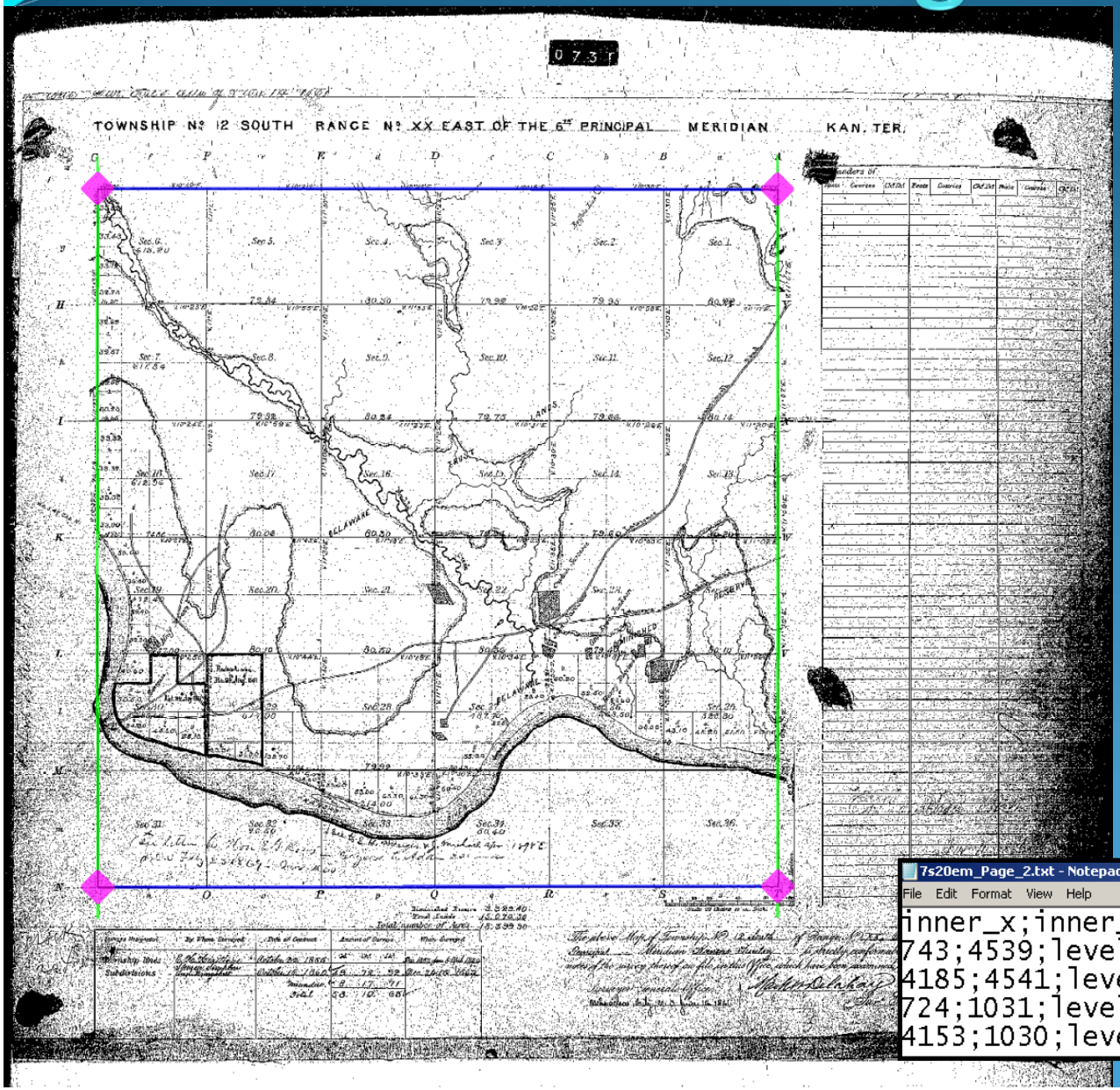


Image Rectification

- 4 corner pixels are selected for GCP's

- The GCP's are matched to a database that contains township corner coordinates

7s20em_Page_2.txt - Notepad

File Edit Format View Help

```
inner_x;inner_y;level_name;class_name;X Center
743;4539;level 2;BottomLeftPx;743.5;3310.5
4185;4541;level 2;BottomRightPx;4185.5;3308.5
724;1031;level 2;TopLeftPx;724.5;6818.5
4153;1030;level 2;TopRightPx;4153.5;6819.5
```

Data Problems

- Not all township maps are suitable
- Obstruction of section line grids is often the case
- Irregular township shapes & sizes, borders to rivers or reservations
- Scanning artifacts, missing maps,