40-Yard Dash Stopwatch

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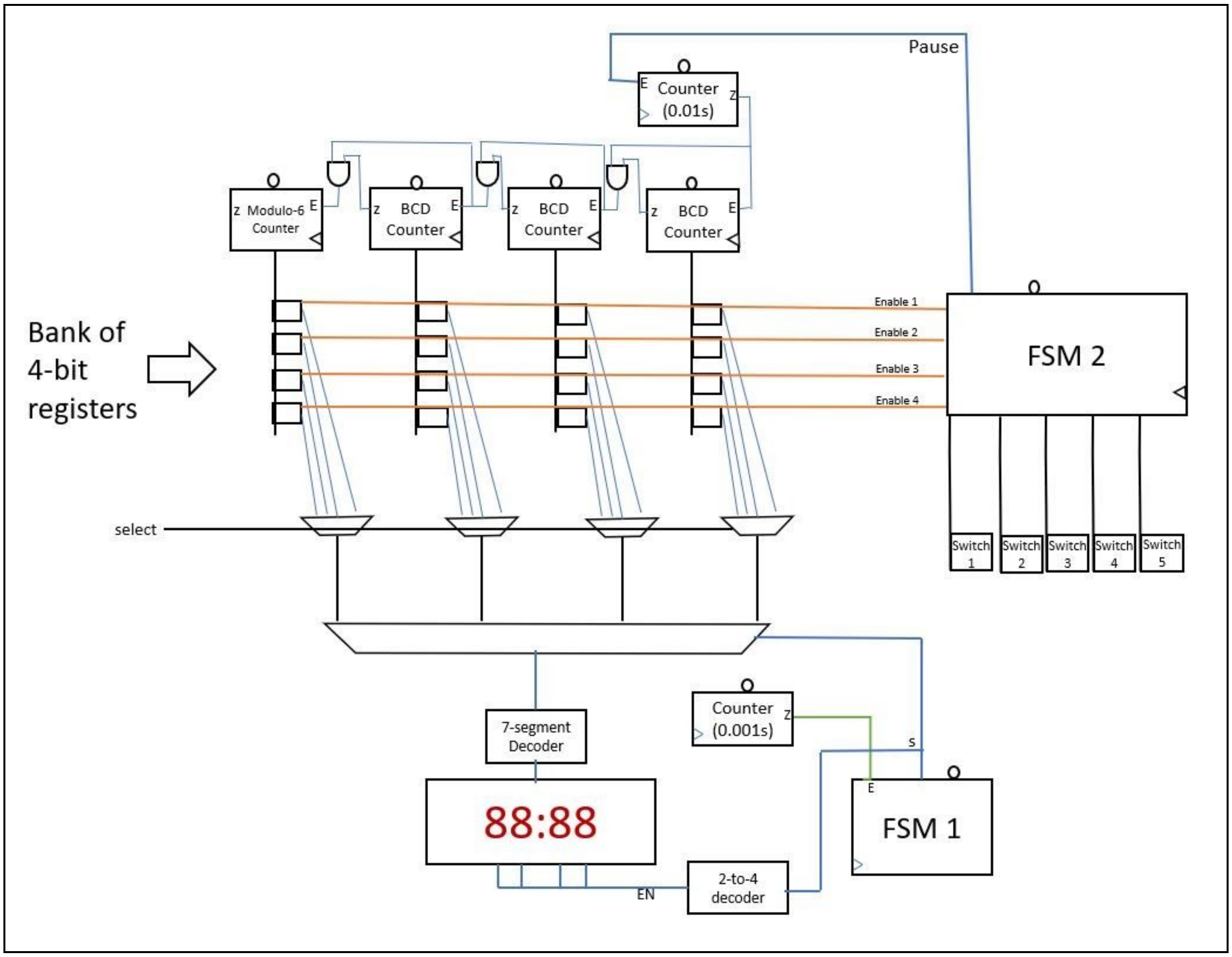
Abstract:

