Pinewood Derby

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Introduction:

Pine wood derby races are for hobbyists of all ages. We wanted to design an automatic timer to solve the lack of precision, provide insightful race statistics, and improve overall user experience in pinewood derby racing. Our timing system provides a low-cost design, memory of previous races, and an online site where a live stream of the race and race results can be seen. Our design's low cost and easy setup allows it to be implemented on any track, thus incentivizing both small and large organizations to use this timing system by offering a hassle free racing experience

Testing:

The first test that was done was finding precision and accuracy of the of the Arduino's timing shown by **Figure 1**. This test was preformed by simulating 2 pulse in WaveForms AD2, both low for 25ms and high for 5secs, offset by 10 ms. The Arduino code calculated the difference in time between the 2 rising edges of the pulses. The second test that was done was to fins the optimal distance to get an accurate reading from the QTI sensors of the cars' speed shown by **Figure 2**. This test was performed by using an AD2 as a 5V source. The sensors were then moved to different distances from the car. Once the tests were both completed, we knew what distance to place the QTI sensors on each lane to be accurate and how precise our timing could be.

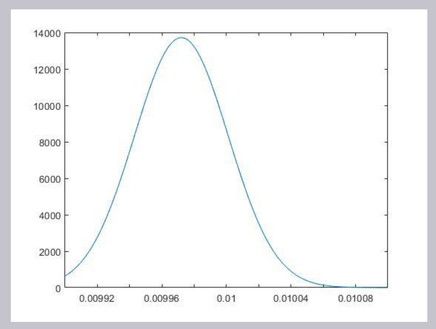

Figure 1 shows the normal distribution of the time difference between 2 known pulses. The curves shows the how the samples vary from the average.

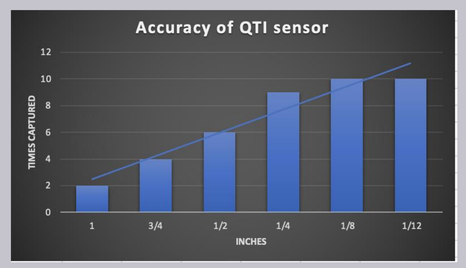

Figure 2 shows the distance of the QTI sensor from the car and the ability to be triggered. The trend line shows that the closer the sensor was to the car the more times it would get triggered.

Components and Design:

- We built a 32 foot, 2 lane track out of ply-wood.
- The QTI Sensor is an infrared emitter/receiver that can differentiate between a dark surface with low IR reflectivity and a light surface.
- We have all wires that are connected to the QTI sensors hook up to a breakout box so that a constant 5V supply can be provided from the wall socket.
- Database
- The comparator circuit takes the output of the sensor and compares it to our reference voltage of 4V.
- There is a relay switch at the top of the track that is triggered when released. The PVC pipe drop gate will release the relay and start the Arduino code.
- We used an Arduino UNO WIFI Rev. 2 microcontroller for the center of the project, controlling the timing and QTI sensors with a 46-state state machine
- Data is sent over WiFi using Arduino Library "Firebase Arduino based on WiFiNINA"
- Google Firebase is used to host our web application at the domain https://trinepinewood.com
- The database is also located on Firebase, using Google Realtime

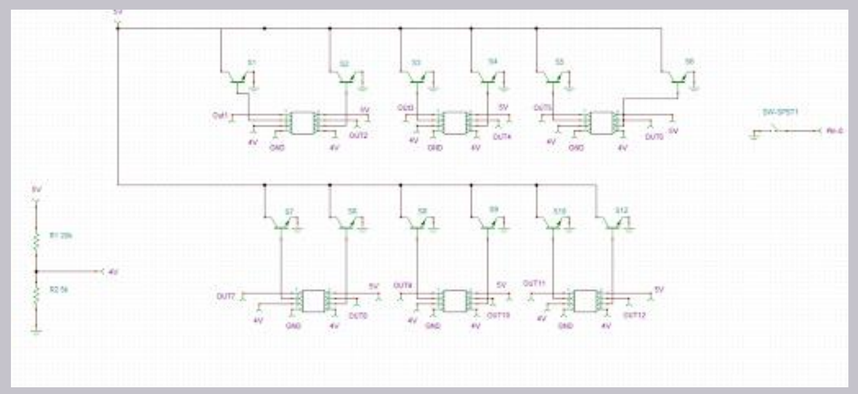

Figure 3: This TINA diagram shows how our timing is set up. The transistors represent the QTI sensors as they both have 3 pins. The right pin goes to ground, the middle go to the Arduino digital pins, and the left pin goes to the 5V supply. The relay is shown by the switch. One pin goes to the Arduino digital pin, the other goes to ground.

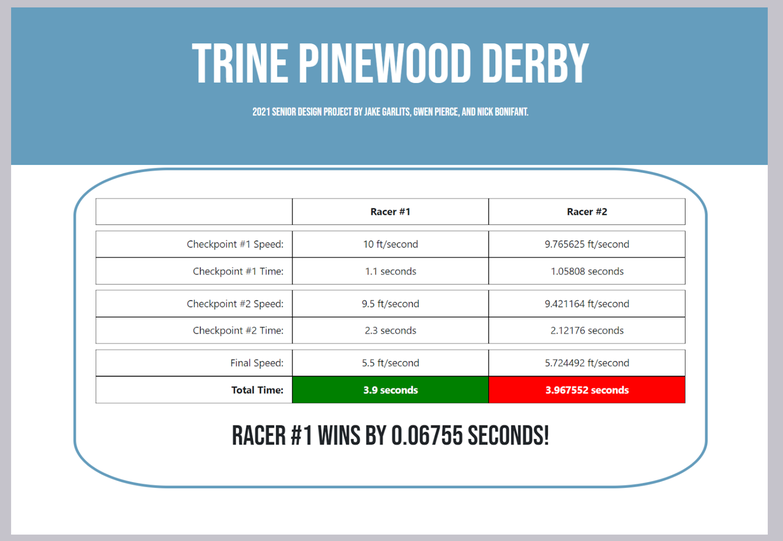

Figure 4: This is a screenshot that came from trine-pinewood.web.app

Conclusion:

This design is geared to those that need an updated pinewood derby track and timer whether it is at your home or a professional pinewood derby race that will be used in large events. Our timer design solves human error and accuracy when timing race cars for a pinewood derby race. The components and materials for the system and track are relatively inexpensive compared to commercial tracks. The designed webpage will provide fast, convenient, and insightful data whether you could make it to the race or not. With these features, this track can provide racers a better Pinewood Derby experience.

Future Work:

The following are ideas to further improve the ATNS Smart Power Supply:

- Create a weatherproof track and system
- Create visors for the sensors to improve signal reception with the sensors.
- Automated drop gate system
- Light indicators
- PCB circuit board

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