Boston University

Electrical & Computer Engineering

EC464 Capstone Senior Design Project

The RightAlert User's Manual

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RightAlert

Table of Contents

Executive Summary

In the city of Boston, where countless bikers share the same streets as cars every day, bike safety is of utmost importance. Unfortunately, each year there are numerous collisions between bicycles and cars and the results can be fatal. One of the most dangerous situations bikers find themselves in is when cars make right turns across the bike lane. Sometimes drivers fail to check their side-view mirrors before turning, and as a result crash into bikers. Our team, RightAlert, provides a solar-powered system to warn drivers of oncoming bikers when a collision like this is imminent. A camera detects bikers traveling down the bike lane while an LED-lit traffic alert sign functions as a visual cue for drivers letting them know of the oncoming bike traffic. The RightAlert system is an intuitive tool for all drivers turning at an intersection. RightAlert provides a website which displays real time data while the system is running. It also allows for remote administration of specific system settings. Our system rivals alternative technologies that dedicate themselves to warning only one vehicle and fail to log traffic information. We at RightAlert are making Boston a haven for both bikers and drivers and seek to further improve overall traffic research in the city by providing our findings.

1 Introduction

RightAlert began as the "Bike Detector and Alerting System II", a continuation and an alternative to the 2015 ECE class' *CARR* system. Their project was designed as a bike detector for individual vehicles, and consisted of a small box attached to the dashboard and two cameras affixed to the side-view mirrors. This prototype system and the previous team's logbooks was made available to our team as a starting point for our design. While their project initially guided our research, we discovered our system was much different.

First, our product is meant to be utilized not by one driver, but by any vehicle and bicycle that crosses through our final location. Our system's initial requirements state that it must be a stationary "alerting system for the driver without having any special equipment installed or mounted in the car." This means that every vehicle crossing through our intersection will be warned of a bicyclist approaching their rear, creating a safer road at no extra cost to the consumer. This obviously implies that our product is designed for a different audience than that of *CARR*. Instead of a system designed for an average driving consumer, the natural "customer" for the system is the City of Boston. The city has incentives to make bike transportation as safe as possible, and preventing deadly accidents saves money and increases trust throughout the community. However, with the city in mind as our eventual customer, a horde of standard regulation shaped the design and placement of the final system, the alert sign, and the power budget.

The *RightAlert* system with the current training has a true positive rate 92.84% of and a false positive rate of 1.98% (precision: 96.54% and accuracy: 96.08%). A detection triggers a TAPCO custom-made traffic sign with 8 super-bright LEDs embedded into the sign using ultrasonic welding. The alert sign is MUTCD-compliant and comes with pole mounting straps and an anti-graffiti overlay. The main box that houses our processing components is completely water and weather-proof. Our solar panel can last for about 12 hours at full use without charging, but has a higher expected average power cycle. Finally, the *RightAlert* website collects data from the system, provides a graphical display of peak bike times, and records a daily bike count, the current battery voltage and current, an image of the latest detection, and other advanced engineering stats and options.

The current version of our project uses anti-vandal mounting straps for the alert sign, and we purchased miniature combination locks to secure the main box and the camera housing, however, if someone gains access to the Jetson, the system cannot be re-programmed to record video of the street.

2 System Overview and Installation

2.1 Overview block diagram

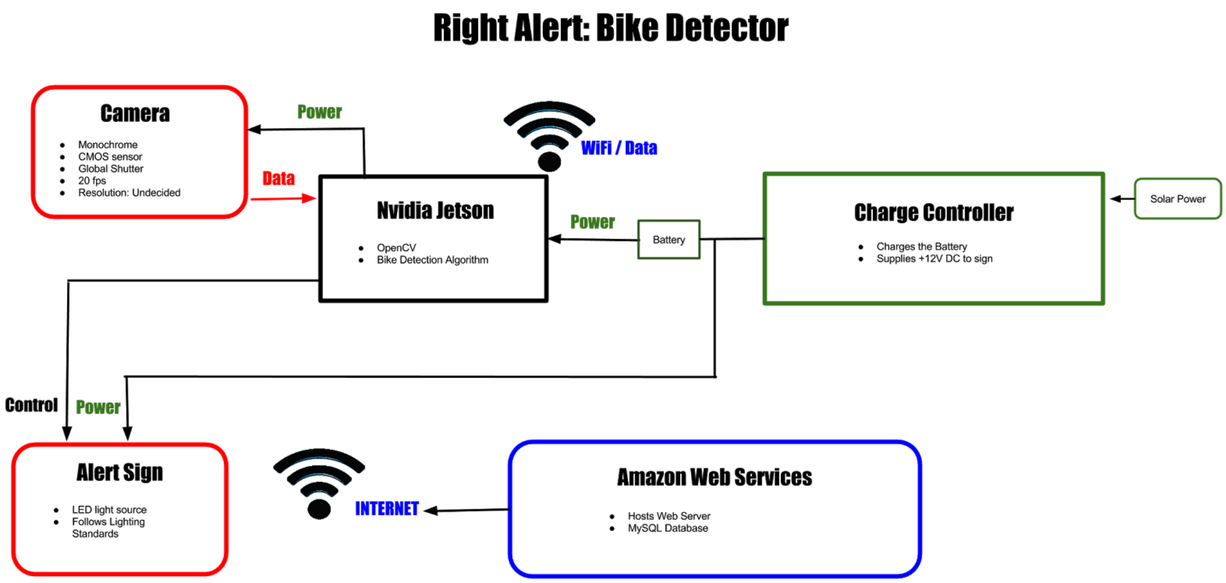

Figure 2.1.1 High level block diagram describing the RightAlert system

2.2 User interface.

RightAlert functions both as an alerting system for drivers as well as a monitoring station for bike traffic. Depending on the user, the interface will be different. Drivers using RightAlert will interact with the device through the physical alert sign itself which is mounted on a street implementing the system. When the driver comes near the intersection and a biker approaches from the right, the sign will flash and notify the driver.

Figure 2.2.1 Viewpoint of a bicycle from approx. 60 ft. away from sign with car tuning in front of them

Figure 2.2.2 Close up view of the mock-up alert sign in relation to the pole

On the other hand, government workers as well as traffic researchers will benefit from RightAlert’s website, “admin.rightalert.net.” At the site they will have access to traffic data, view the last detected bike, and access to an administration portal which allows direct control of the system provided Internet connectivity.