In the national football league (NFL), before college football prospects enter the NFL draft, they must participate in an event called the NFL combine. In the combine, the players test a variety of their physical skill sets (vertical jump, 40 yard dash, lateral quickness) to set record numbers and increase their draft stock. In the 40 yard dash, the player starts on the zero yard line and the stopwatch begins to tick as soon as they cross the starting line. Once they complete the sprint and cross the finish line (40 yard line), the timer stops and the sprint is over. For the final project, we'll be creating a 40 yard dash simulation stopwatch through VHDL that triggers on when the object crosses the start point and off when it reaches the end point. Furthermore, we'll be incorporating three 'lap' times (10 yard line, 20 yard line, 30 yard line) which will store specific times and reset the stopwatch to zero. Once the object is successfully across the finish line, it'll accumulate all of the laps to display the total time needed to complete the sprint.

Introduction:

This report will cover the functionality of the unique stopwatch used in the 40-yard dash, a drill widely known from the NFL combine. The significance that this traditional drill of football has is immense. Football, being one of the most popular sports in the country, is a sport that is judged upon several parameters. However, some are most definitely more important to others. Moreover, the 40-yard dash is perhaps the most important combine exercise. Every year there is a strong emphasis on what a player's 40-yard dash time is. The other drills are most definitely important, but none of them have the prominent reputation that the 40-yard dash has. With that being said, the impact of doing this experiment is significant in the sports world because the logic developed in this project is the basis of many drills in other sports. The logic developed in this project encompasses a variety of concepts. Some of which were learned in the classroom and some were discovered on the journey to the final product. Concepts such as registers, multiplexores, decoders, counters, and finite state machines were all utilized in this project and explored through the classroom. On the other hand, breakthroughs were made in the group through the creation of the logic for the finite state machines, constraints, top file, and test bench.

Methodology:
The top level design of our digital stopwatch can be seen in the following figure:

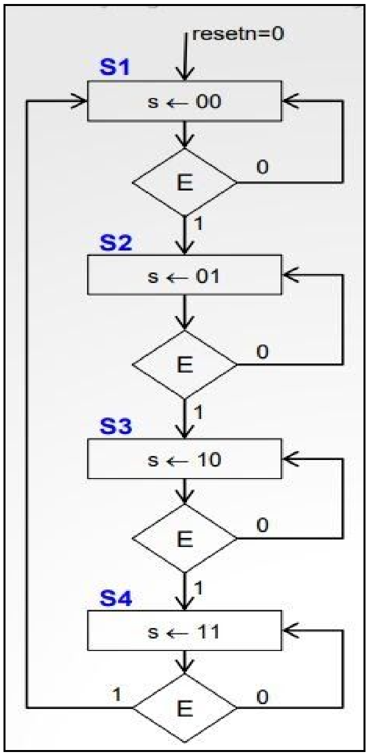


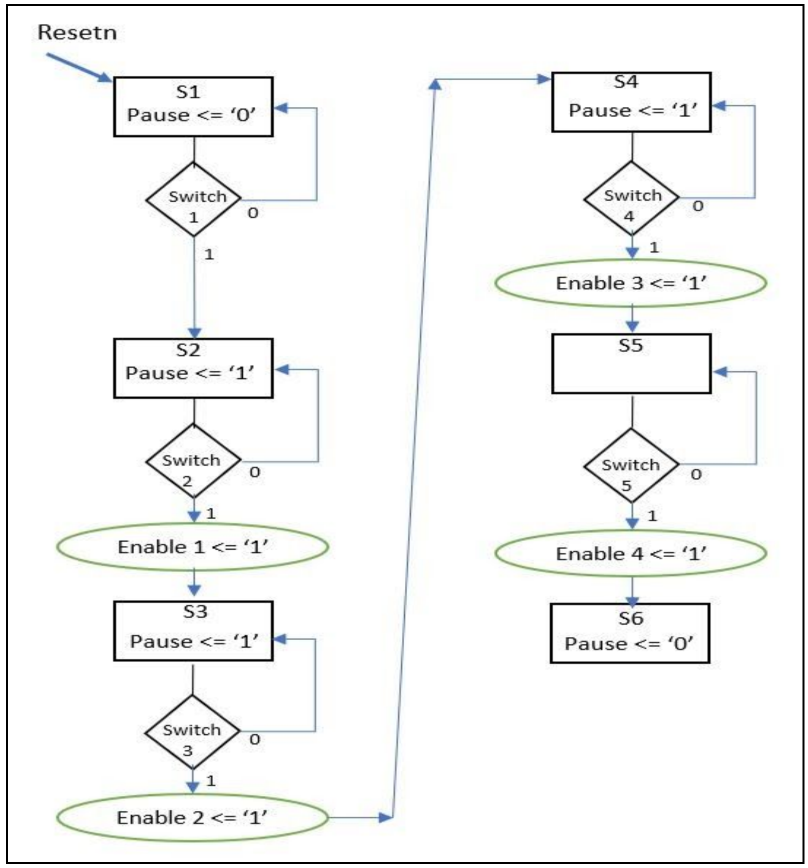
Basically it is composed of a series of counters to keep time, Registers to store lap times, and the appropriate architecture to display the times on the 7 segment display.

The multiplexers with select will be controlled by physical switches on the board allowing the user to choose whether they want to display one of the lap times or the finished time.

Switches 1-5 will be external light beam switches utilizing the I/O pins on the board. The FPGA will be able to see when the laser beam is broken and execute its tasks accordingly.

FSM 1 is only responsible for displaying the times on the 7 segment display. It is necessary to light each segment for 1ms, and cycle through all of the segments to correctly display the desired time. The Flow diagram is shown below:





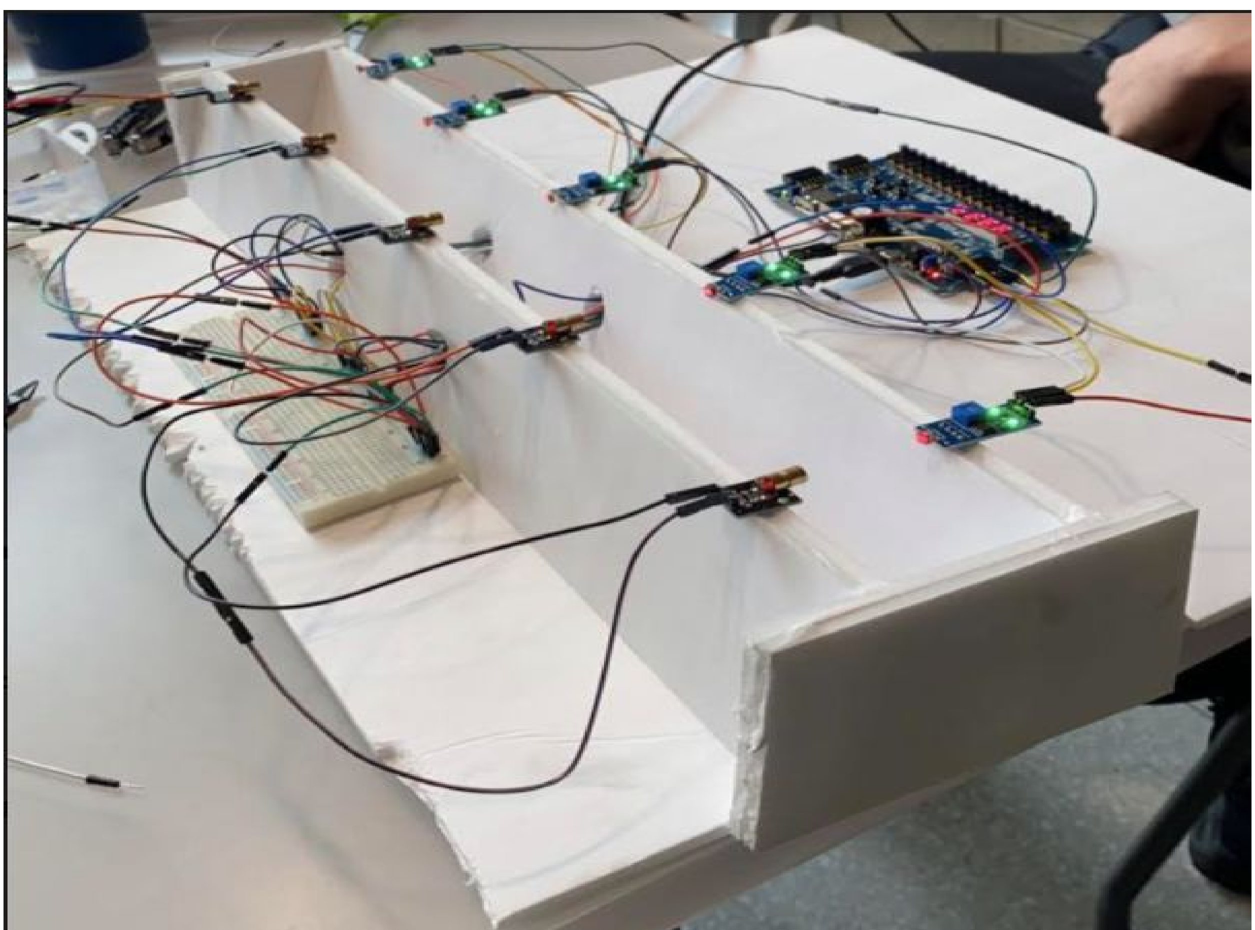
FSM 2 (see below) is slightly more complex as it is required to start the timer when the first light beam is broken, and enable the appropriate row of registers to record the lap times as the next sensors are triggered. When the last sensor is tripped, it stops the timer, and the times can be viewed on the display based on the user's selection. The flow diagram below shows FSM 2.

