Copier Jam Detector

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Design Brief

Client:	Local Printer Company
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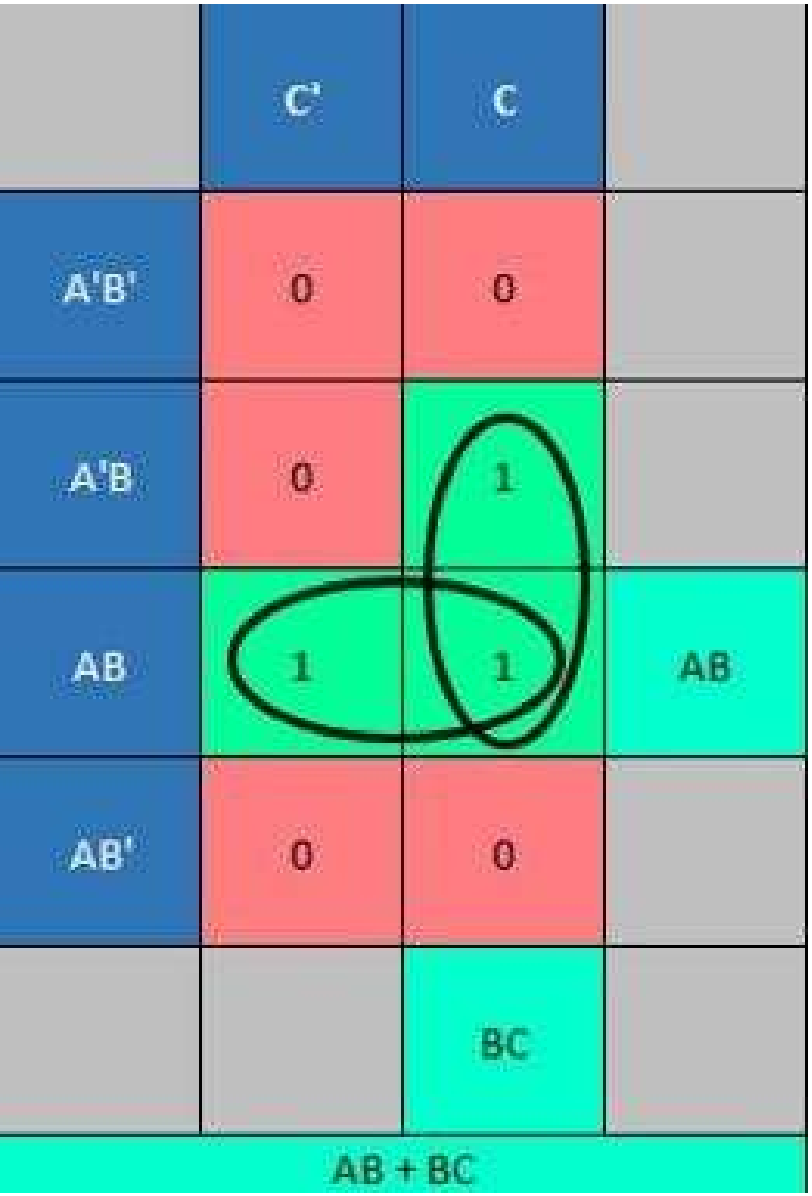
Problem Statement:	A paper copier at a local company moves paper between three areas as it is making copies. However, because of this, the copier undergoes jams specifically when two adjacent areas have paper in them.
Design Statement:	Create a circuit that is capable of monitoring three input sensors, detecting a jam in the copier. If a jam does occur the system must stop the copier motor and activate a light that indicates that the copier is jammed, allowing a human to fix the issue. To start the copier after a jam there must be a fourth input that resets the system.
Constraints:	❖ Must have three input SPDT switches representing the paper sensors, each connected to an LED to indicate paper is currently in the area. ❖ Must have a Reset SPDT switch to detect whether a jam has been cleared. ❖ Must have a Motor Out LED which indicates normal operation without a paper jam. ❖ Must have a Jam LED which indicates that two adjacent areas contain paper at the same time. ❖ Must use one active low D flip-flop integrated circuit. ❖ Must use AOI logic ❖ Must be completed by December 13, 2023
Deliverables:	❖ Design brief ❖ Proof of working circuits ❖ A simulation of my circuit in MultiSIM ❖ A simulation of my circuit in TinkerCAD ❖ Justification as to the type of circuits used ❖ Project reflection which describes the process I took to design my circuit and any errors/problems I faced ❖ A portfolio which describes the process I took to design my circuit