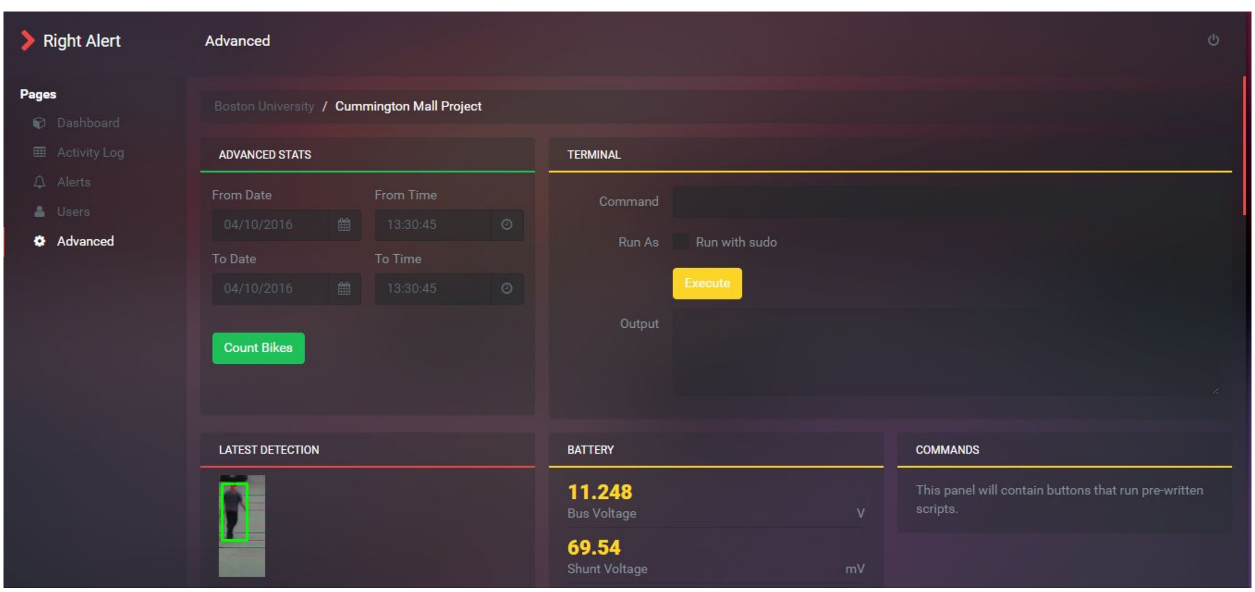

Figure 2.2.3 Screenshot of the Advanced Section of the admin portal for our website “admin.rightalert.net”

2.3 Physical description.

The physical components of RightAlert include the hardware hub, the alert sign, and a solar panel for power. The hardware hub itself is the brain of the system and is what detects bikers, uploads data to the website, and distribute control and power to the sign. More specifically, inside the hardware enclosure is:

1. NVIDIA Jetson TK1 running the bike detection algorithm
2. ELP 1080x960 Hd 2.8-12mm Varifocal Lens USB Webcam
3. Venom 12V 6400 mAH Lipo Battery
4. Current sensor which monitors battery level
5. Relay circuit controlling the alert sign
6. Charge controller orchestrating the charging of the battery and powering of the sign
7. Power splitting PC board
8. USB Wi-fi dongle

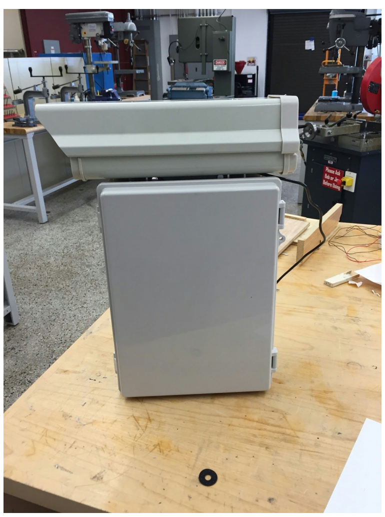

Figure 2.3.1. Exterior of hardware hub

Figure 2.3.2 Interior of hardware hub. Battery is missing from this picture

All components inside the box are affixed with small hex screws that come through the back and keep the components in place. A nut is then used on the far end of the screw to hold everything together. Then, waterproof rubber sealant is applied around the head of each screw on the back face of the box. The enclosure is accompanied with 7-9" diameter pole strap mounts. These are used to securely install the hardware hub at a desirable height and keep it there for a long period of time.

Figure 2.3.3 There are two metal mounts, each accompanied with a metal ring for hanging on a pole.

Figure 2.3.4 View of Cummington Ave. from the viewpoint of the camera

The Alert Sign is a 30"x 30" TAPCO custom-made "BlinkerSign" with 8 super-bright amber LEDs embedded into the sign using ultrasonic welding. The sign is MUTCD-compliant, meaning it adheres to all governmental traffic sign regulation, and comes with anti-vandal pole mounting straps, high performance reflective aluminium sheeting, and an anti-graffiti overlay. It is powered by a 12V source and can be connected by feeding wires into the small electrical box on the back face of the sign, described in detail in the following section.

Figure 2.3.5 Traffic sign we are using: MUTCD Sign R10-15 (Mod.)

Figure 2.3.6 An example of a TAPCO-made flashing stop sign

The off-grid solar panel is ordered directly from Renogy manufacturer. The 50W 12V Volt Polycrystalline Solar Panel has a maximum current output of 2.84A when standard test conditions are met(Irradiance 1000 W/m^2, Temperature 25°C). According to NASA Surface meteorology and Solar Energy data, the average solar radiance in Boston area is 3910 Wh/m^2/day, which means the solar panel can receive 3.9 hours of sun per day in 1000 W/m^2 in average. In the lab, we measure the average current output from solar panel is around 0.98A at 12:00pm in mid-April. The circuit has been designed to let battery make up for the insufficient power supply if the system draws more power than solar panel can provide at the daytimes. In the normal situation, the fully charged battery can support the system for 12 hours without charged, and an protection program has been embedded that will automatically shut down the Jetson TK1 when the voltage in the battery drops below 11.1V, the minimum safety voltage for 3-cell lipo battery.

2.4 Installation, setup, and support

2.4.a Setup of Bike Detection Algorithm

The Jetson TK1 will come with OpenCV 2.4.8 loaded as well as the necessary files and folders required to run the setup. To run the algorithm do the following once the physical setup is complete:

1. Connect to the Jetson via the SSH protocol by typing **ssh -X ubuntu@ra-jetson.duckdns.org** ***(password: savingL1v3s)***
2. Direct yourself to the **Bike Detector 3.0** folder by typing **cd Desktop/Bike\ Detector\ 3.0/**. Here run the **./out** command. This should display a help message with the possible flags you can use.
3. We first want to find out the dimensions for the region of interest at the new location. Run **./out --cameraTest 0**. This will open a window with the video feed from the camera. Move your cursor to get the coordinates (outputted to the terminal) of a specific point in the frame. Take down the x and y coordinates of the top left corner of your region of interest and its width and height.
4. Open the **main.cpp** file, **vim main.cpp**. Hit **I** to start inserting and change the variables, **top_left_x**, **top_left_y**, **roi_width** and **roi_height**. Hit **‘esc’** followed by **:wq** to save and quit. Then type **make**.
5. Now type **./out --detection --debug --camera 0** to start the detection and also see the visual output for the program. Repeat steps 3 to 5 until you are happy with the area of detection. **NOTE:** Keep the area small to avoid using excess computational power. Hit ‘**esc**’ to quit the program.
6. Run the program without the debug flag to run it without the visual output, **./out --detection --camera 0**.

2.4.b Setup of RightAlert Hardware Hub

As a customer, you should receive a fully functioning hardware hub during installation. However, if any issues concerning bike detection, alert sign lighting, or power occur please inspect the interior of the hub for abnormalities and consult these installation instructions. These are the steps to connect all the devices and components inside the hub so that all functionality is present. The lock combination is 666.

1. Ensure all peripheral devices and circuits are properly connected to the Jetson
    a. Connect the USB hub located on the right side of the box to the USB port of the Jetson, providing it with a total of 4 possible USB connections
    b. Locate the camera’s wire and Wi-Fi dongle and insert it in any of the USB hub’s unoccupied ports
    c. Inspect all the wires connecting the small circuit board below the Jetson and make sure they are secure in their appropriate ports. Below is a reference image to where each wire is supposed to go.

