Bits and Bytes

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CS121 - B

Project Proposal

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Introduction

Over the past several weeks, Bits and Bytes has undergone extensive deliberations in an effort to draft a proposal for a final project centered around the use of a Raspberry Pi, seeking approval from entrepreneur and investor Jim Eddy. Although many great pitch ideas were brought to the table from all members of the team, it was actually a friend of project manager Andrew Snell who can be credited with the inspiration for Bits and Bytes' project idea. Snell's acquaintance vehemently claimed that he could run faster than NFL starting quarterback Jared Goff, specifically quoting his "slow" forty-yard dash time. Project manager Snell recounted this amusing tale in front of the team before kicking off a meeting, only to realize he had laid out the perfect project idea. Bits and Bytes is planning to move forward with a prototype for an electronic motion-sensor timing system to accurately record forty-yard dash splits, similar to that used in the NFL combine.

The model for our electronic timer will revolve around the use of the Raspberry Pi, which will receive input from two laser "trip-wires" placed at the start and finish of the forty-yard track. When the subject starts his or her run, they will break the plane of the first laser, activating a timer. When the subject crosses the forty-yard mark, and subsequently the second laser, the timer will stop. The lasers will be mounted at an appropriate height to ensure they target the runner's midsection for optimal results.The laser trip-wires will be constructed from a laser diode pointed at a phototransistor, an electrical component that acts as switch in an electrical circuit based on the intensity of light it is receiving.

At the heart of the operation lies the Raspberry Pi, a small but powerful and versatile computer. The RasPi will be responsible for detecting a break in the path of the laser diode, by which it will receive electronic signals through its GPIO (general purpose input/output) pins. These electronic signals will be interpreted and the data sourced from them will be used in a Python script that holds the program for the timing system, thus completing a functional and precise electric timer, similar to that used in the NFL combine.

Definitions, Acronyms, and Abbreviations

Raspberry Pi (RasPi) - a computer the size of a credit card that has the capability to interact with external devices

GPIO - General Purpose Output Input; GPIO pins allow the Raspberry Pi to interact with external components

Python - programming language compatible with the Raspberry Pi

Photoresistor - electrical component that decreases resistance with an increase of light intensity to its surface

Phototransistor - electrical component that acts as a switch in an electrical circuit based on the intensity of light it is receiving

Laser Diode - semiconductor device that emits light of the same frequency, creating what is known as a laser beam