Truth Table

A truth table is a diagram of all possible inputs in a system and their outcomes. If the output of the chart is one, then the decision in this scenario is positive. To decide when an output should be one, I looked back at the problem at hand and placed them when the two inputs that are next to one another are sending high signals.

In this project, I used this chart to check whether or not anything I simulated, built, or drew works. I also used it to create a simplified logic expression using the K Mapping technique.

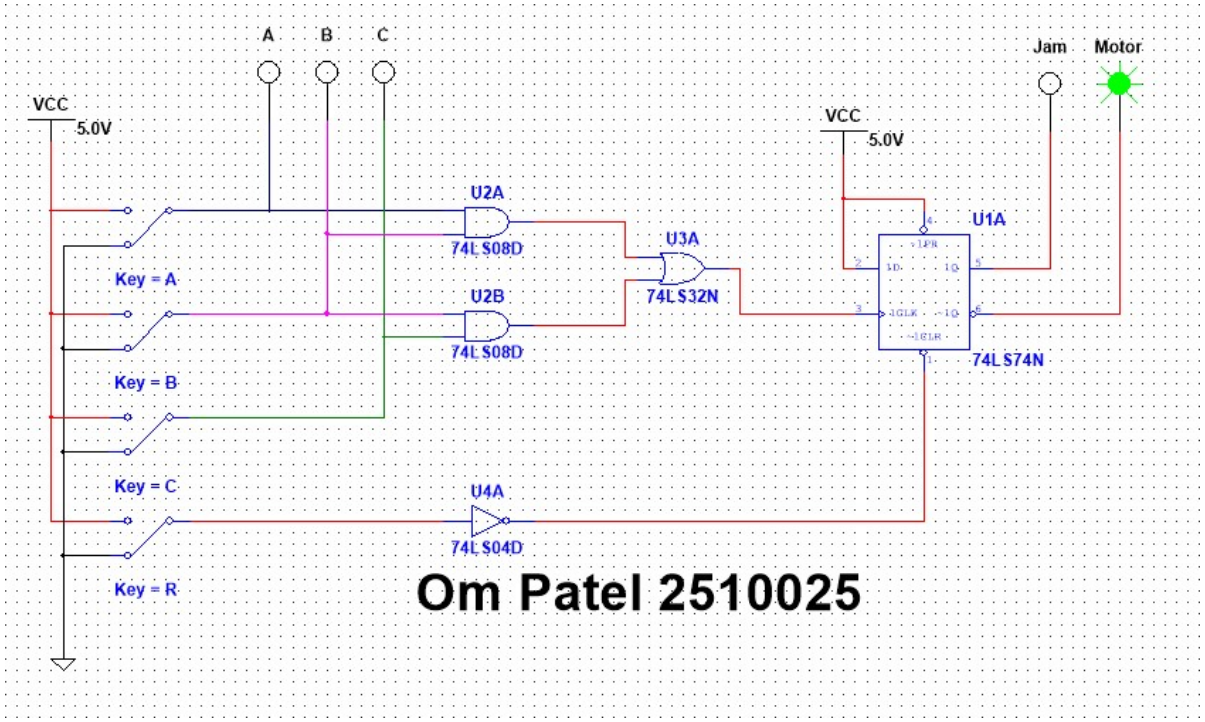
Sensor 1	Sensor 2	Sensor 3	Decision
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1



Karnaugh Mapping

Using a method called Karnaugh Mapping also called K-Mapping I can easily derive a simplified equation from a set of outputs. To create the equation from a table you must group ones in a way to eliminate any excess inputs.