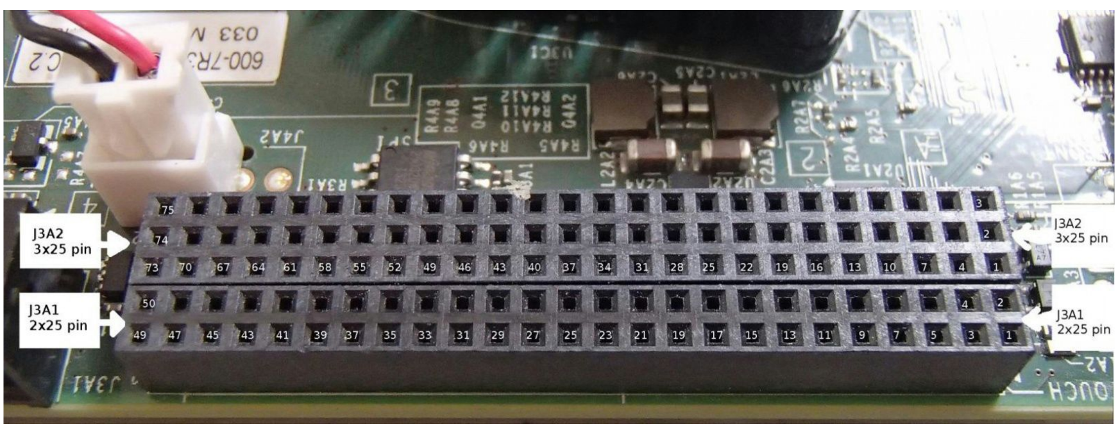

Figure 2.4.b.1 Image displaying the pin values of the Jetson’s GPIO.

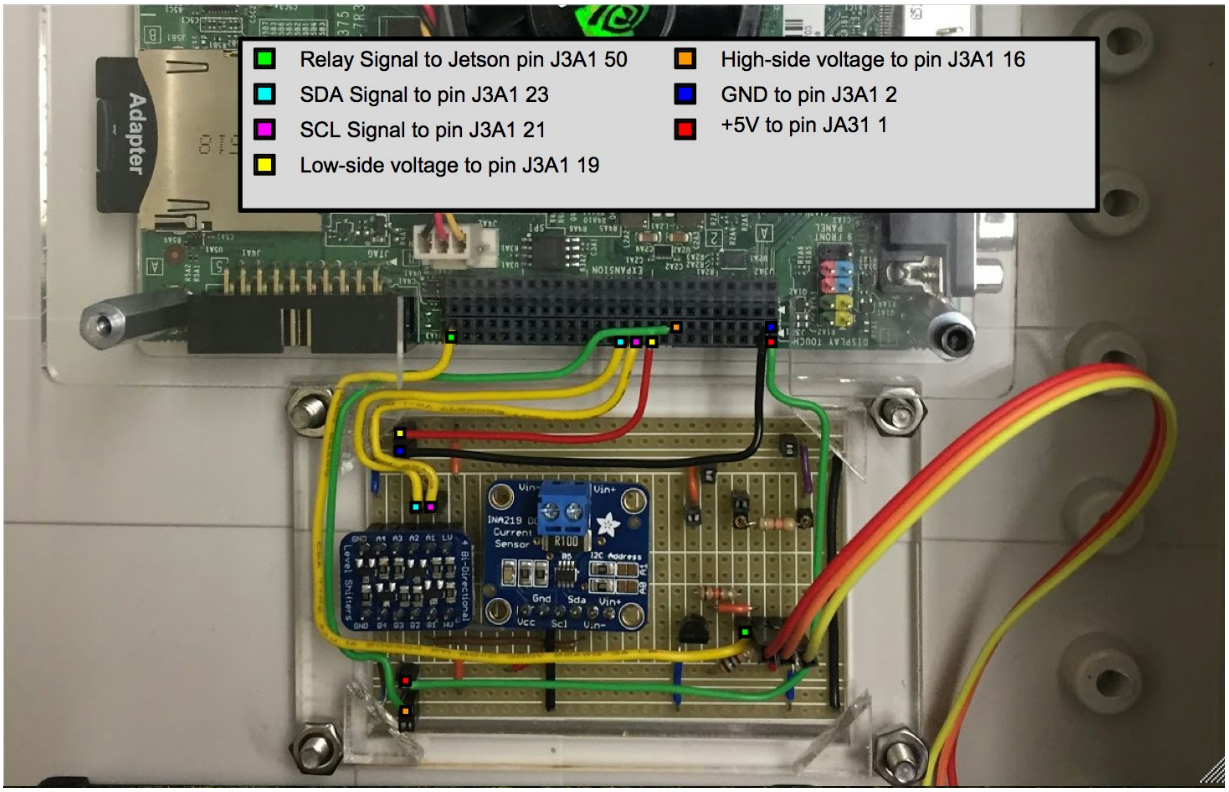

Figure 2.4.b.2 The connections between the circuit board and the GPIO.

d. Check that the wire strip from the relay is connected tightly and to the right ports of the to the small circuit board

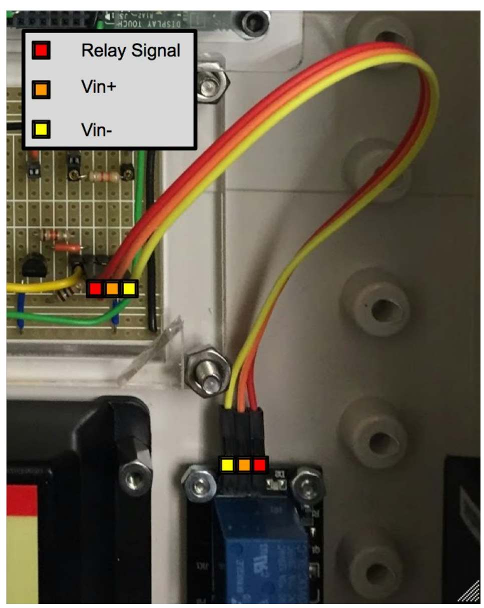

Figure 2.4.b.3 Connections between the relay and the circuit board.

2. Ensure the power supply is properly setup and the wires are secure

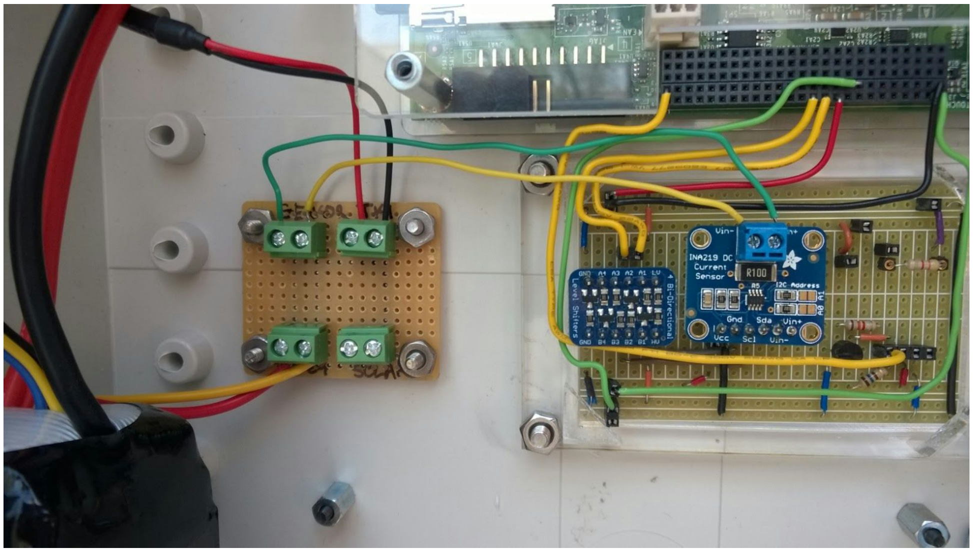

Figure 2.4.b.4 The small circuit board to the left orchestrates how the battery is charged and distributes power. Top left green circuit connects to current sensor as shown. Top right green circuit connects to power port on Jetson via splitter. Bottom left green circuit connect directly to battery (yellow to Batt Neg, red to Batt Pos)