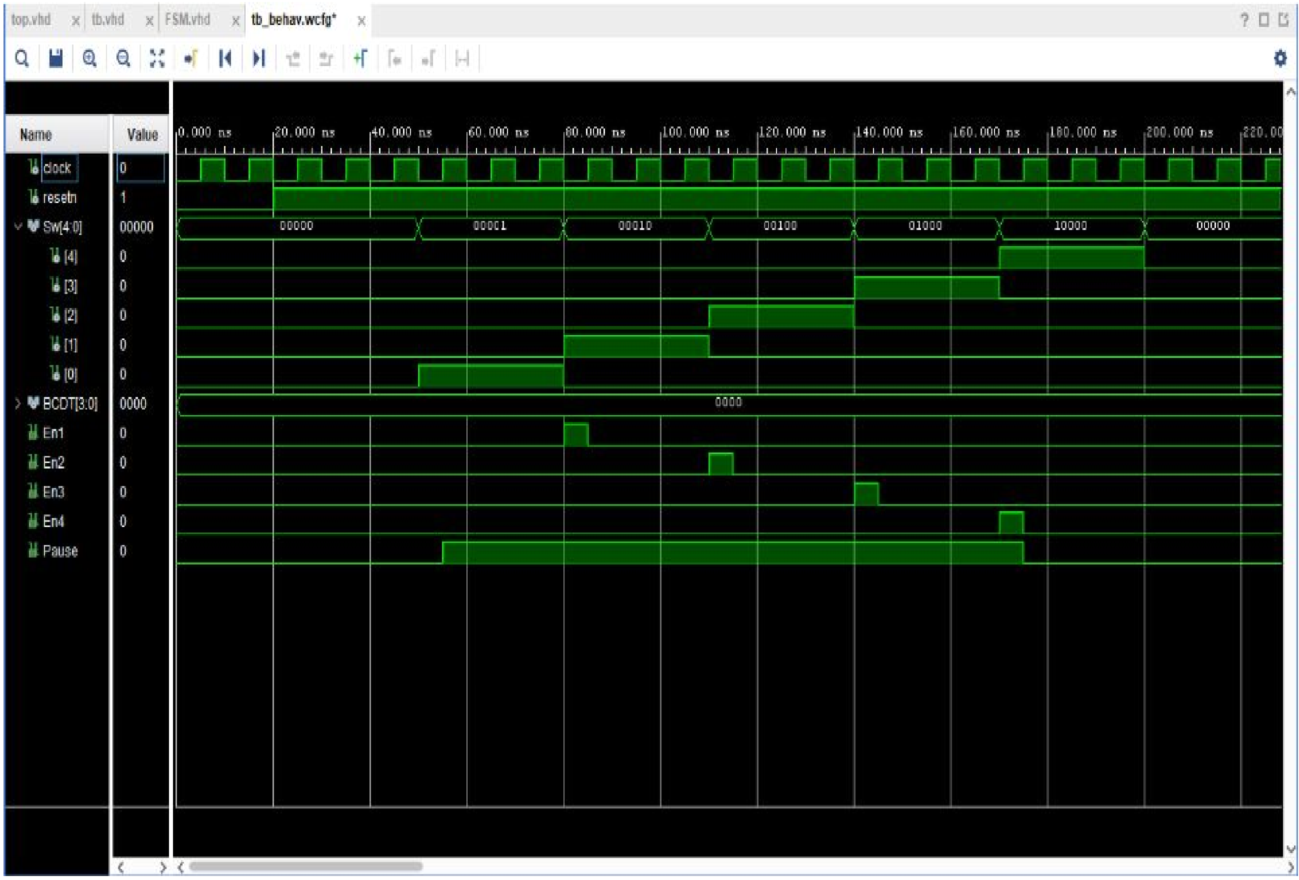
Experimental Setup:

To verify that we have a working system, we will use a scaled down set up of our concept. We start with 5 sensors and we spread them out 5 inches apart to resemble the 40 yards. The first sensor is the sensor that initiated the start of our clock. The second sensor is the first lap time, the distance that it takes the runner, or in this case our hand from start to the 10 yards. The third laser represents the 20-yard lap. The forth sensor represents the third lap at yard 30. The fifth and last sensor represents the 40-yard line, which will stop the clock once the runner (hand) breaks the plane. In order to decide which time is represented on the display, we will use the switches in order for the select clock time to display. The first two switches dictat which lap time we are looking at. If both switches are low, it represents a “00” which will display the first lap time. If the second switch is low and first is high, it represents “01” which is our second lap time, “10” represents third lap time anywhere “11” represents final time. What we would like to see is the lap times be similar and to be able to add up to the final stop time. When the lap times increment up towards the final stop time, we know our design is working.

Current Project Status:

The schematic is completed as well as the simulation and implementation. Each member had their own design sources to insert code (counter, BCD counter, modulo-6, multiplexores, registers with sclr, etc..) so that we can bring all vhdl files together in the top file. After that was completed, we created a testbench to manufacture a simulation or basically a script for the code to run, along with modifying the constraints file to allow the appropriate inputs and outputs to be used on the board. Below, you will find a photo of the implementation and structure we created relating to the 40 yard dash in the combine. The lasers are mounted on the left side of the board with the light sensors directly across from each of the lasers. We decided to space them about 5 inches apart from each other with the first set being the “start” function, the next three sets (10, 20 and 30 yard line) setting off a “lap” function for our stopwatch and finally the 5th sensors (40 yard line) being a “stop” function. We were able to display and toggle through the lap times and final time by using the switches on the FPGA board.





Video of working Model:

https://youtu.be/wYSRvY8j-3Q