Automatic Vehicle Speed Trap

AUTOMATED VEHICLE SPEED TRAP

Project Design

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Content

Introduction

First, let me tell what this project is about. This is not a system for controlling vehicles or traffic jam. The system designed to measure the speed of the vehicles. There are systems available that have the ability to measure vehicle speed. But that systems are useful when they only handling manually. Then what are the additional features that the system can offer?

Automated traffic trap is a system design which capable of the snap of vehicles which are moving than allowed speed. How this progress happens is described in the document. For a brief introduction, the system will be measuring the speed of all the vehicles and compare each speed with speed limit at an instant and find out which vehicle moves faster than the allowed limit. If it so, the camera that connected will be activated and frame vehicle. (Here most important is not the vehicle but the number plate.)

The snaps will be sent to the centralized server which only permits access to limited authorized persons. With the snap, some important details are contained such as speed, time, venue. According to that authority able to get the required action.

Uses

Thought automated traffic trap system can be applied to any highways when considering with features which the system includes according to the design; it would be very beneficial when the system is with expressways.

Advantages

- The system is fully automated
- Simple mechanism and low cost
- Authorities able to access the system from anywhere

Hardware

Let’s get an idea of how this system works. The main function which the system offers is, measuring the vehicle speed. That is where Doppler Radar Sensor Module associates in action.

Doppler Radar Sensor Module

This sensor can detect motion or speed of moving objects through Doppler principle. It transmits a 10 GHz microwave frequency electromagnetic signal and waits for the signal to receive back and monitors the shift in frequency signal. The Doppler Effect is a shift in frequency perceived by a receiver from a signal source due to relative movement of the source.

Features

- Simple to Use an Analog Output
- Works at 5V power
- Outputs Analog data in a range of 0-5V suitable for Direct ADC interfacing of any microcontroller.
- Reliable and continuous output
- Many applications for Speed-Sensing of Objects and Motion Sensing
- Range around 20 meters

USB Camera

One of the features that we decided to add to the system takes a photo of the vehicles that are traveling more than maximum speed. This is where the USB camera comes into action.

Features

- Simple to Use
- Reliable and continuous output
- Range around 20 meters
- Can be focused

Raspberry-pi 2

Raspberry-pi is the main component that the ‘Automated speed trap’ system includes. That is because it connected to all other components like camera and Doppler sensor. The Raspberry-pi runs Linux operating system from an SD card and powered by a USB charger. The size, portability, cost, programmability and connectability are some of the advantages that we can achieve through this component.

Features

- A 900MHz quad-core ARM Cortex-A7 CPU
- 1GB RAM
- 4 USB ports
- 40 GPIO pins
- Full HDMI port
- Ethernet port
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- Video Core IV 3D graphics core
- 5V @ 2000mA!

Router

The router is used to make the connection between the centralized server and the raspberry pi. The unit sends a request via a router, connected to the server, the required details and snap will be sent.

Hardware Implementation

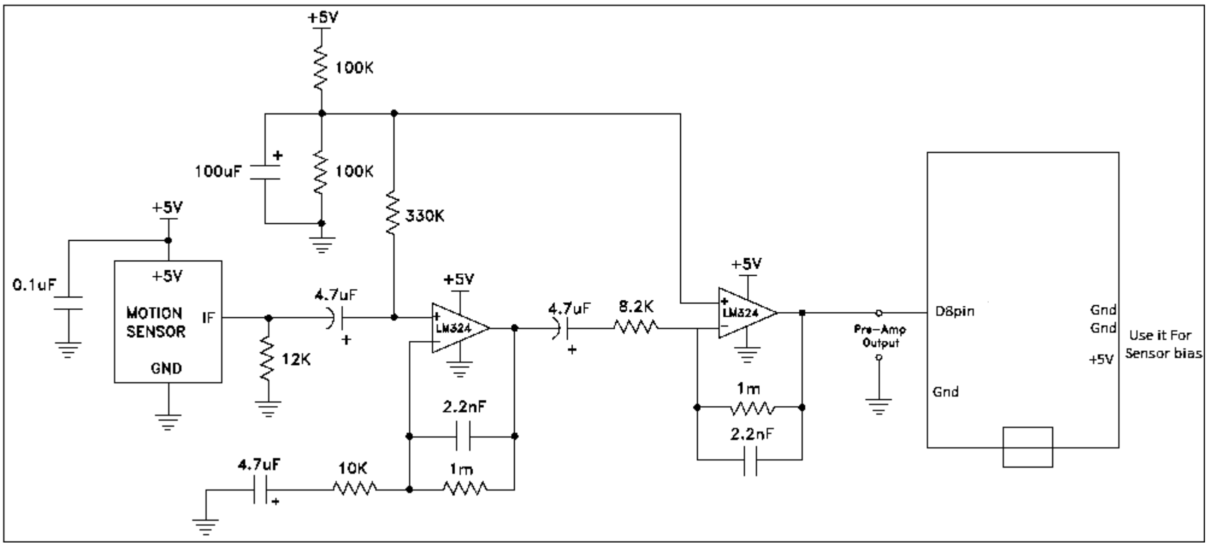
Doppler sensor needs some amplification from a circuit. That is because the output of the sensor is not enough to measure. While it amplifies the signal, it reduces the noisy while transmitting.

Let’s see how this circuit implements and how it connects to the raspberry pi to make the connection.

Components

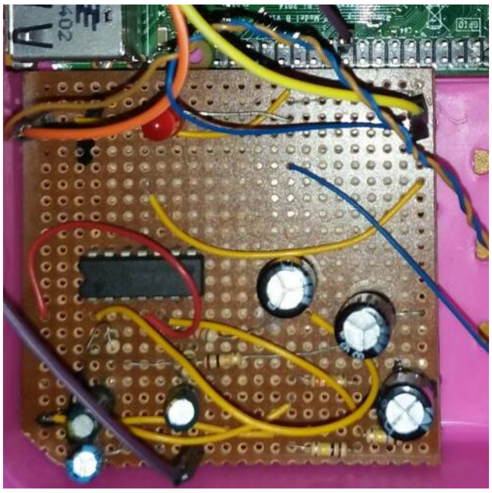
- Resisters
- Op-amps
- Capacitors

The circuit diagram of the amplification is given below.