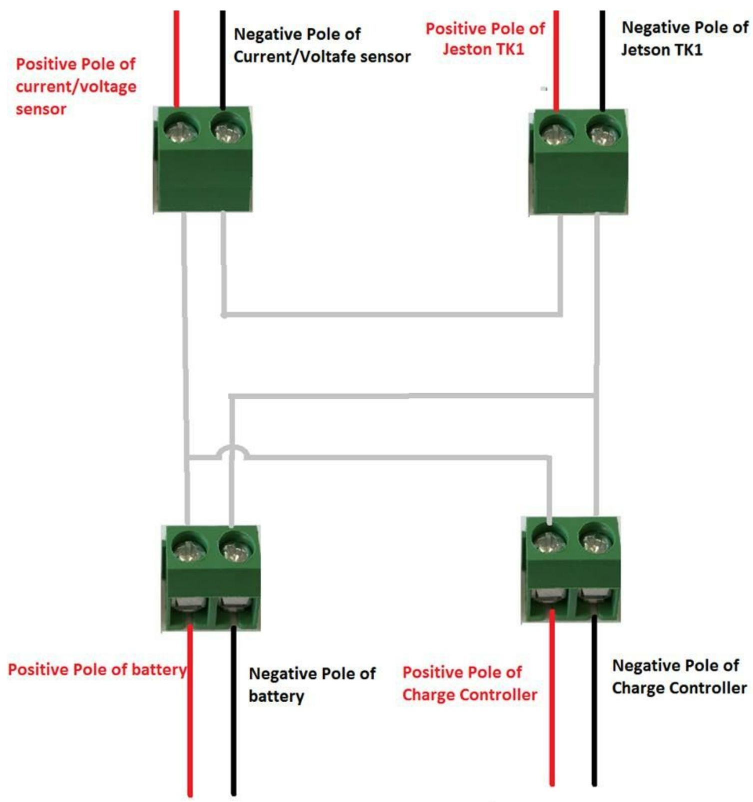

Figure 2.4.b.5 A schematic sketch of the small circuit shown in Figure 2.4.b.4

3. Ensure the charge controller is properly setup and the wires are secure

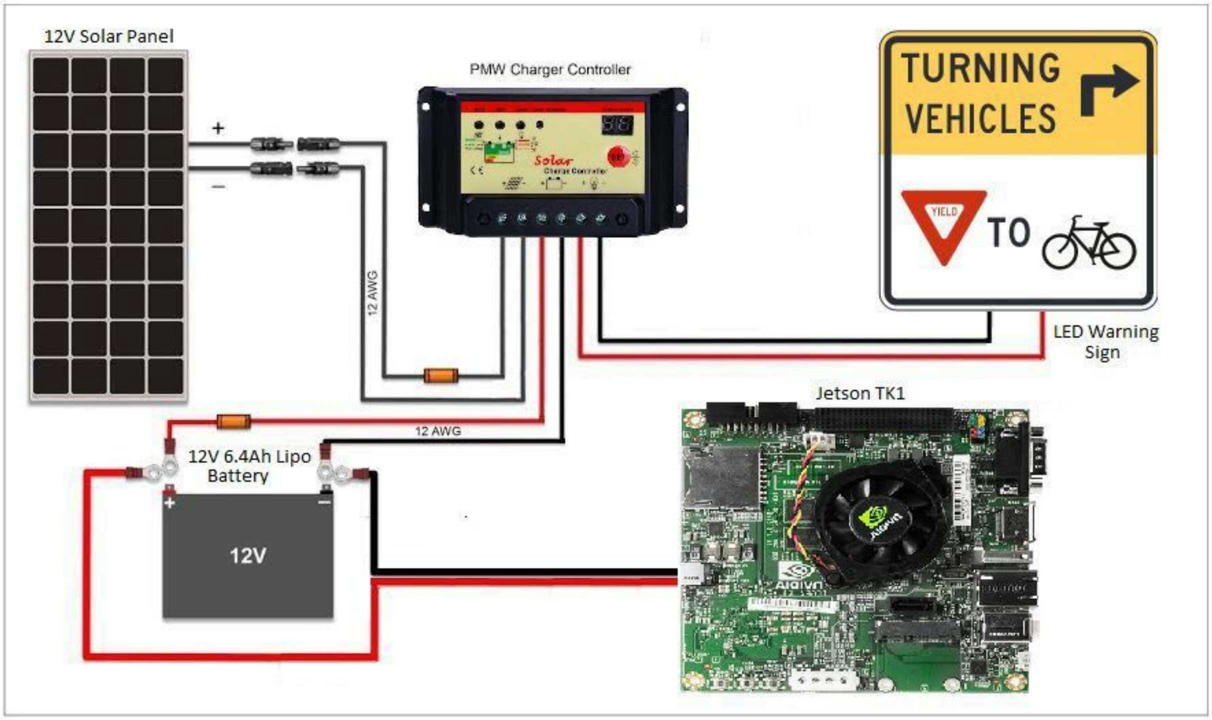

Figure 2.4.b.5 Displays the connections to the charge controller

4. Check for loose hex screws of all mounted devices, including the camera housing (located at the top)
5. If you must detach the camera or box (hardware hub) from the pole, use a secure ladder and, while someone holds the box from the bottom, use a flathead screwdriver to turn the screw on each strap to loosen and remove.

2.4.c Installation of Alert Sign

The electrical connections to the Alert Sign are extremely simple. As outlined in the QuickStart guide provided by TAPCO, you have to feed your own 12VDC power source cable through the junction port and into the box, as shown in Figure 2.4.c.2. If needed, strip some of the plastic insulation off the cable and then, the white 12VDC+ sign wire connects to your own 12VDC+ power lead & the black 0VDC- sign lead connects to your own 0VDC- lead. Using insulated electrical caps, splice positive to positive and screw a cap to hold it together, and splice negative to negative with another cap.

There are 2 holes in the sign that accept 5/16" mounting bolts, as seen in Figure 2.4.c.1. Note that the actual sign used in this project is faced squarely straight, not tilted as shown. As part of a deal with TAPCO, they are providing us with a free set of anti-vandal mounting straps that are meant to attach to a large pole. Make sure that the sign is securely held from below as another person attaches/detaches the straps. Always use a secure ladder with another person holding the bottom rung in place; if sign mount height >10 ft., use a Genie lift or similar product.

