Optical Character Recognition Reader for Manufactured Drawings

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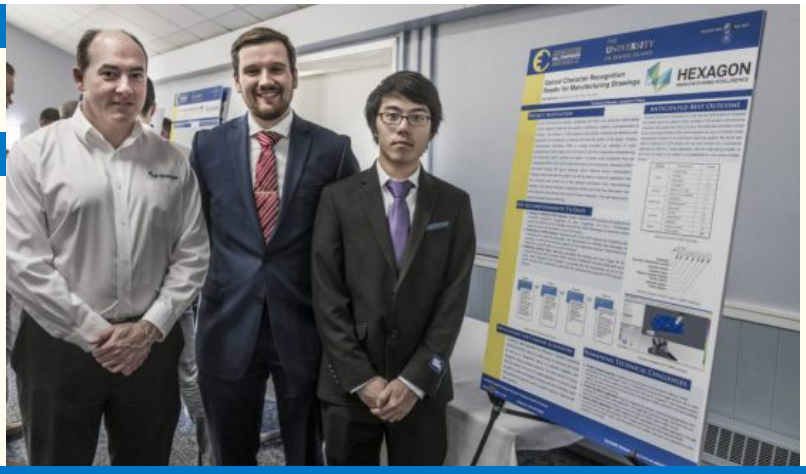

PROJECT MOTIVATION:

In the manufacturing industry, companies use computer aided design (CAD) software to create, modify, analyze and optimize a design. CAD programs have increased the efficiency and productivity of the designer and improved the quality of the design. Product manufacturing information (PMI) is included as metadata in more comprehensive CAD models, with information such as geometric dimensioning and tolerancing (GD&T) symbols and glyphs. Currently, companies have not incorporated PMI in their CAD models and resort to conveying the necessary GD&T information through 2D layout drawings, requiring human interpretation. The information from manufacturing drawings is extracted manually and logged into other programs. This process is time-consuming, is prone to errors, and results in massive losses for companies. Hexagon hopes that we will create an application that can recognize and extract PMI from manufacturing drawings using optical character recognition (OCR); enter the information into other programs automatically with minimal human interaction, thus reducing error rates with improved efficiency.

ANTICIPATED BEST OUTCOME:

The best outcome for this project is to first train an OCR engine to recognize and extract all of the relevant GD&T symbols in the product manufacturing information with greater than 90% accuracy. The extracted information should be put into a logical format so that other programs can use it to directly create measurement routines for an automated measuring system. We would also need to integrate the OCR engine that we have trained into a standalone application as well as a mobile application, with the code being portable so that it can be used on any platform and distributed for use across multiple devices.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

A working mobile application for GD&T character recognition would be very useful to many customers and could be sold as an inexpensive add-on to extended capability with Hexagon's existing software products. The other benefit of having the OCR engine as a mobile application is that it could be used as a direct link between Hexagon and their individual users and could also be used as a tool to maintain customer relations with their customers.

PROJECT OUTCOME:

The Anticipated Best Outcome was not achieved: the mobile application was not developed.

KEY ACCOMPLISHMENTS:

Testing of different OCR engines: Tested 7 different OCR engines and applications, Tesseract, JavaOCR, ImageGear for Java, ImageGear for C/C++, FineReader, LeadTools Winforms OCR Modules and Winform OCR Advantage to determine which engine to use for the foundation of our OCR engine.

Evaluation of OCR engines: Evaluated each of the OCR engines by comparing and contrasting the supported languages, the requirements for training new language, its accuracy, as well as the licensing options for the respective engines. Determined that Tesseract is a good engine to use for this project.

Preparing training files: Manually generated the training text and image file for Tesseract training, which includes GD&T symbols of different font size mixed with each other. Used Tesseract OCR Chopper to generate box file coordinates for all of the GD&T symbols. Ran commands to generate the unicharset file using the TIFF and box file pair.

Training Tesseract: Finished the training process of Tesseract by making a starter traineddata from the unicharset and using this as a base to build upon. We iterated through this process to push accuracy of character recognition close to the desired level of 90%.

Integrating Tesseract into Hexagon's PC-DMIS: Integrated Tesseract with GD&T recognition into a test harness Hexagon provided with the help of Hexagon developer Robert Jurca. Through this we were able to integrate Tesseract into PC-DMIS without having to gain access to the program.