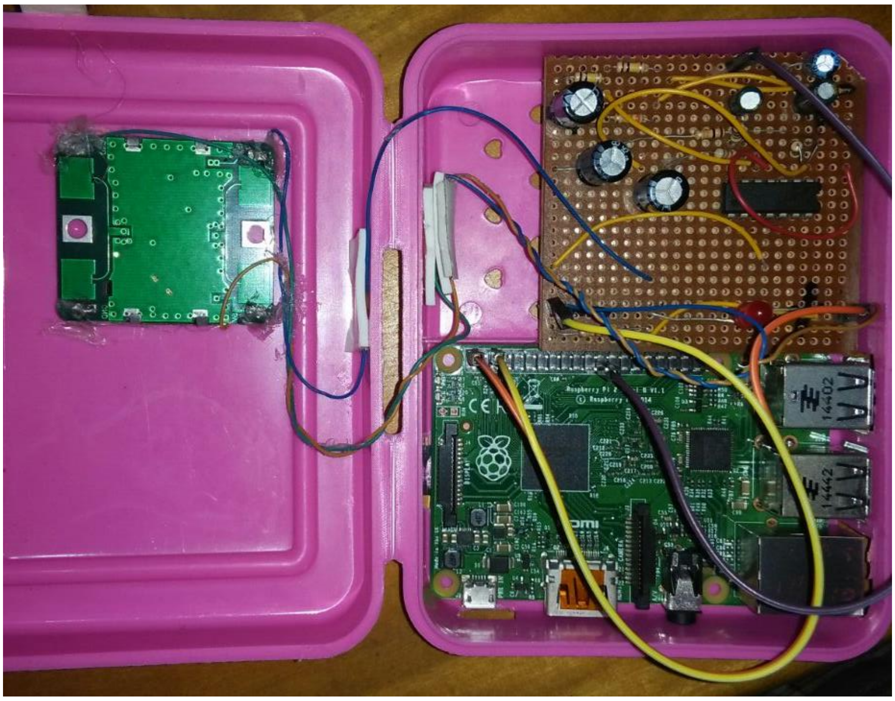
When the circuit is made up it might look like below. And the output of the circuit is connected to a raspberry pi digital pin. That pin is mentioned in python code and it measures pulse time and calculates input pulse frequency.

`



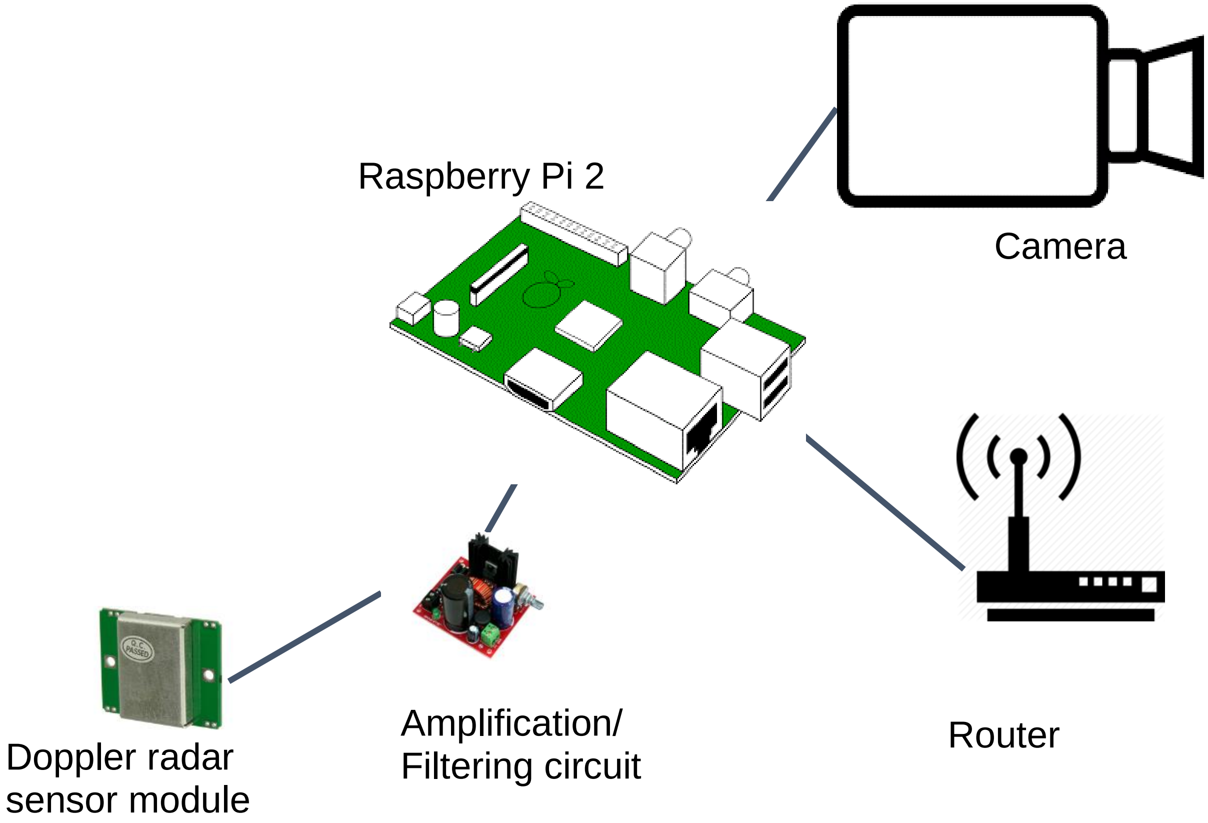
Circuit connection

Then the circuit should be connected to the Doppler sensor and the raspberry pi. And the following image shows how the Doppler sensor is connected to the circuit that designed and how the Raspberry Pi is connected with the circuit that designed.