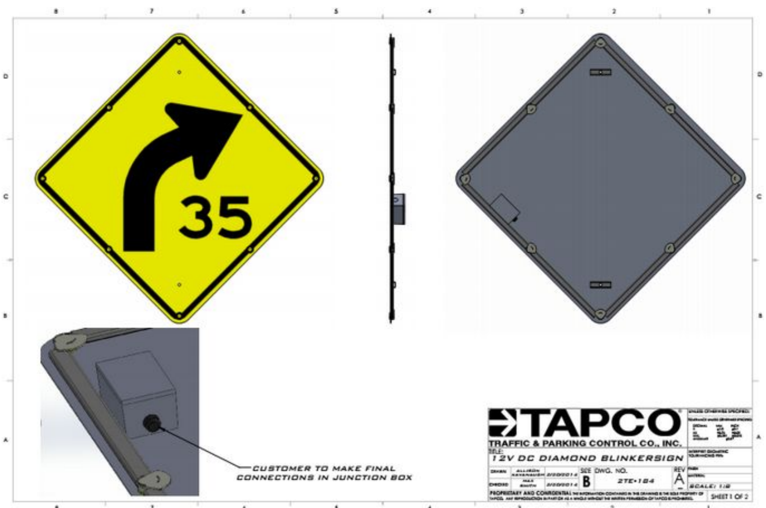

Figure 2.4.c.1 From TAPCO QuickStart guide. Location of mounting holes, junction box, and LEDs can be seen. Our physical sign is tilted 45° from this one (not a diamond).

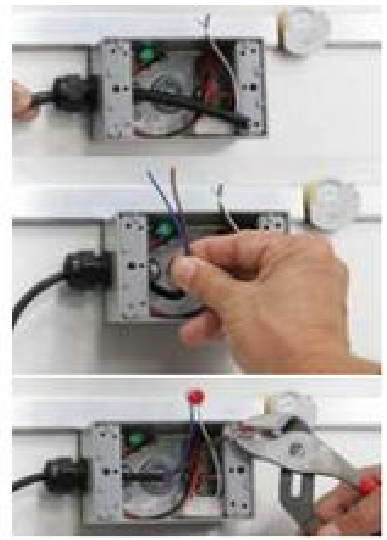

Figure 2.4.c.2 From TAPCO QuickStart guide. Inside the junction box

2.4.d Installation of Solar Panel

1. As shown in the figure 2.4.d.1, place the rails on the back of the panel so the lip of the rail containing the module mounting holes is facing towards the center of the module.

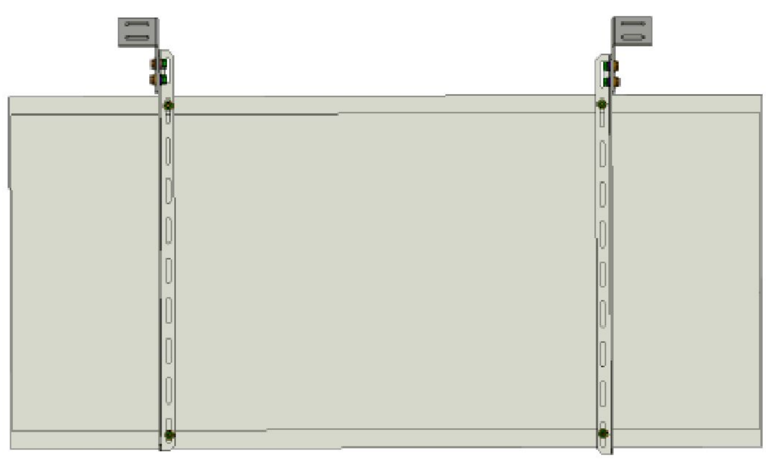

Figure 2.4.d.1 Installation of Solar panel

2. Thread each hose clamp through one of the sets of narrow center holes in the bucket as shown and place at the desired location on the pole.

Note: This hose clamp is only compatible with poles ranging from 2.0” to 4.5”. If want to mount the solar panel to a wider pole, the longer hose clamps are needed.

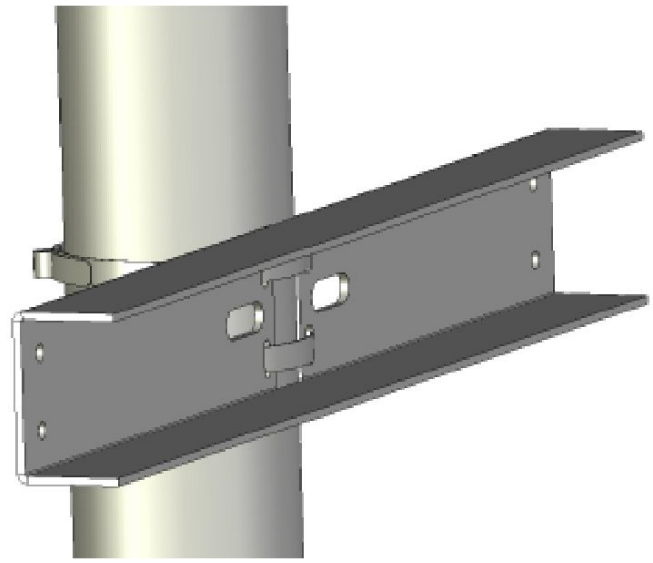

Figure 2.4.d.2 Installation of Solar panel

3. Attach the clips to the bucket. In each of the 4 mounting holes, use a bolt and flat washer on one side, and a washer, lock washer and nut on the other.
Tighten the bolts to 8.3 ft-lbs.

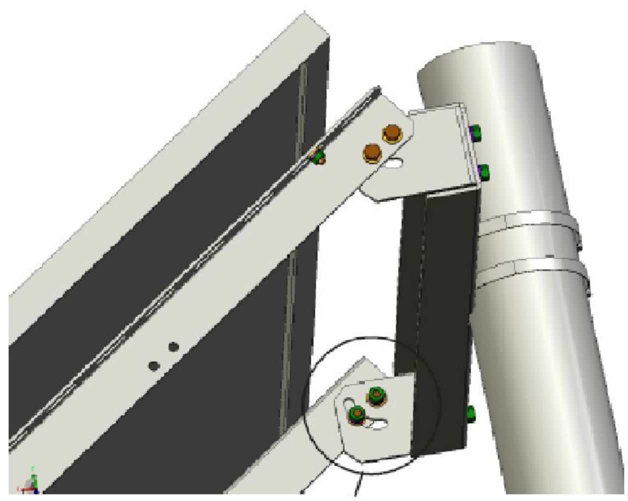

Figure 2.4.d.1 Installation of Solar panel

2.4.e Setup and Support of *RightAlert* Website

A management website is set up for you at http://admin.rightalert.net. The default login for RightAlert system administration pages is username: admin, password: password. After logging in, users may change their password and add/remove other admin and guest accounts in the Users section. This and further website functionality is documented in Section 3.1.