LDR - Light Dependent Resistor

ADC - Analogue to digital convert

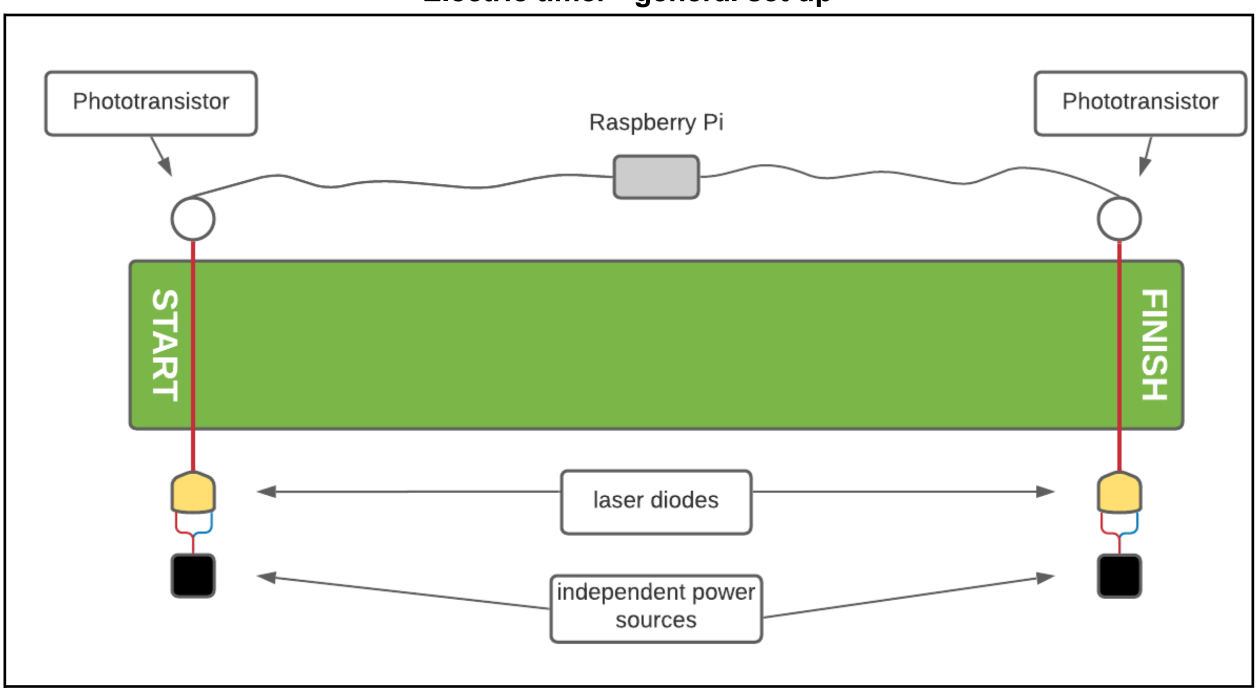
B&B - Bits and Bytes

Project Details

The General Set up

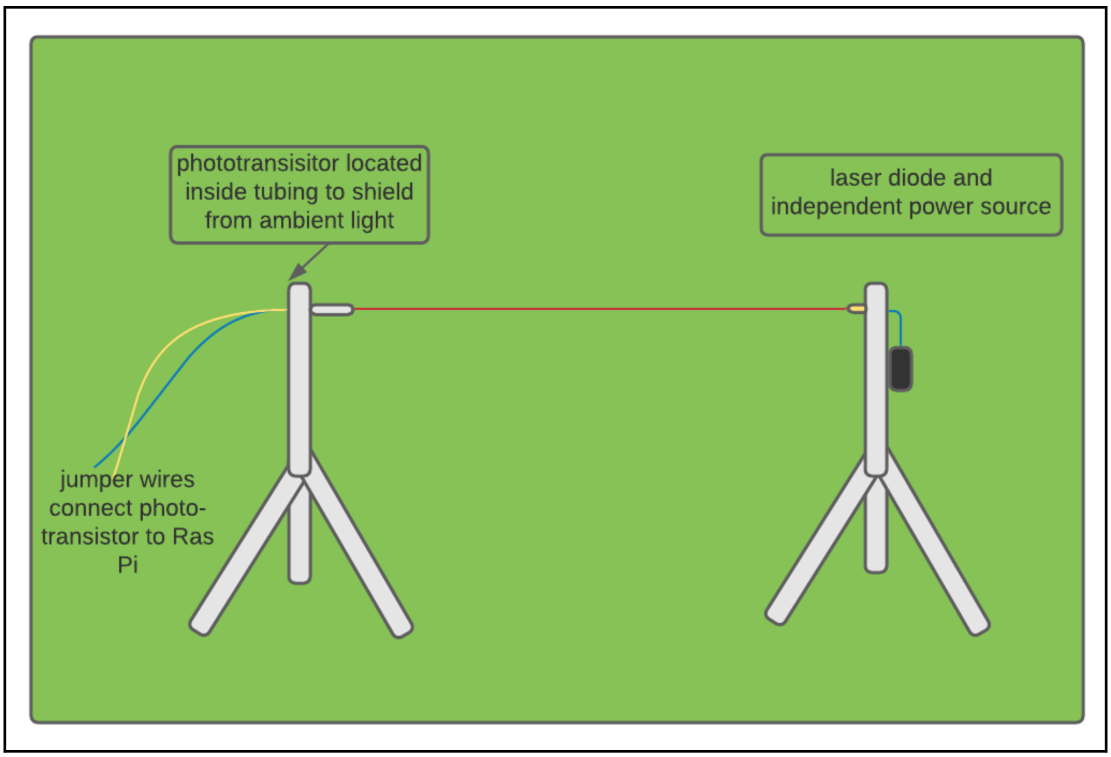
The set up for the electronic timer will include two laser trip-wires set up forty yards apart, one placed along the start line and other along the finish line. Jumper wires will connect the laser trip-wires to a Raspberry Pi, centrally located halfway down the track (20 yards from each sensor). The laser trip-wires will be constructed from a laser diode, powered by an independent power source, and a phototransistor that connects to the RasPi via a breadboard and a system of jumper wires. The laser diodes and phototransistors will be mounted on separate structures a few feet apart, allowing the subject to pass freely between the two. The laser will be focused directly onto the surface of the photoresistor, creating a plane that spans the width of the running surface. When the runner passes between the structures mounting the laser and phototransistors (located at the start/finish lines), the path of the laser will be obstructed, triggering a response from the phototransistor to start or stop the timer. Below is a model of the general set up:

Electric timer - general set up



The Mounting System

The mounting system will secure the laser trip-wires in place, elevating them off the ground so they are approximately waist high (about 3 ft). Each laser diode and phototransistor will be mounted on separate structures, so each structure holds one component. The structures will be constructed from PVC pipes in the form of a tripod with three legs and a vertical shaft. Each laser and phototransistor will be secured on the vertical shaft at the same height, ensuring that the beam of the laser can easily be focused on its corresponding phototransistor. The mounts with the phototransistors will also include tubing to encase the component in order to shield it from ambient light. Below is a model of the mounting system:

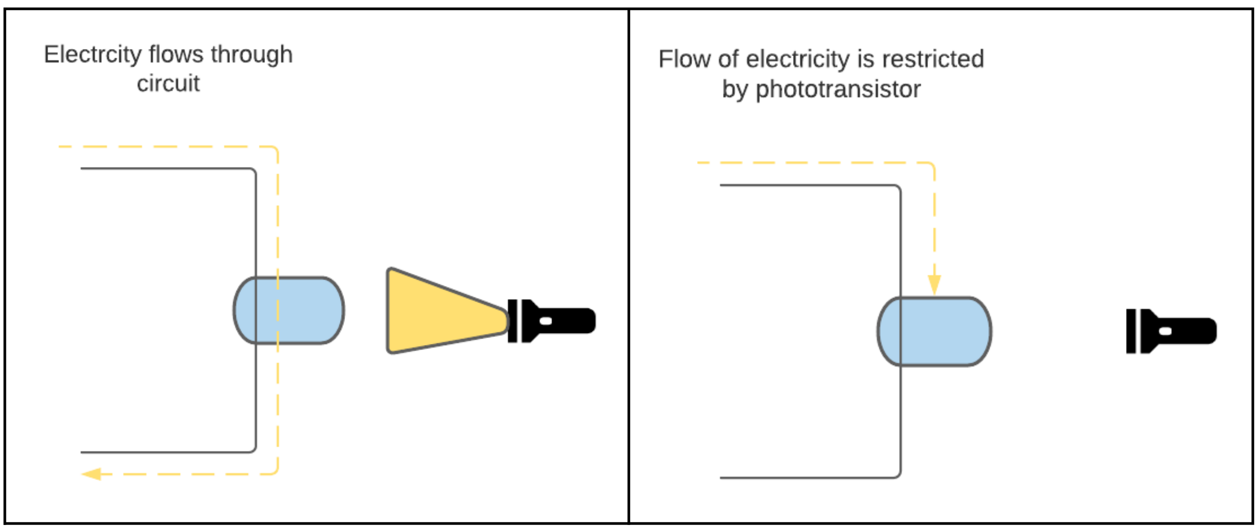


The Laser Trip-Wire

Simply breaking the path of the laser does not trigger a response from the Raspberry Pi to start/stop the timer, but in actuality it is the change in light detected from the phototransistor that sends a signal back to the RasPi as input. In this case, it will be receiving light from the laser diode, which operates at a frequency around 650nm, which is at the top of the visible light spectrum. In order for the phototransistor to detect a change in light, caused by the brief interruption of the laser due to the passing runner, it will be placed several inches deep in a tube in order to block out ambient light. Thus, the only (or vast majority of) light detected by the phototransistor will be from the laser, meaning there will be a dramatic difference in light intensity due to the laser compared to when it is momentarily impeded by the passing runner. Although the path of the laser will only be disrupted for a few milliseconds, theoretically it should be enough time for the photoresistor to register a change in light intensity.