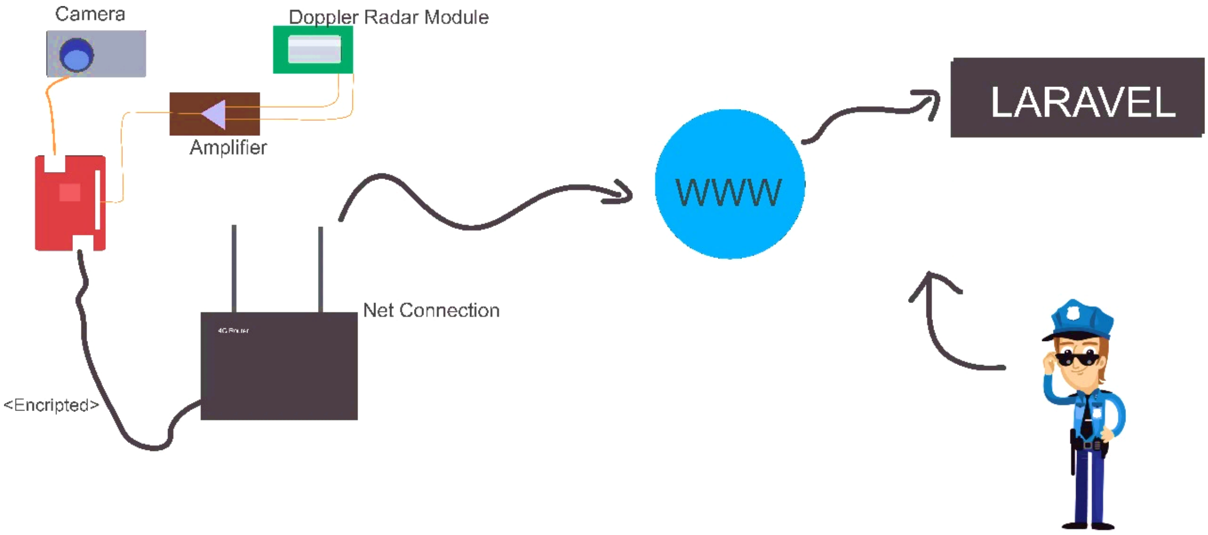


Design Plan

The final outcome of design is given below. The camera is connected to a USB device and the router is connected via the network port. The circuit is connected to the pins of raspberry pi as mentioned above.



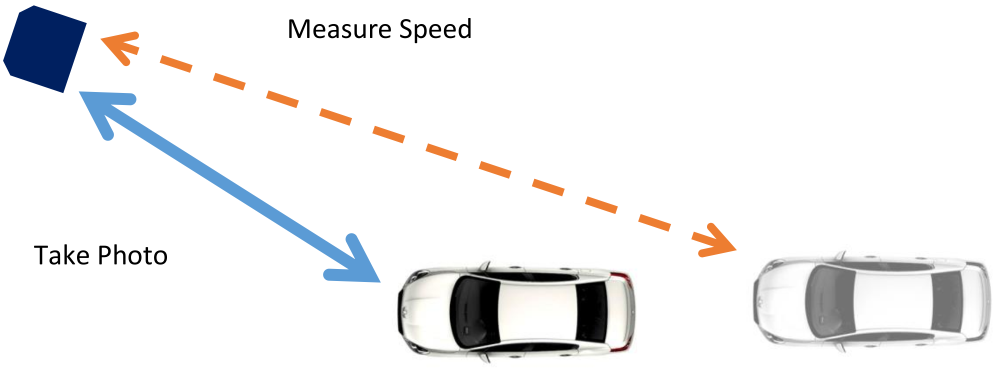
Circuit Design



Development of the system will be placed near the expressways as below. The black box shown below will be the hardware development. It contains the sensor with the amplifier, the camera and the raspberry pi.

In the developed design there will be one router both system at one place and via a wired connection, they will be connected.

There will be more units lay within roads at required places and from all the points snaps will be sent to the centralized server for authorized persons to further actions.



$$f = fo^* \frac{C + Vr}{C + Vs}$$

$$Vs = \frac{C(\Delta F)}{f} \qquad f = 10GHz$$

By above equitation, unit calculates the speed of the vehicle. ΔF prod used by amplifying circuit and module.

Software

- Python -To make connection Raspberry-Pi with the camera, python is used

  And used OpenCV library for handling image part.

- PHP-Laravel Native Language

Third Party Software

- Laravel -Laravel is a PHP framework that used to build the backend of the design as well as the frontend
- MySQL -To store data in database MySQL is used
- JavaScript/HTML
- CSS

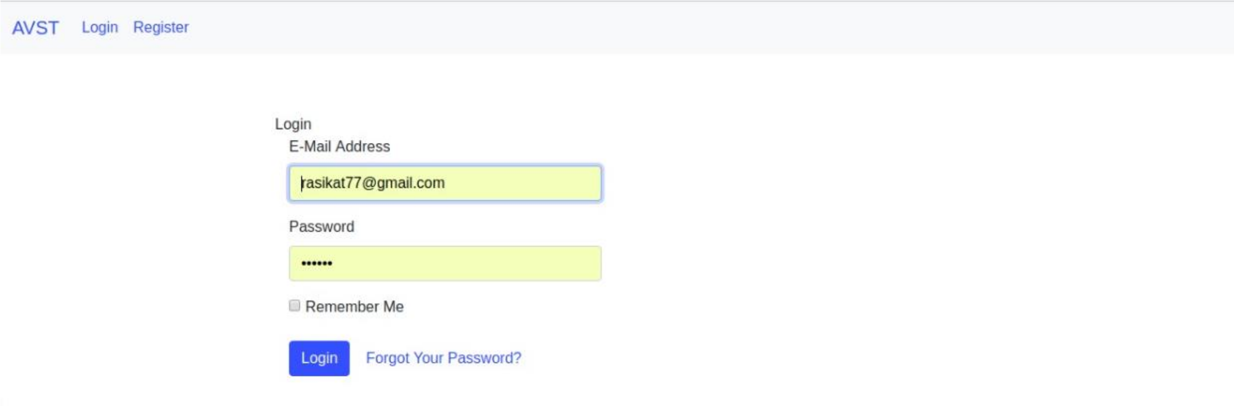
Software implementation

Frontend

The server part is used for given access all the authorized peoples to view images sent via camera at each unit.