3 Operation of the Project

3.1 Operating Mode 1: Normal Operation

Our system is only designed to execute in only one mode of operation. Once the initial setup is complete, the system is intended to run a simple routine without human intervention. Normal operation assumes the algorithm is running and the Jetson is connected to the Internet. Government workers as well as traffic researchers will benefit from RightAlert's website, "admin.rightalert.net", if the system is in normal operation. The features they should be able to:

1. Login at http://admin.rightalert.net:

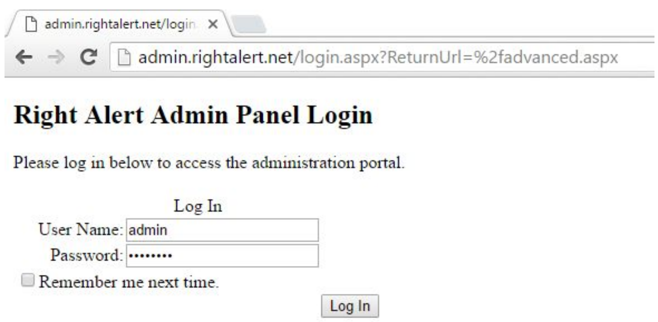

Figure 3.1.1 Right Alert admin login page

2. View biking statistics and system overview on Dashboard. Observe bike count update live as bikers are detected.

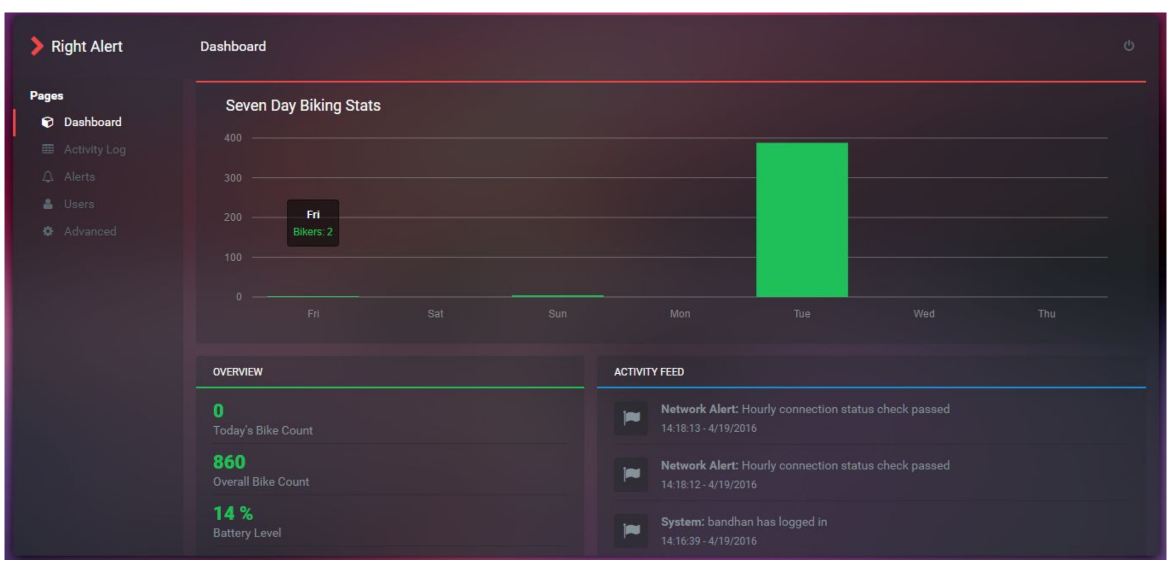

Figure 3.1.2 Right Alert dashboard. Brought here once you log in.

3. View recent system activity. This includes health checks, connectivity tests, logins, executed commands, etc.

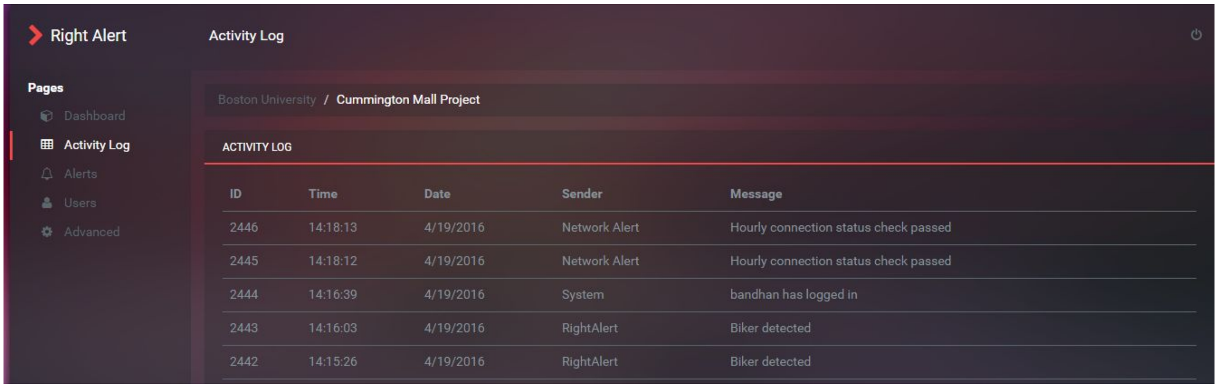

Figure 3.1.3 Right Alert activity log

4. Set up Alerts

   At this page, users are able to create email alerts for themselves. Users can choose to elect which alerts to receive including bike detection to system alerts. This feature is not yet implemented.

5. Create/Modify/Delete admin and guest user logins

   The default login is provided as username: admin, password: password. For security reasons, it is advised that the default password be made more challenging. It is also advised to set up separate admin accounts for different persons and provided guest accounts to those who require limited access. This feature is not yet implemented.

6. Advanced control of system. Admin users will be able to directly run commands through the web browser, view specific data, view battery voltage data, and the last detected biker. A panel of buttons with different functions is also available on this page to directly enable detection algorithm, disable detection algorithm, enable LED lights, disable LED lights, and more. The buttons to manually control algorithm process and lights have not yet been implemented.
7. System shut down. Admin users will be able to login in and click a shutdown command on the Advanced page. The same can be achieved through the Terminal panel. For remote shutdown, the system must be in normal operation mode for the command to transmit.

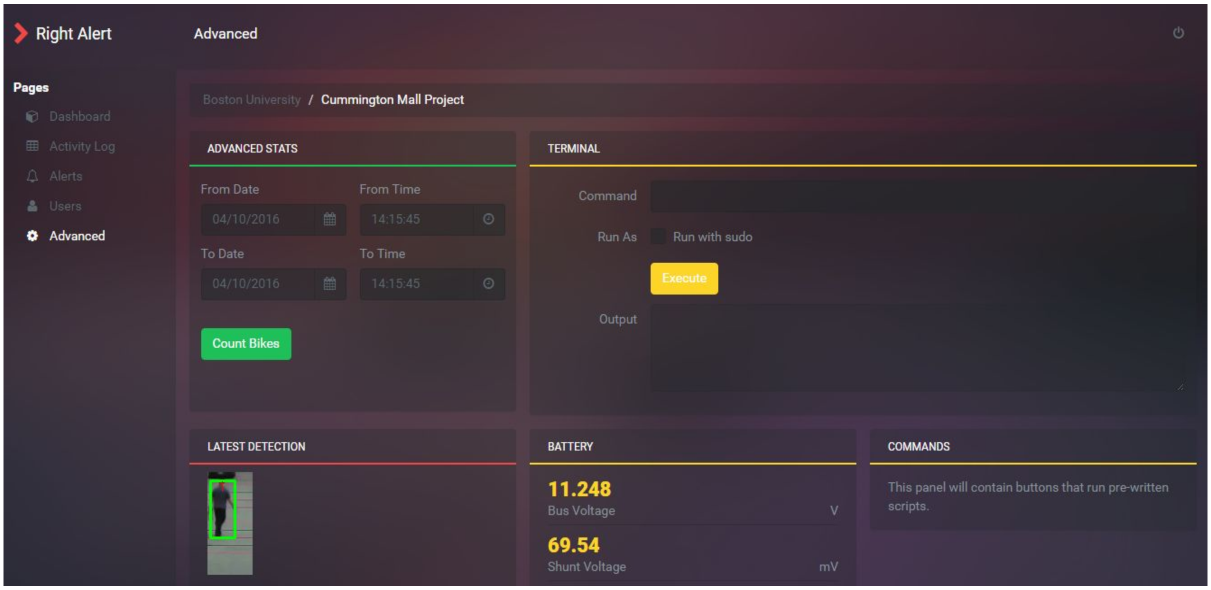

Figure 3.1.4 Right Alert advanced options tab

From the perspective of a driver on Cummington Ave., they will be able to immediately see the large mounted 'Yield to Bikes' traffic sign whether flashing or not. Drivers seeing the sign for the first time should immediately understand its significance and meaning, as it is a standard traffic sign that is ubiquitous throughout Boston. If a bike is present in the camera's region of interest, the sign will flash with a true positive rate of 92.84% and a false positive rate of 1.98%, attracting the driver's attention. If the sign does not flash when a bike is present, it may mean the algorithm does not recognize the biker as such, and manual adjustments to the training set must be made to increase performance. Our hope is that drivers will become more conscious of bikers and make a habit of checking for bicycles on their right before making a turn.

