Ahmedabad University

CSE 631: Machine Learning

Weekly Report(1)

(Group - 9) Learning Machine

Section 1

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Weekly Progress Report - 1

Machine Learning–Based Automated Stone Counting System for Embroidered Fabrics

1. Detailed Summary of Work Done During the Current Week

In the present week, the main tasks were directed to the understanding of the project, conducting research, and learning key concepts and methodology that would be necessary to execute the proposed stone counting system successfully. It was an excellent week of work because it provided a solid technical and conceptual framework on the next steps of the development.

1.1 Problem Understanding and Domain Study

- The working process of the textile industry was thoroughly studied, especially embroidery fabric on decorative stones.
- Challenges that were analyzed in counting of stones manually included:
    1. Human error due to fatigue
    2. Lack of consistency in counting.
    3. Inability to differentiate stones and zari work threads as well as embroideries.
- Well defined project objective:

  To create an automated and reliable stone counting system that is capable of checking the contractor-reported counts of stones through Machine Learning techniques involving image-based methods.

1.2 Image Processing Techniques Research.

- Image processing techniques that have been studied and are required to process high-resolution embroidery images:
    1. Image loading and resizing
    2. Gaussian blur noise filter.

3. Lighting equalization processes.
4. CLAHE enhancement contrast.

- Investigated edge detection, blob enhancement and connected component analysis to isolate candidate stone regions.
- Knowledge of the preprocessing benefits of enhancing the effectiveness of feature extraction and minimizing false hits due to embroidery patterns.

1.3 Feature engineering Research.

- The methods of region-based feature extraction that has been researched and can be used to distinguish between stones and non-stone elements:
    1. Geometric appearance: area, perimeter, circularity
    2. Local binary pattern (LBP), Gray-Level Co-occurrence Matrix (GLCM) are texture features.
    3. Features based on color and intensity.
- Researched how these hand-crafted characteristics can be used to fit classic Machine Learning models and can be evaluated academically.

1.4 Study on Machine Learning Model Selection.

- Traditional ML classifier analyzed that is applicable to binary classification (Stone / Not Stone):
    1. Support Vector Machine (SVM)
    2. Random Forest
- Researched their benefits regarding:
    1. Interpretability
    2. Lower data requirements
    3. Corresponds to the objective of the course in Machine Learning.
- A comparative study was carried out on the object detection provided by YOLO as a secondary benchmarking and performance comparison tool.

1.5 Evaluation Strategy Planning

- Studied suitable evaluation indexes on counting stones:
    1. Counting Accuracy (%)
    2. Mean Absolute Error (MAE)
- Comparative analysis between:
    1. Basic image processing strategy.
    2. Conventional ML methodology.
    3. YOLO based detection method.
- Learned visualization methods with the help of bar charts and error plots, presentation of results.

1.6 Project Architecture Finalization.

- Planned the entire end-to-end project timeline, which included:
    1. Image preprocessing
    2. Region extraction Candidate region extraction
    3. Feature engineering
    4. ML-based classification
    5. Counting stones and checking.
- Tools and libraries to be used are finalized:
    1. OpenCV, NumPy, Scikit-Image
    2. Scikit-Learn
    3. Pandas, Matplotlib

2. Activities to be undertaken in the Week ahead.

The following week will be dedicated to initial implementation and experimentation as opposed to research. The tasks to be planned are as follows:

2.1 Dataset Preparation

- Gather and arrange embroidery cloth pictures together with decorative stones.
- Image annotation or labelling of stone and non-stone regions.
- Make up a trained and tested dataset.

2.2 Implementing Image Preprocessing Pipeline

- The image is processed using a set of computed values known as Image Processing.
- Apply preprocessing to OpenCV and Scikit-Image:
    1. Noise reduction
    2. Illumination normalization
    3. Contrast enhancement (CLAHE)
- Verify Visually, quantitatively preprocessing output.

2.3 Candidate Region Extraction

- Perform connected component analysis to obtain possible stone regions.
- Block filters according to size and shape.

2.4 Feature Extraction Module

- Apply geometrical, texture and color extraction.
- ML training Store extracted features in a structured form.

2.5 Initial ML Model Training

- Classify train baseline (SVM /Random Forest) on extracted features.
- Make preliminary testing and analysis of errors.

2.6 GitHub Documentation

- Dedicate scripting preprocesses and documentation to GH.
- Write README about project overview and methodology.