There are a lot of features added for the authorized person who has access to the site. All the locations where the systems are going to established will be displayed on a map for better progress.

The frontend will be used by an authorized person only. So, there should be a login page and it developed as below.



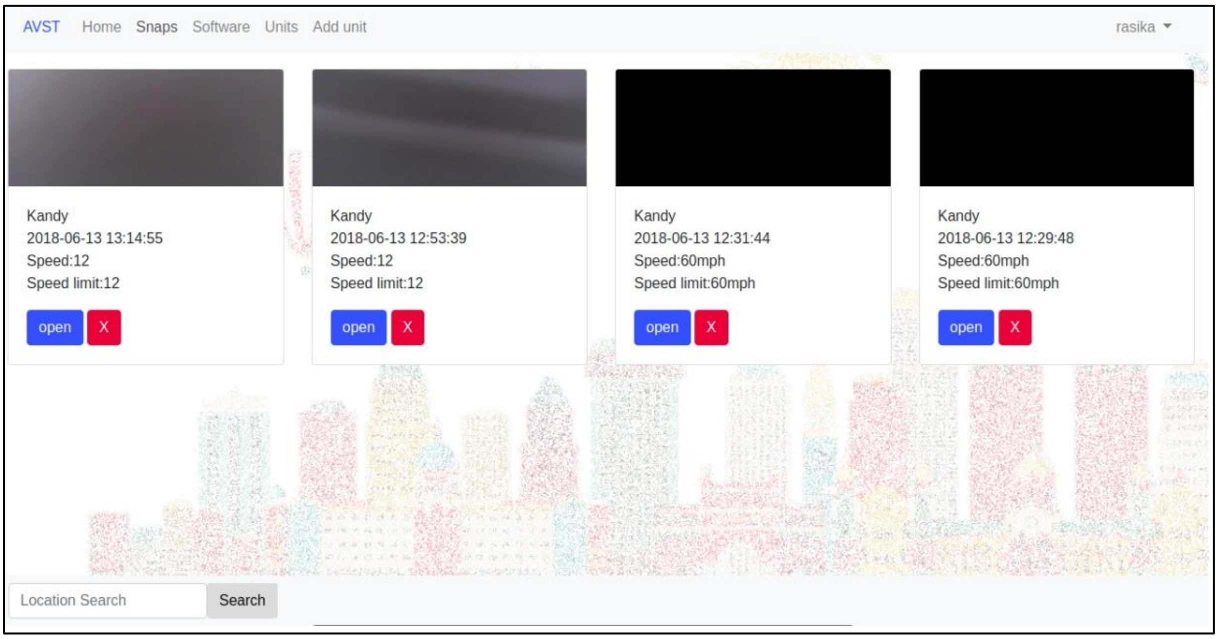
Login

E-Mail Address: rasikat77@gmail.com

Password: ••••••

□ Remember Me

When a user logged for view snaps that will be appeared below. The required details are displayed along with each snap and the snaps can be separated according to its locations.



Kandy
2018-06-13 13:14:55
Speed:12
Speed limit:12

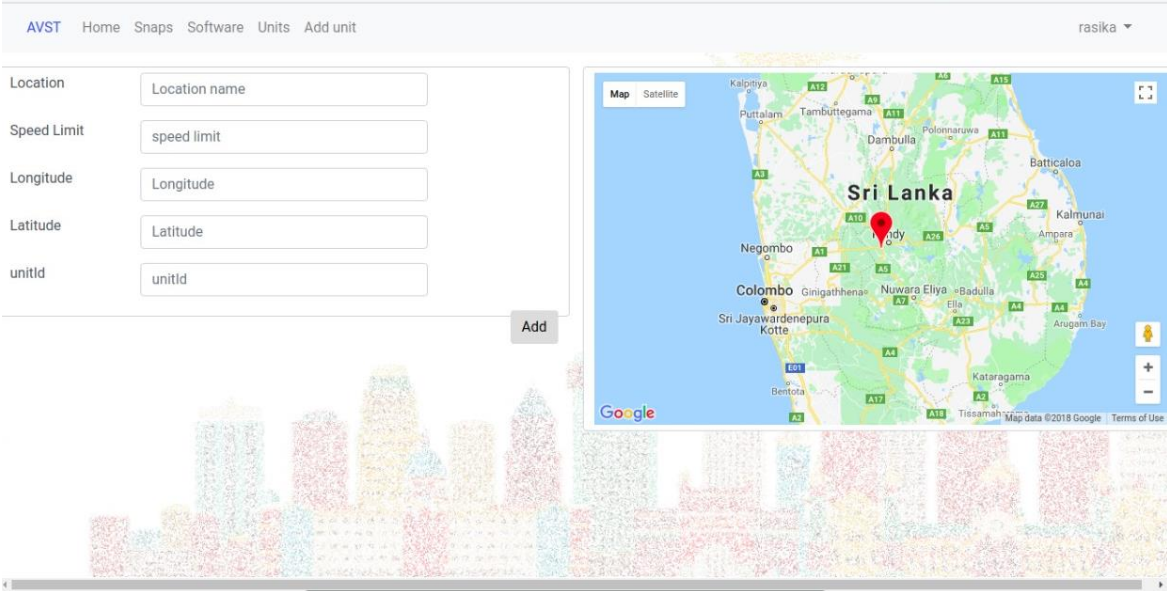
Kandy
2018-06-13 12:53:39
Speed:12
Speed limit:12