As a biker, it is common practice to ride on the right side of the road as vehicles do. However, for our current location bikes may ride across the entire street and not pay as much attention to cars because it is a private BU-owned road. Our hope is that bikes will notice the sign when they are detected approximately 160-140 ft. away and heed the warning sign just as much as a driver by staying to the right-most side of the street.

3.2 Operating Mode 2: Abnormal Operations

It is very unlikely for the system to go into abnormal operation mode. Abnormal operation mode will only occur when the RightAlert System has no network connectivity or loses power. The administration website is still accessible without network connectivity. A warning page is displayed and the user is allowed to continue on to the administration portal. Without the system connected to the network, any website functions that rely on the RightAlert system will not work.

1. **Network Disconnect:** If the RightAlert system is not connected to the internet, a cronjob running every minute checking for network connectivity will cause the network management program to restart. In most cases, as long as the Right Alert wireless network is within range, the system will reestablish Internet connection.
2. **Network Disconnect, *hardware failure*:** If the RightAlert system is not connected to the internet for an extended period of time, where it has been provided enough time to already reconnect given a regular Network Disconnect as described above, the system will reboot. This will ensure all drivers are reloaded and the hardware is recognized once again.
3. **Power Supply:** The RightAlert system requires **11.1 Volts** to supply adequate power to all onboard devices. To prevent any safety issues or system damage, the Jetson will automatically shutdown if the battery voltage is detected to drop below 11.1 Volts. To recover from this state, a maintenance call must be made to recharge the battery for normal operating state.

3.3 Safety Issues

While the *RightAlert* system is normally very safe, there are a few possible general safety concerns:

1. **Components Separating from Pole:** If mounting straps for the Alert Sign, Hardware Hub box and camera, or Solar Panel become loose or are tampered with, there is a possibility of injury from these components falling and striking someone. Similarly if the straps are rusted or the screws which connect the components to the mounts are loose, they could break and the system might fall.
2. **Battery Discharge:** If the battery were to completely discharge, or below **11.1 Volts**, there is a small possibility that the battery would overheat and rapidly vent (see: explode) causing permanent damage to the system inside the Hardware Hub box. This can also be caused by a fire directly by the battery or a particularly strong earthquake.
3. **Data Security:** Customer municipal regulations may require features which display and/or store images of detected bikers to be disabled. Also, the combination locks that are securing the camera box and main housing can be cut easily with bolt cutters, which presents a potential data/system security flaw.

4 Technical Background

The RightAlert system was intended to detect bikers and alert drivers as they turn right at intersections. The technical approach taken by the RightAlert team always followed our high level block diagram as shows in Figure 2.1.1. The team divided technical tasks into four primary groups as listed below.

1. **Detection Algorithm (HOG with SVM):**
   The detection process using a Machine Learning algorithm. The approach creates a descriptor vector, based on the histogram of oriented gradients (HOG), for the positive and negative training images. A Support Vector Machine is then trained with these feature vectors to create a single descriptor vector. This vector is then used to determine whether or not an image contains a biker. The accuracy of the algorithm depends on the quality and quantity of the training images.
2. **Off-Grid Solar Charging**
   For calculation, we assume there are 500 bikers turning right at the cross everyday, and LED sign is triggered and turned on for 10 sec for each warning. Considering the size limitation and electrical performance under extreme weather conditions in Boston area, we choose to use Lipo(lithium polymer) battery. The capacity of battery is 6400 Ampere-hour, which can support our system for roughly 11 hours without charging.

Item	Description	Voltage (V)	Average Current (A)	Peak Power (W)	Duty Cycle
			Consumption		
1	Jetson TK 1	12	0.5	6	1
Built-in	Camera	12			
Built-in	Wi-Fi Adapter	5			
2	LED	12	0.5	6	$\frac{500 bikers \times 10 sec}{24 hrs \times 3600 sec} = 0.06$
		12V power needed		Power Total	6.36 W
				Est. Efficiency	90%
				Input Power Needed	7.06 W
				Total Energy in 24Hrs	169.45 W·h

Figure 4.1 Right Alert power budget

According to NASA Surface meteorology and Solar Energy data, the average solar radiance in Boston area is 3910 Wh/m^2/day, which means the solar panel can receive 3.9 hours of sun per day in 1000 W/m^2 in average. Thus, we choose our

Renogy 50W 12V solar panel, which can provide 12V/2.84A power to the system in 1000 W/m^2 condition. In this case, the solar panel can provide 195 W·h in the daytime, which is larger than the total power consumption of entire system 169.45 W·h in 24 hours.

10-year Average Insolation kWh/m2 /day

State	City	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year Avg
MA	Boston	42' 22" N	71' 2" W	2.3	2.7	3.51	5.77	6.11	6.11	5.47	5.05	4.3	4.12	3.0	2.1	3.9

Figure 4.2 Boston Average sun insulation over 10 years

3. **System Hardware and Design (Jetson, Camera, Sign):**

We purchased the NVIDIA Jetson as our processor, mainly because the previous team, C.A.R.R., was very successful using it. On board is a powerful NVIDIA Kepler GPU
which we used to process all the frames of the street that our project relies on. Also included is a quad-core CPU, 16Gb memory, HDMI port and more. See product details at http://www.nvidia.com/object/jetson-tk1-embedded-dev-kit.html or in the resource "CD" github repo.

The team decided to use the ELP 2.8-12mm Varifocal Lens USB Camera for a few reasons. One of the capabilities of the camera that stood out was its ability to change focal length. This meant that we could experiment with the distance we wanted to begin detecting bikes and not have to use different cameras. By the end of testing, we decided to begin detecting bikes which were about 110ft from the camera. With the varifocal lens, there was no issue on focusing into this location down the street. In addition, this camera has a USB connection and was the perfect means with which to interact with the NVIDIA Jetson. In addition, the camera is small and compact and was a good size for our system.

The alert sign presented legal and regulatory issues early on. After some research we found there are strict guidelines in the Manual on Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA). First of all, we need to use a standard approved traffic sign, and not a custom design. Secondly, there are only a few use cases of blinking traffic signs throughout the country and even fewer with studies associated with them. One of these studies can be summarized here (although I have not found a more thourough disscussion about it:
http://bikeportland.org/2015/04/02/right-hook-risk-drops-flashing-yield-bikes-sign-ne-couch-136458. Given that there is such limiting study into how a system like this would make traffic safer, Boston City Hall is reluctant to provide assistance, even though the mayor claims to be big on bike safety. My contact in city hall was Stefanie Seskin in the Dept. of Transportation (contact info: Email -

stefanie.seskin@boston.gov ; Personal Office: 617-635-4156). In order to have better luck with city officials in the future, I would suggest connecting with bike advocacy groups such as Boston Bikes to add more pressure on the officials.