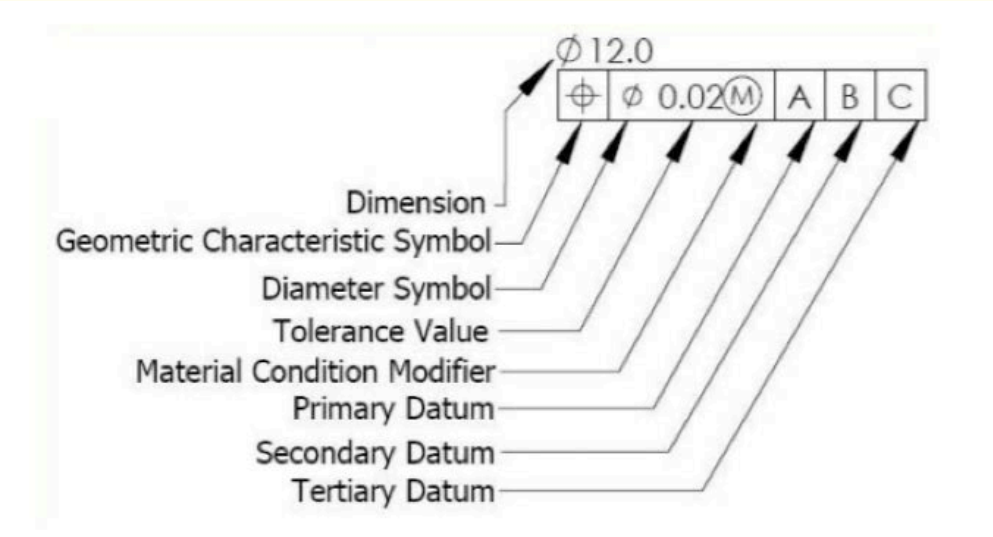

Fig 1: Example of a feature control frame used in CAD (Computer-aided Design) blueprints to describe the conditions and tolerances of a geometric control.

TYPE OF TOLERANCE	CHARACTERISTIC	SYMBOL
FORM	STRAIGHTNESS	—
	FLATNESS	▱
	CIRCULARITY	○
	CYLINDRICITY	⌭
PROFILE	PROFILE OF A LINE	⌒
	PROFILE OF A SURFACE	⌓
ORIENTATION	ANGULARITY	∠
	PERPENDICULARITY	⊥
	PARALLELISM	//
LOCATION	POSITION	⌖
	CONCENTRICITY	◎
	SYMMETRY	⌯
RUNOUT	CIRCULAR RUNOUT	↗
	TOTAL RUNOUT	⌰

Fig 2: Some of the common GD&T (Geometric Dimensioning and Tolerancing) symbols seen in feature control frames. These are the symbols we need to train Tesseract to recognize.