Kandy
2018-06-13 12:31:44
Speed:60mph
Speed limit:60mph

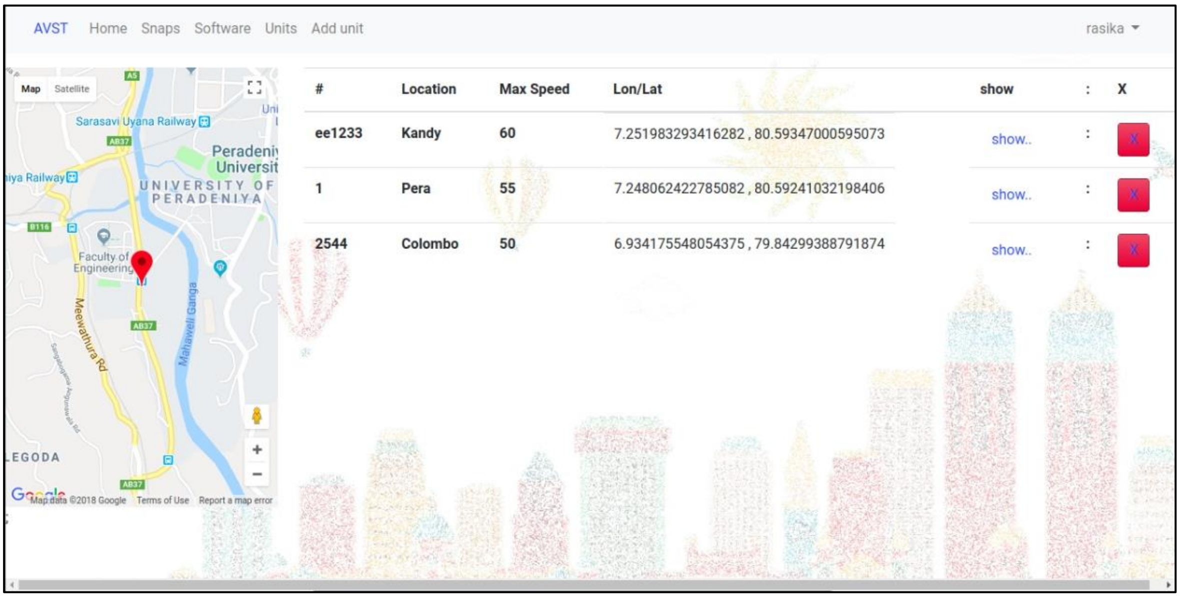
Kandy
2018-06-13 12:29:48
Speed:60mph
Speed limit:60mph

Location Search

The new locations will be added by the users whenever a new unit is placed. So, via the site, a new location can be added and an existing location can be removed. The new units will be identified by their unique ID which is assigned to each unit when they are placed.

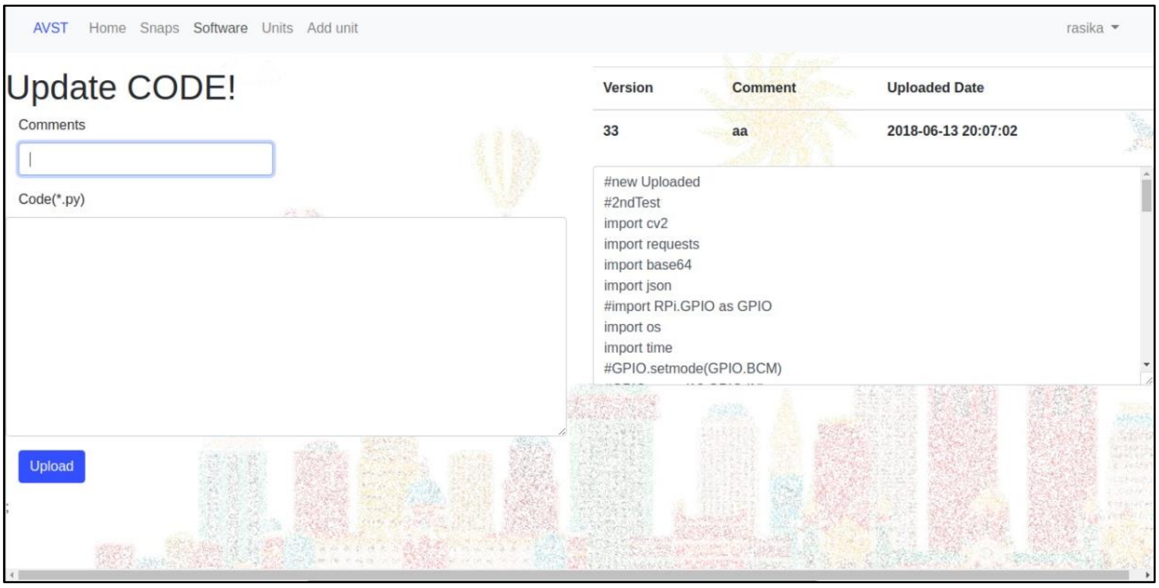


Location: Location name
Speed Limit: speed limit
Longitude: Longitude
Latitude: Latitude
unitId: unitId



#	Location	Max Speed	Lon/Lat	show	:	X
ee1233	Kandy	60	7.251983293416282 , 80.59347000595073	show..	:	X
1	Pera	55	7.248062422785082 , 80.59241032198406	show..	:	X
2544	Colombo	50	6.934175548054375 , 79.84299388791874	show..	:	X

One of the best parts is the via the web all the system units can be updated at once. When the upgraded version is built, the existing version that is running in the raspberry pi can be replaced by the new version and it is applied to every unit.