This logic expression will help me design the decision-making portion of my circuit, only sending a signal to my D flip-flip when there are two adjacent pieces in the copier.

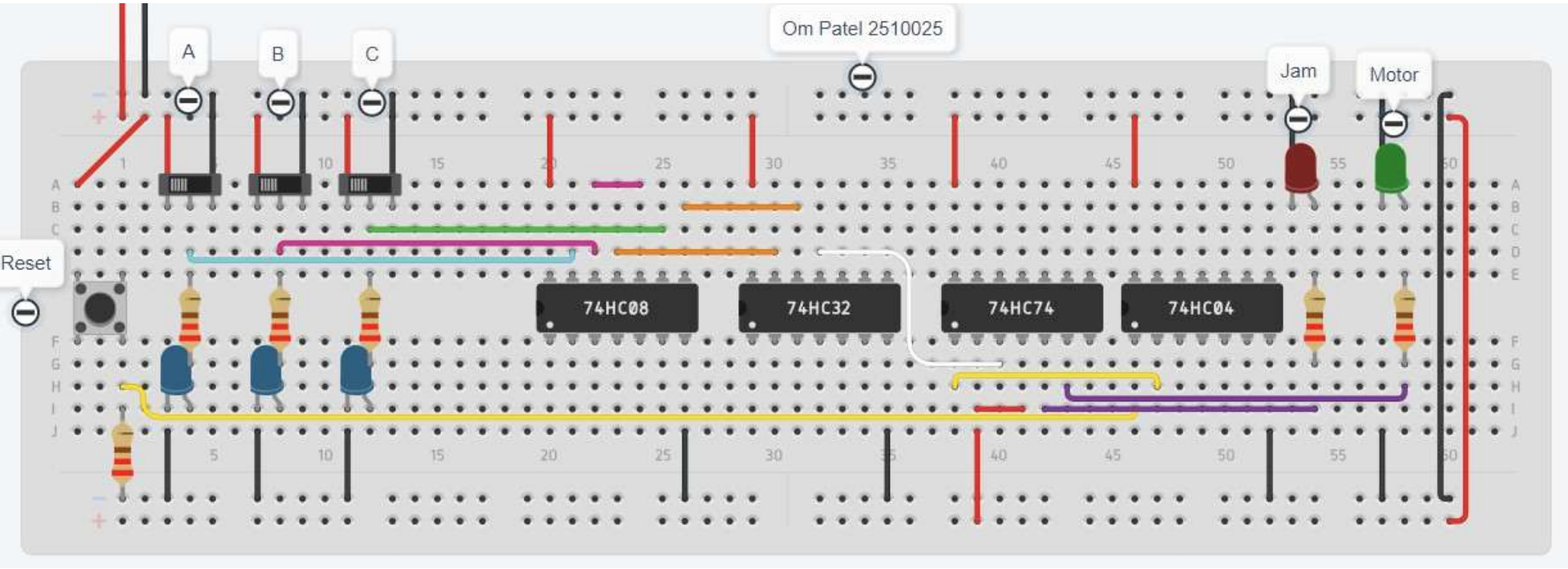


MultiSIM

Having my logic equation, I could then test and create a circuit in MultiSIM.

Once confirming my AOI logic works, I then placed my D flip-flop into the system, allowing for the system to reset and light both the Jam LED and the Motor LED at opposite moments.

For my reset switch, I placed an inverter on its signal as when making it in real life or TinkerCAD, the switch would be a button rather than a switch.



TinkerCAD

Utilizing a digital breadboard software called TinkerCAD I can visualize what a breadboard of this circuit would look like without the repercussion of physically making it. This allows me to create a working prototype that I could use later if I wanted to create a real working product.