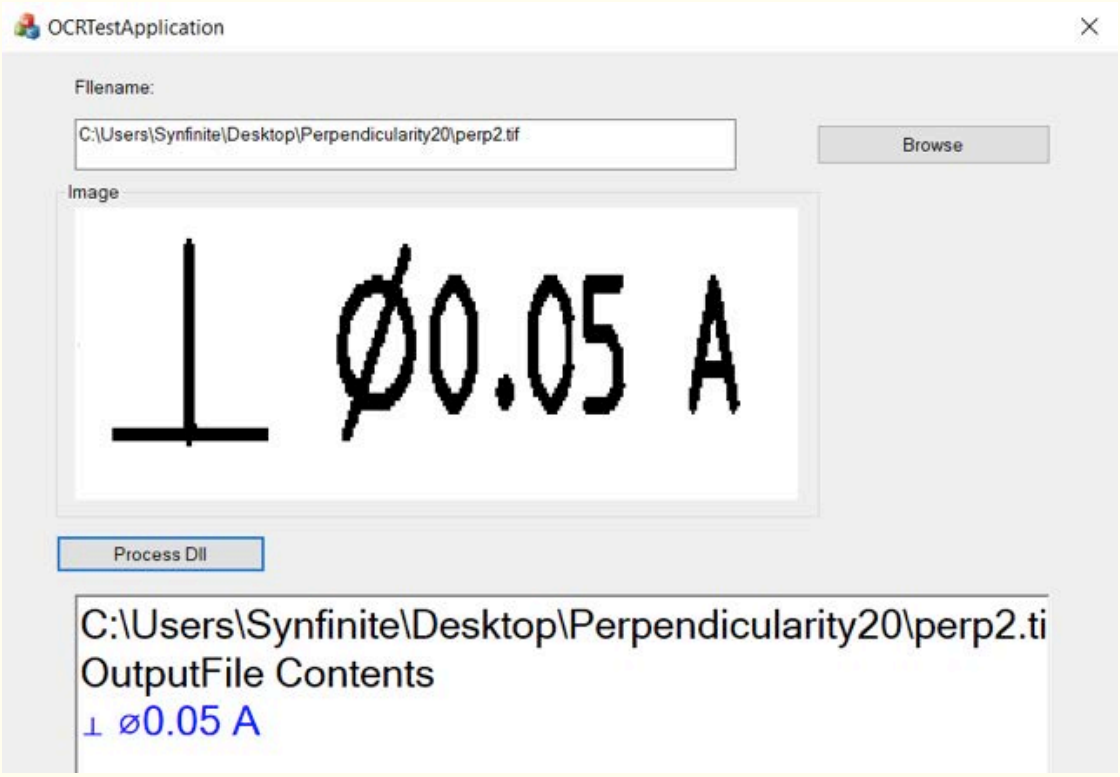

Fig 3: Screenshot example using the test application developed by Hexagon. This is used to integrate Tesseract with GD&T recognition into the company's software, PC-DMIS.

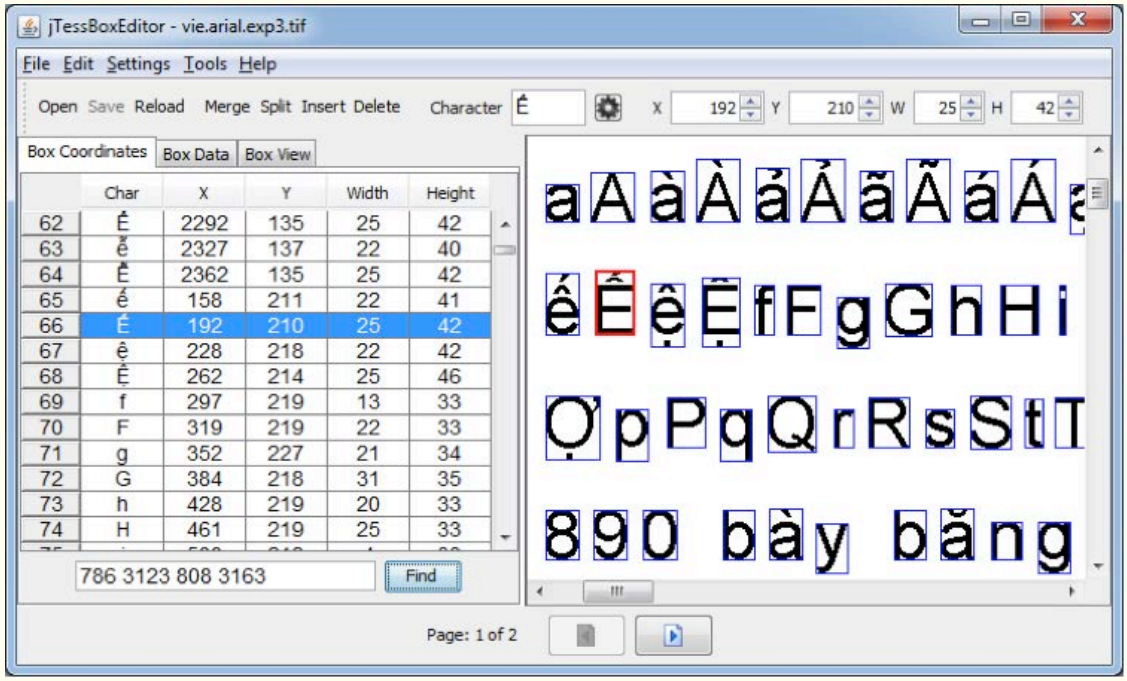

Fig 4: Example of a box editor needed for the training process. It reads common image formats such as PNG or TIFF create boxes around the characters that Tesseract needs to recognize. Data includes the box coordinates, the font, as well as the font size of the character.