Update CODE!

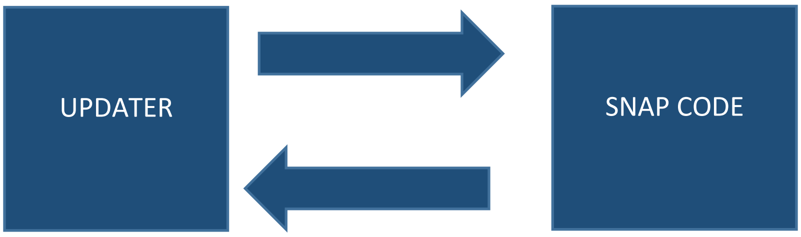
Comments

Code(*.py)

Version	Comment	Uploaded Date
33	aa	2018-06-13 20:07:02

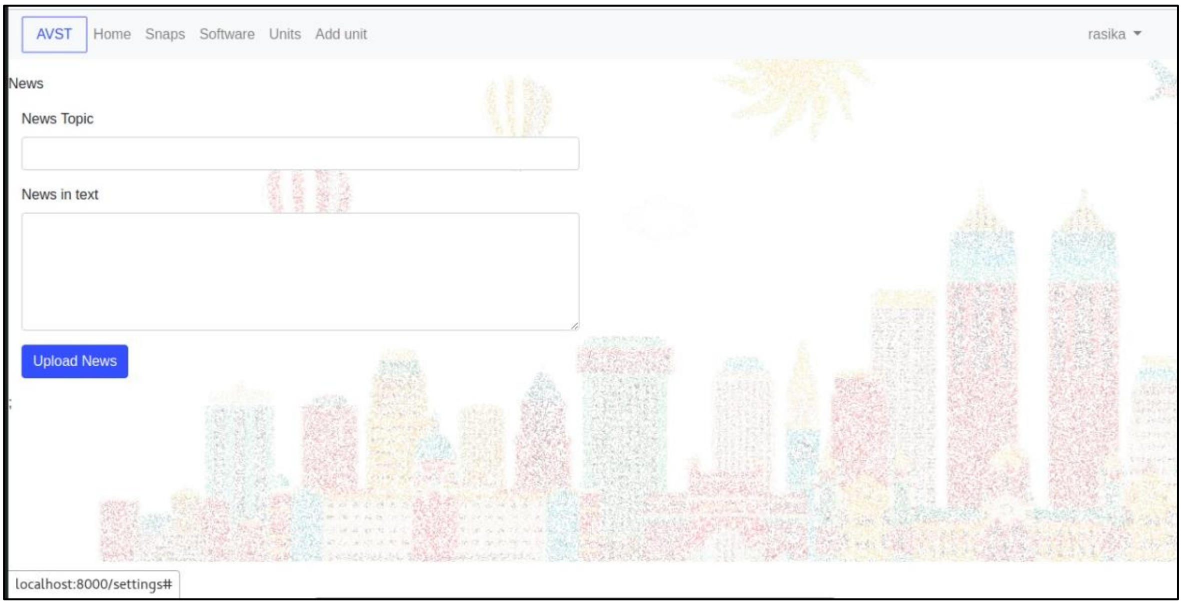
```
#new Uploaded
#2ndTest
import cv2
import requests
import base64
import json
#import RPi.GPIO as GPIO
import os
import time
#GPIO.setmode(GPIO.BCM)
```

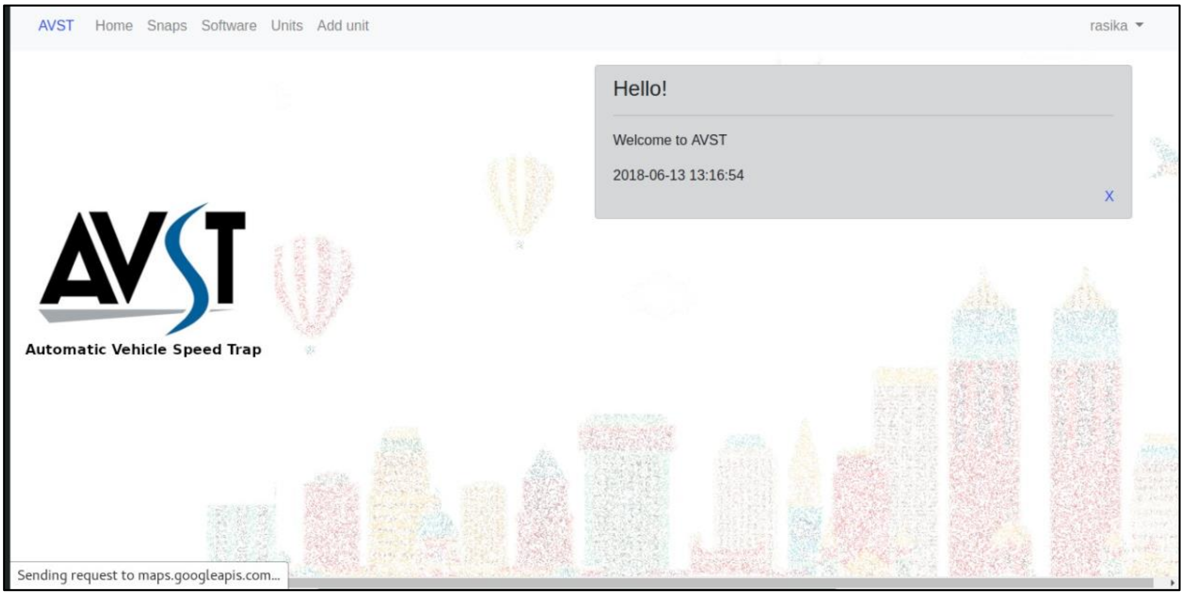
The mechanism of this system is the unit having two programs one of them is static which checkup the centralized server and update 2nd program if the server has a new one. The static code has unique data of unit such as ID of the unit.



