Road and Field Boundary Detection in Satellite Imagery

Group 15

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Problem statement

Road and field boundary detection in satellite or aerial view images is very important in specific areas such as agriculture and urban plan designing. To perform tasks such as managing the field areas supplying resources, it is necessary that the maps of the roads and fields should be accurate and detailed. The clarity of the images is the key. But in this case, the landscapes are very complex and complicated with many interconnections. Hence, the automation process will be a little bit difficult. To overcome this, the project requires a method that can identify the roads and field boundaries in increased pixels to have large and clear images.

Thus, the main problem statement of this project is to detect the roads and field boundaries. And to differentiate the roads and field boundaries from other line features such as waterbodies, railway lines, etc.

Data

The project utilizes two data sets. The images utilized for this project are satellite-captured aerial images of various places in the United States. These images provide visual information about the landscape.

The first set is the development data, which is used to train the models, and the second set is for evaluation and validation, which determines how good and efficient the model is. The images in the dataset are provided by the U.S. Department of Agriculture from the agricultural fields in the USA. They are in jpeg format. These images are cropped from the sections of the large images, and their pixel size is 1 m^2.

Method

To perform this project there are many methods that need to be followed. They are mentioned below:

1. **Data preprocessing:** This includes techniques such as Noise reduction, increasing the contrast, resizing the image, using filters for better results, etc.
2. **Model Design:** The model is designed using MATLAB including the steps mentioned below:
    - Convert the images into grayscale.
    - Create the ground truth images using manual annotating.
    - Applying different types of Edge Detectors –

Sobel Edge Detector – This filter is a built–in function in MATLAB. It is a technique to detect edges in an image both vertically and horizontally.
Canny Edge Detector – This filter aims at finding the strongest edges and the edges that are connected. This technique blurs the image to suppress noise and detects the edges accurately with very few false edges.
Gaussian Filter – This is an image preprocessing technique. This filter is applied to reduce noise in the image and smoothen the image.
Applying Feature Transform – Transformer such as Hough Transform will be applied to detect the lines or geometric figures in the images.

Various methods are performed on the images to detect the edges clearly. Later we evaluate each method using the evaluation metrics.

3. **Evaluation:** Evaluate the models' performance using different evaluation metrics. The accuracy and precision of the methods is calculated. The result depends on various factors such as image normalization, equalization, noise reduction, and suitable parameters etc. The accuracy of different methods when different parameters are given will also be obtained.

Evaluation

Evaluation is one of the most important parts of developing a model. In this project, evaluation of the models' performance is done using evaluation metrics like precision, recall, F1-score, and Intersection over Union (IOU) on the validation dataset, shows how good the developed model is. By evaluating, we can also configure how a model can be improved.

The table below shows the evaluation methodology:

Name	Size	Type	Filter	Accuracy	Precision
field	2048 x 2048	JPG	-	Pending	Pending
L88a	2048 x 2048	JPG	-	Pending	Pending
L88b	2048 x 2048	JPG	-	Pending	Pending
L96a	2048 x 2048	JPG	-	Pending	Pending
L96b	2048 x 2048	JPG	-	Pending	Pending
L97a	2048 x 2048	JPG	-	Pending	Pending
L97b	2048 x 2048	JPG	-	Pending	Pending
W107a	2048 x 2048	JPG	-	Pending	Pending
W107b	2048 x 2048	JPG	-	Pending	Pending

Table 1. Evaluation Metrics

Timeline

List of activities	Timeline	Team Member
Project Kickoff and planning	Sep 15 – Sep 30	Working together.
Data acquisition and initial preprocessing.		Harsha, Sasidhar
Begin model selection and Ground Truth setup.		Harsha, Preethi
Continue model selection and setup.	Oct 1 – Oct 15	Harsha, Preethi
Try different hyperparameters to improve performance.		Working together.
Complete the model.	Oct 16 – Oct 30	Working together.
Evaluate the model.	Nov 1 – Nov 15	Working together.
Report	Nov 16 – Nov 30	Expected equal Contribution

Table 2. Project Timeline

Expected Outcome

List of activities	Expected Outcome
Project Kickoff and planning	Begin the project
Data acquisition and initial preprocessing.	Dataset gathering Dataset preprocessing by applying filters to remove noise, Histogram Stretching, Equalization, Median Filtering etc.
Begin model selection and Ground Truth setup.	Performing manual annotations to create ground truth for the dataset. Models' selection such as Sobel edge detectors, Canny edge detectors etc.
Continue model selection and setup.	Ground Truth images. Working models of edge detectors to achieve project goal. Application of models on the ground truth images.
Try different hyperparameters to improve performance.	By applying different thresholds for different methods to improve models' performances.
Complete the model.	Final models should be able to detect the lines along with points detection. Hough Transform.
Evaluate the model.	Models' accuracy and precision calculation. Compare the models.
Report	Problem Statement, Methods Description, Evaluation, Results, Models' comparison, Future Scope.

Table 2. Expected Project Outcome