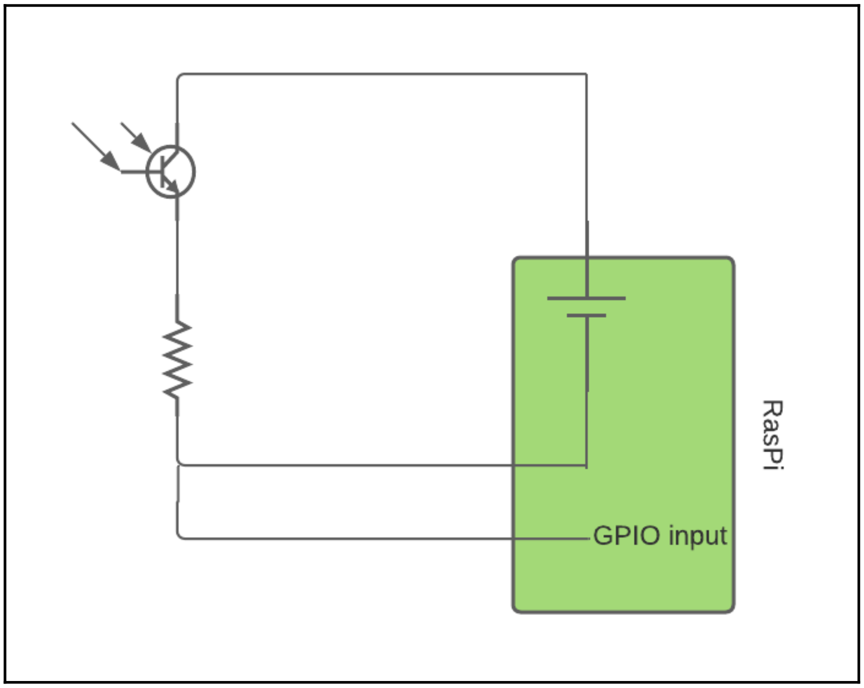
A typical transistor will block the flow of electrical current unless a small amount of voltage is applied to its base. This concept applies to a phototransistor as well, except that the voltage is created by light contacting its surface. When light strikes the surface of a phototransistor, it acts as an “on” switch and allows current to flow through the circuit. When it does not come into contact with light, it acts as an “off” switch and restricts current from flowing through the circuit.

Example: simplistic representation of a phototransistor



The concept depicted in the above image is the basis for our motion sensor timer. When the laser diode is focused on the phototransistor, an electrical current will flow through the circuit. When the subject impedes the path of the laser, a lack of light will cause the phototransistor to restrict the flow in the circuit. The RasPi will be able to detect this change of electrical flow via its GPIO pins, triggering the proper start/stop response for the timer.

The circuit containing the phototransistor will draw its power from one of the 3.3V pins on the Raspberry Pi. The circuit, constructed on a breadboard, will also include a resistor and an ADC, grounded in a GND pin. The ADC, which will convert analogue signals to digital, is necessary for the GPIO pins to interpret input, as they can only understand digital signals. Below is a circuit diagram which will serve as a model for our prototype:



Budget

Estimated Cost of Labor

Position	Hourly Wage	Expected Hours Worked	Cost
Project Manager	$25.00	25.5	$637.50
Head of Software Development	$40.00	20.0	$800.00
Network Engineer	$18.00	12.5	$225.00
Lead Technician	$35.00	19.5	$682.50
Testing and Quality Assurance	$17.00	8.0	$136.00
		Total Cost	2,481.00

Estimated Cost of Materials

Materials	Count	Cost
Phototransistors	2	$4.99
MCP3008 Analogue to Digital Converter	1	$3.75
Jumper Wire	120	$19.98
Breadboard	1	$5.99
Laser Diodes	2	$5.99
Battery Pack/Holder	2	$6.99
Double AA Batteries	24	$15.99
Mounting System	-	$20.00
	Total Cost	$83.68

Estimated Budget Costs:

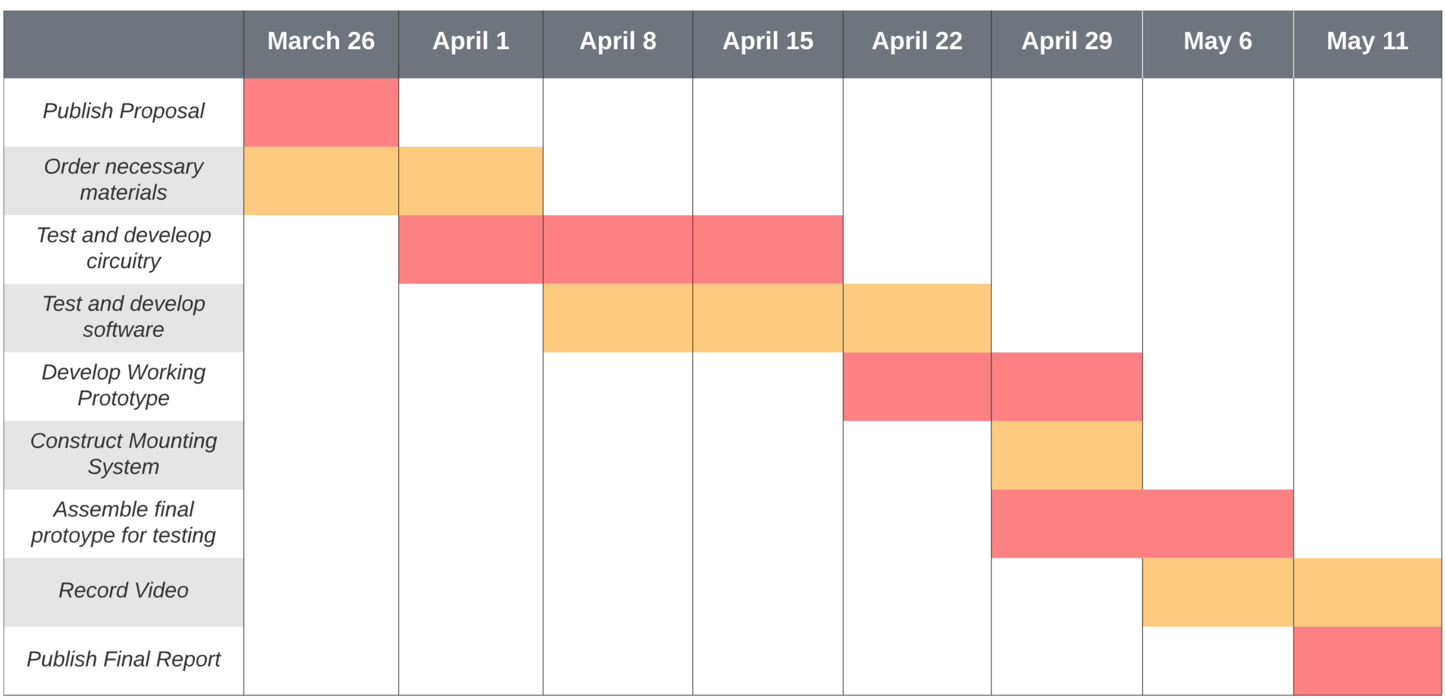
Labor	$2,481.00
Materials	$83.68
Total	**$2,564.68**

Project Plan

The Bits and Bytes Team

Name	Role	Duty
Andrew Snell	Project Manager	Manage the due dates and expectations of the team, ensure proper materials are ordered, provide oversight in all fields
Andrew Snell	Head of Software Development	Write and test programs that require data from external systems and integrate it into functioning software that fit desired result
Andrew Snell	Network Engineer	Integrate user interface into product
Andrew Snell	Lead Technician	Construct proper circuitry and any physical systems in order for prototype to function properly
Andrew Snell	Testing and Quality Assurance	Ensure prototype is functioning properly, diagnose and report any and all problems

Gantt Chart



Target Audience

The target audience for Bits and Bytes' new proposal would be athletes interested in gathering accurate and dependable results for their forty-yard dash (and other running related) splits. The forty-yard dash is a metric of speed and quickness used across many sports, and is a large indicator of one's athletic ability. A fast forty time will automatically grab the attention of any scout or coach and place you at the top of their board. It is important for athletes to know their forty split so they can improve upon it if it does not live up to coach's or scout's standards. Athletes shouldn't have to rely on their moms to record their times with an iPhone, so that is why Bits and Bytes' electronic motion-sensor timer will be marketed to those athletes who want to compete at the next level. Although B&B's electronic timer is intended to record accurate forty-yard dash splits, it is not it's exclusive purpose. The timer will record reliable results from someone who wants to focus on acceleration (10 yards) or a track star trying to qualify for the olympics (100 yards).

The secondary target audience for this device is quite the opposite. A campaign will be launched to target out-of-shape people who are past their prime, but swear they could beat the athletes they see on TV in a race. This electronic timer will hopefully bring humility to those who got cut from their high-school sports team, and put an end to the average Joe who almost pulled a hamstring getting up from the couch from criticizing the best athletes in the world.

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