With this function admin no need to visit units places for further implementation. Units can control by head office.

When a user wants to place a message to visible everyone who is using the system, the site has given that capability.





Hello!

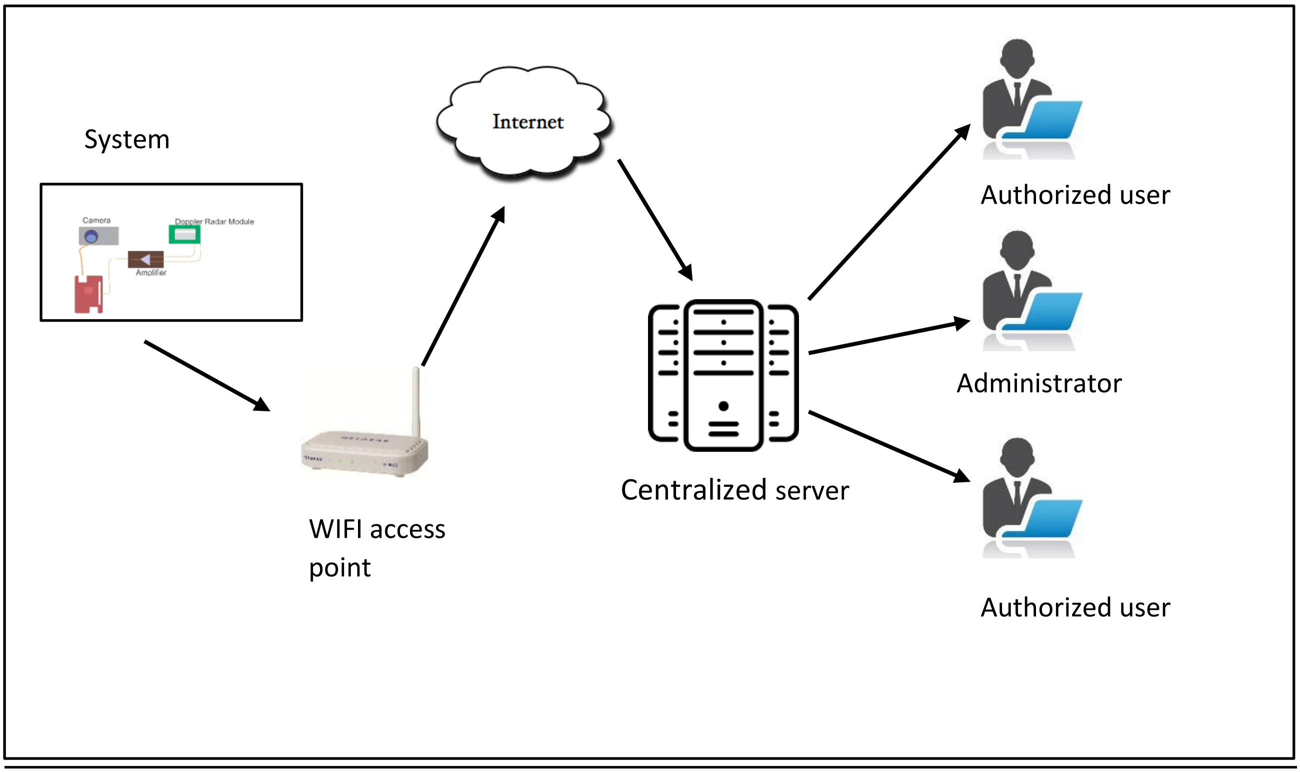
Welcome to AVST

2018-06-13 13:16:54

Sending request to maps.googleapis.com...

The message will be shown on first screen after logging. And anyone can remove it by clicking X button.

Network Diagram

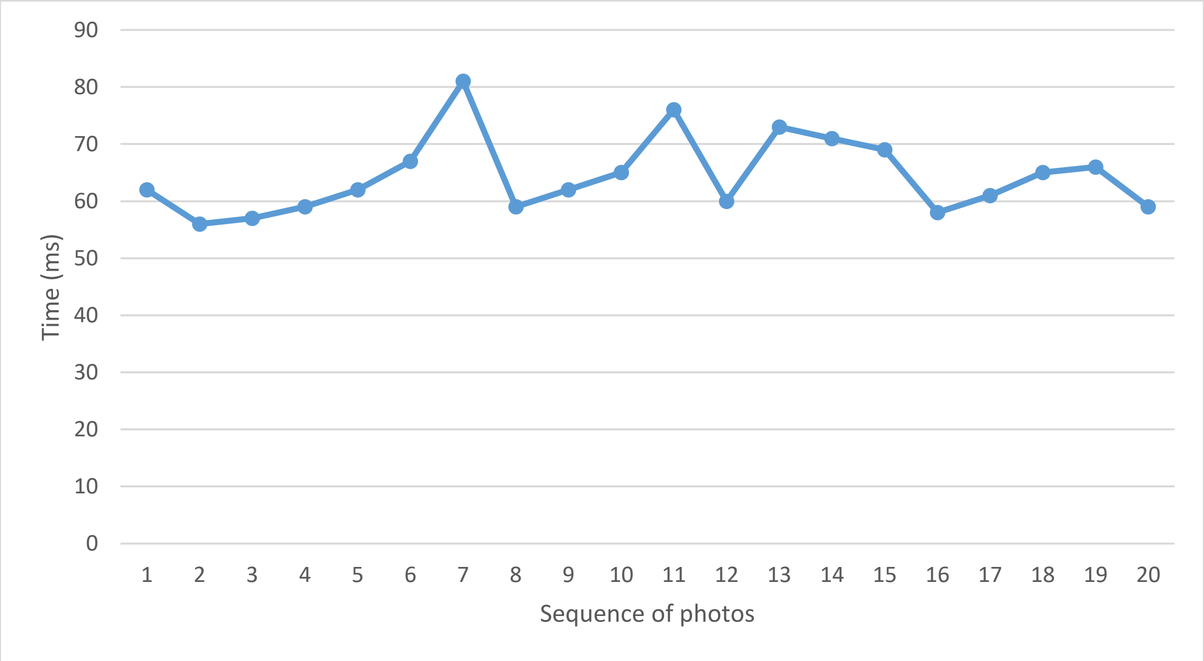


All the units are connected to one centralized server and all the data are saved in there. Data are visible to every authorized user from everywhere.