We ordered the alert sign from TAPCO because of their experience and quality assurance in making flashing traffic signs. The alternative solution is to buy a standard traffic sign from Dept of Transportation (approx $70) and embed LEDs and wire the circuit yourself. The sign is designed to operate at 12VDC and permanent damage is guaranteed if run at an average of 15VDC for an extended period of time.

4. **Administration Website (AWS, ASP.NET, C#, SQL):**

When the RightAlert system is up, the only method for the customer to view data and adjust system settings is remotely through the RightAlert website. The domain http://rightalert.net was purchased through AWS Route 53. The web application was developed using Microsoft Visual Studio 2015. The application utilizes HTML5, Bootstrap framework, and JavaScript for design and limited functionality. All server side code is written in C# and executed on a Windows Server 2012 instance on AWS EC2.

The RightAlert website design was initially conceived from the "Right - Response Admin Template" purchased over at http://wrapbootstrap.com. The template was modified and panels edited to display relevant information for the RightAlert system. The template included a blank template page for which each page in the final web application is created from. For each .aspx page containing HTML and JS, there is a .cs file containing C# which executes on the server. All website development was completed on a local machine using Visual Studio 2015. The first page to be developed was the homepage which displays a graph of the last seven days' biking data, an overview panel with some general information including a bike traffic counter and system battery percentage.

The data presented on the website is pulled from a MS SQL Server running on the same EC2 instance. Data on the SQL Server is populated directly by the RightAlert system. Whenever a biker is detected, the Jetson will run a script to update the database with a record containing the date and time a bike is detected. Whenever other system events occur such as system checks or alerts, they will also post a record to the SQL Server.

A few pages in the web application reflect data from a database running on the same Windows Server 2012 EC2 instance in real time. For this specific functionality, the SignalR ASP.NET library is use. This library allows for a connection protocol to be kept alive between the client and server while a web page is open. Whenever there is a change made in the database, a notification is triggered on the web server, which invokes a client side JavaScript function. The JavaScript function updates the value of the visible data on the client side webpage presented to the user.

In addition to displaying data, the website is also used to remotely manage the Jetson board in our system. To do this, we use the SSH protocol. Fortunately, there is already a library built for sites using ASP.NET to utilize SSH connections. RenciSSH is used whenever a command must be made remotely on the Jetson. The website allows for remote commands such as turning the camera on and off, turning the alert sign on and off and for changing other detection parameters. All such commands, executed with button clicks, trigger C# code that utilizes the RenciSSH library. A connection is made to ra-jetson.duckdns.org which translates to the IP address of our Jetson. After the connection is made and established, pre-written commands are executed. In the case that the Jetson is in abnormal operation and does not have network connectivity, any web application tools that require SSH will not work!

The website continues as a work in progress. A basic login page currently differentiates admin users and guest users. Admin users are privileged to access the "Advanced" section on the webpage while guest users are not. If the Jetson is detected to be in abnormal operation mode, the user will be notified upon login or any attempt to run a remote command on the Jetson over the Internet.

5 Cost Breakdown

Project Costs for Production of Beta Version (Next Unit after Prototype)				
Item	Quantity	Description	Unit Cost	Extended Cost
1	1	TAPCO Traffic Alert Sign w/ Mounting Straps (Special Discounted Price for University Testing for potential usage in the city in Boston)	$250.00	$250.00
2	1	NVIDIA Jetson TK1	$194.98	$194.98
3	1	ELP Variable Zoom USB Camera	$53.00	$53.00
4	1	Enclosure for system (Hardware Hub) + mounting equip	$41.20	$41.20
5	1	INA219 DC Current Sensor	$9.95	$9.95
6	1	Renogy 50W 12V Polycrystalline Solar Panel	$86.99	$86.99
7	1	Venom 12V 6400mAH Lipo Battery	$67.29	$67.29
8	1	IronRidge SP/01A Universal Pole Mount	$72.8	$72.80
9	1	Edimax EW-7811Un 150Mbps 11n Wi-Fi USB Adapter	$9.99	$9.99
			Beta Version-Total Cost	$786.20

The alert sign provided by TAPCO was only $250.00 as part of a deal that we would provide them data and the city of Boston would potentially pick up the idea and use their signs. If a beta version of this product were to be made, I assume a renegotiation of price would be necessary. Also, the enclosure box could be smaller and still fit all the components, perhaps saving some money. Similarly, the solar panel when placed in a much better location with lots of direct sunlight could be smaller and save some money.

6 Appendices

6.1 Appendix A - Specifications

True positive rate	92.84%
False positive rate	1.98%
Battery Charge Cycle	12 hrs/charge
Input Power for Jetson	12VDC
Input Power for Alert Sign	12VDC
Enclosure Dimensions	14" x 10" x 6"
Weatherproof	Yes

6.2 Appendix B – Team Information

Shantanu Bobhate (CE '16) –
Shantanu is a senior pursuing a Bachelor's degree in Engineering with a major in Computer Engineering. Shantanu is the leading the efforts on software development for the bike detection algorithm. This role makes him responsible for the accuracy and design of the algorithm as well as ensuring its completion within time in an organized and planned out fashion. It also entails the responsibility to work with Brian, the lead on the hardware, to ensure that both the components match and work in-sync with each other. Shantanu can be reached over email at sbobhate@bu.edu.

John McCullough (CE '16) –
John is a senior Computer Engineering student at Boston University and the only biker in the group!. Originally from Los Angeles, CA, John is taking the lead role in creating the alerting system and designing the physical layout of the system, as well as contacting city officials and bike advocacy groups. He will ensure the success of our project by making sure drivers are aware of the RightAlert system as they whiz by busy intersections. John has accepted a position working as a software consultant for Tata (TCS) in San Jose, CA next year consulting out for Cisco Systems. John can be reached over email at johnpat@bu.edu.

Brian Tan (CE '16) –
Brian is currently experiencing his second year at Boston University having transferred from SUNY Binghamton after his sophomore year. He is originally from Queens, New York. Brian is the hardware lead for the Right Alert system. He is in charge of overseeing that the NVIDIA Jetson can successfully interface with the detection algorithm, Intel Edison, camera, and alert sign. Brian is a computer engineering major who has found a lot of joy in coding with C++ and C# in his classes. After the graduation, Brian will be working as a consultant for Tallan in New York City. He can be reached through email at btan3@bu.edu.

Bandhan Zishanuzzaman (CE '16) –
Originally from Cambridge, MA Bandhan is spending his fourth and final year studying Computer Engineering at Boston University. Bandhan is taking the lead role in making sure that the Intel Edison is able to send relevant data to AWS, which is then displayed publically to users to demonstrate the success of Right Alert. Bandhan has a keen interest in computer networking and cloud technology. Next year he will be working as an Infrastructure and Security Analyst for Accenture in New York, NY. He can be reached through email at bandhan@bu.edu.

Teng Zhang (EE '16) –
Teng is a fourth year Electrical Engineering student at Boston University. He is the only Electrical Engineer on the team and has assumed responsibility for ensuring that all components of our system receive adequate power during day and night. Teng is also supporting the construction of the Alert Sign, specifically the electrical components required to illuminate the sign. Teng can be reached through email at zt520@bu.edu.