Digital Circuit Sketch Recognition

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Toolchain Summary

The toolchain begins with a sketch being input into Microsoft Journal Reader and saved as a .jnt file. This .jnt is passed through a converter to change it into the MIT XML format that our group uses. The sketch is now ready to go through the actual meat of the toolchain. The sketch is first fragmented into lines and arc-segments to give us more strokes to train on, and simpler strokes to recognize. For more information on the fragmentation, see the report by Aaron Wolin [Wolin]. The fragmented sketch is next passed into a Conditional Random Field for recognition of the individual strokes. For more information on the stroke-level recognition, see the report by Jason Fennell and Max Pflueger [Fennell and Pflueger]. Once stroke-level recognition has finished, another program called a segmenter uses the recognized strokes to segment our drawing into logical parts by grouping sets of strokes that make up gates or wires together. This segmenter goes back and forth with an object-level recognizer that attempts to recognize the objects the segmenter found. For more information on segmentation and recognition, see the report by Devin Smith [Smith]. Once this final recognition step is complete, the circuit undergoes analysis and is passed to a design program, fully understood by the computer.

Example

This section shows an example of our toolchain in its current state.

In Figure 1 we see the digital circuit just after it has been finished. It is ready to go through the toolchain.

In Figure 2 we see the fragmented circuit. Note the wire between the AND and NAND with the selected stroke. This wire was drawn in one motion, but has been broken up into line segments by our fragmenter.

In Figure 3 we see the circuit after stroke-level recognition. Red strokes have been classified as part of a gate and blue ones as part of a wire. Note that only one stroke, the backplane at the far left of the diagram, was misclassified.

In Figure 4 we see the segmented circuit. Each different color indicates a group of strokes that have been placed together in a segment. Note that the only error in the segmentation is with the wires connected to the misclassified backplane from Figure 3. The backplane and the two wires connected two it are all segmented as different objects when they should not be.

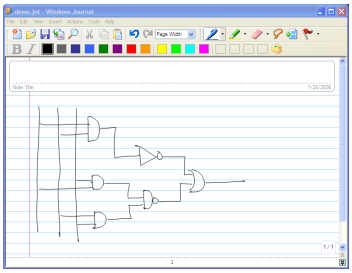

Figure 1: Sketch being drawn

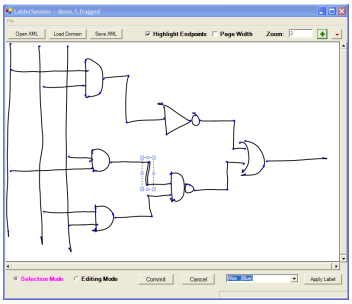

Figure 2: Sketch after conversion to XML and fragmentation

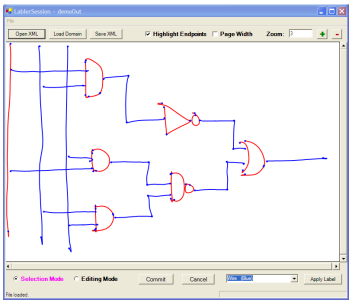

Figure 3: Sketch after stroke-level recognition

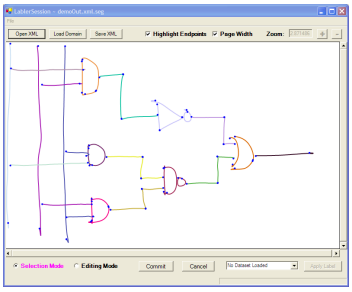

Figure 4: Sketch after segmentation

References

FENNELL, J., AND PFLUEGER, M. Conditional random fields for the classification of digital logic circuits. Paper unfinished.

SMITH, D. Segmenting labeled strokes. Paper unfinished.

WOLIN, A. Fragmenter. Paper unfinished.