Testing

Time variation of capturing a photo

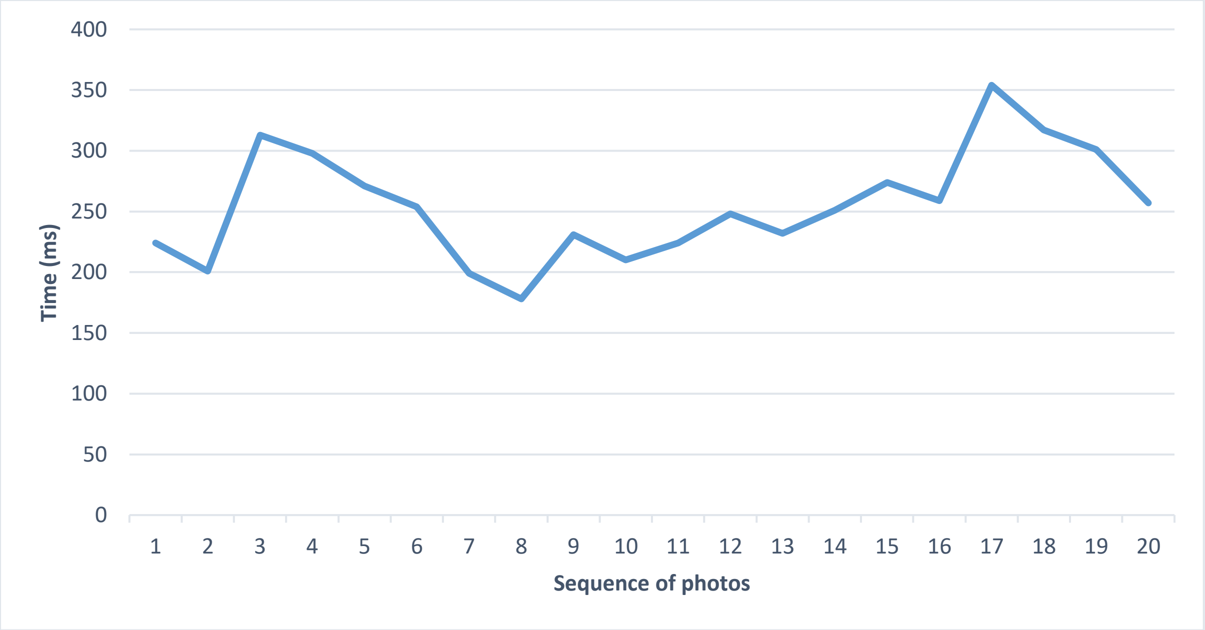
SEQUENCE OF PHOTOS	TIME (MS)
1	62
2	56
3	57
4	59
5	62
6	67
7	81
8	59
9	62
10	65
11	76
12	60
13	73
14	71
15	69
16	58
17	61
18	65
19	66
20	59



This above graph shows capture time of a photo. Checked the time with 20 photos and it gave above result which carries 64.4 ms average time for capturing one photo.

Time variation with uploading a photo

SEQUENCE OF PHOTOS	TIME (MS)
1	224
2	201
3	313
4	298
5	271
6	254
7	199
8	178
9	231
10	210
11	224
12	248
13	232
14	251
15	274
16	259



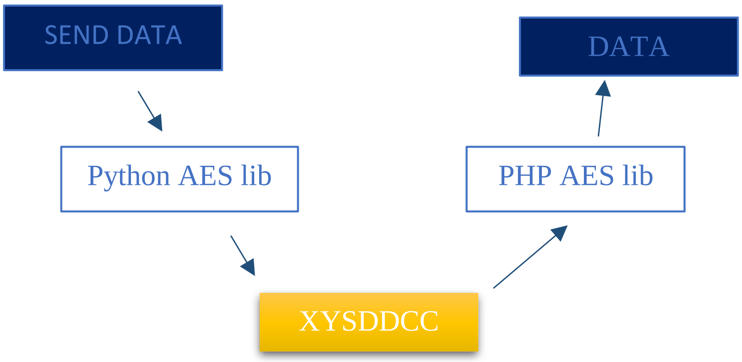
This above graph shows capture time of a photo. Checked the time with 20 photos and it gave above result which carries 64.4 ms average time for capturing one photo.

Security implementation

This System has a high-level security system. By the embedded side the unit encrypts picture and speed and other details with Advances Encryption Library. The sent message decrypt at the PHP server by the same library.

And this system using LARAVEL default authentication system. Which encrypt passwords and other avoid unauthorized request well.

Encryption method



Additional details

When a system is established it will be marked by a unique ID. The ID will be connected to its location. When a snap is taken and send to the centralized server, it contains the details that are required. To avoid being a mess with snaps in a centralized server, each snap also marked by a unique ID. The ID is generated with contain system ID and the time and date. Because there won't be two images at the same time in one system.

The location (system ID), date and time, snap ID, the speed of the vehicle, the speed limit will be sent along with snap. By them, it might possible to apply further actions.

Failures

In any system, there could be failures. The few failures that Automated Traffic Trap might be faced listed below.

Network Failures

There might be failures in a centralized server or the router that uses. So, to face that kind of the failures there will be a storage in the system to store snap until the network comes into action.

Power Failures

Power failure is the most common failure. To avoid the effect of the power failure, the system will contain a battery that has the ability to power up the system for few hours.

Project Links

- https://github.com/rasika2012/AVST-Laravel/tree/newbootstrap4-2