V-CITY TRAFFIC SENSOR

OVERVIEW AND TECHNICAL SPECIFICATION

1. INTRODUCTION

Vivacity Labs provides real-time, hyperlocal data to enable the next generation of transport networks. Our technology makes transport systems more efficient & environmentally friendly, through underpinning smart city projects and informing infrastructure investment. Beyond efficiency, we are improving safety on the roads, protecting vulnerable road users in a new wave of intelligent traffic systems.

We do this through our intelligent cameras, which act as sensors to gather, anonymise, and communicate real-time data derived from video feeds.

This document details the technical specification of our most powerful sensor, the V-CITY.

2. SOFTWARE SPECIFICATION AND OUTPUT

Vivacity's traffic sensors detect, classify and track vehicles within a field of view. The software works in a number of stages, first identifying instances of vehicles (and pedestrians) and their location within the field of view, then classifying these instances (output of this stage shown in Figure 1) and finally tracking instances from frame to frame (output of this stage shown in Figure 2).

Figure 1: Classification Software Output

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Figure 2: Tracking Software Output

DATA OUTPUTS

The following outputs can be requested:

- Count of vehicles across a line on the road
- Count of pedestrians stood within a zone (e.g. waiting at a pedestrian crossing)
- Classification of counted vehicles. Current classifications include (*day time only):
    - Pedestrians*
    - Cyclists*
    - Motorbikes
    - Cars
    - LGVs*
    - HGVs
    - Bus*
- Average vehicle speed
- Vehicle/Pedestrian path through field of view, with detailed track of positions at each point in time

AUTOMATED INSIGHT

Congestion can be detected by flagging when average speed drops or vehicle count in a zone increases to a set level, or when a combination of these conditions is met.

If a vehicle stops on the road in a zone that has not been designated as a parking area, but is not blocked by another vehicle in front of it (as would be the case in congestion), this can be flagged as either a breakdown or collision.

Other bespoke cases can be flagged, such as unauthorised vehicles or pedestrians entering a marked zone.

ADDITIONAL OPTIONS

The sensors run software based on state of the art machine learning techniques. As such, if a client requires slightly different output or classification sets, the system can be simply “retrained” to accommodate the new requirement.

Out sensors are equipped with Bluetooth functionality, allowing us to detect Bluetooth devices passing the sensor. By recognising when a unique device is detected by a number of Vivacity sensors across a city, data on cross city travel time can be gathered. This can give point to point travel time. Note that, from experience, only c. 5-10% of vehicles have a Bluetooth device which advertises position, and so this methodology will only give sample data.

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DATA CONNECTION & API

Data can be accessed directly through our RESTful API. A sample of the data produced detailing the path of vehicles though the field of view is below:

Timestamp	Sensor ID	Speed	Class	Lane
1471276028349	1452	34	Car	1
1471276028827	1452	25	Car	1
1471276032214	1448	13	Cyclist	2
…	…	…	…	…

Note that Timestamps are in Unix format, and so include time in milliseconds.

SET-UP AND CALIBRATION REQUIREMENT

Connectivity:

- If a Wi-Fi connection is to be utilised, details of the network name and password will need to be provided to Vivacity prior to sensor dispatch.
- For 3G enabled sensors in the UK, Vivacity will provide data connectivity as part of a standard contract.
- For 3G enabled sensors outside the UK, we recommend that the client send Vivacity a SIM card loaded with the required data allowance (data requirements vary depending on data output requested). We will then install these into the sensors before dispatch.

Location Set Up:

This currently needs to be done by a Vivacity engineer remotely, although some aspects of this process will be automated in the near future.

- Counting lines and zones need to be defined
- Format and frequency of data output defined
- The system requires familiarisation with new background features

This process will take approximately two weeks following installation for a small-scale sensor deployment.

SYSTEM ACCURACY

The system accuracy is location dependent, and the system can be improved in new environments by supplementary training. Typically, however, we have been able to achieve a 95% accuracy on count accuracy and c.90-95% classification accuracy depending on the environment. Speed accuracy is a function of the accuracy of calibration, and is sufficient for congestion detection and aggregate statistics but not enforcement.

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3. HARDWARE SPECIFICATION

Vivacity's software runs on our traffic sensor hardware:

Dimensions:

280 mm x 200 mm x 80 mm

Figure 3: Traffic Sensor Mounted to Lamppost

Processing Speed:

The processor has been specified to run our software at a rate of 4 frames per second in areas up to 4 lanes across.

Power Requirements:

- Continuous power supply required
- Power draw between 8 W to 12 W for normal operation
- Low power mode (offering only motion detection) reduces consumption to 3 W
- Maximum rated power draw of 15 W

IP Rating:

IP65 (Internally tested by Vivacity; external certification to follow in the next few months)

Sensor Field of View:

The sensor field of view is defined as a function of sensor height above the ground.

- Sensor Height should be between 3.5 m and 8 m above the ground.
- Different camera locations may be possible but have not been tested.
- The field of view defines the area in which detections are possible.
- The working range defines the area for which accuracy figures have been quoted.
    - If high accuracy detections are required, the road coverage should be confined to the working range.

Parameter	Field of View	Accurate Detection Zone
Vertical Plane **(Figure 4)**	80°	>20° Elevation from ground
Horizontal Plane **(Figure 5)**	130°	110°

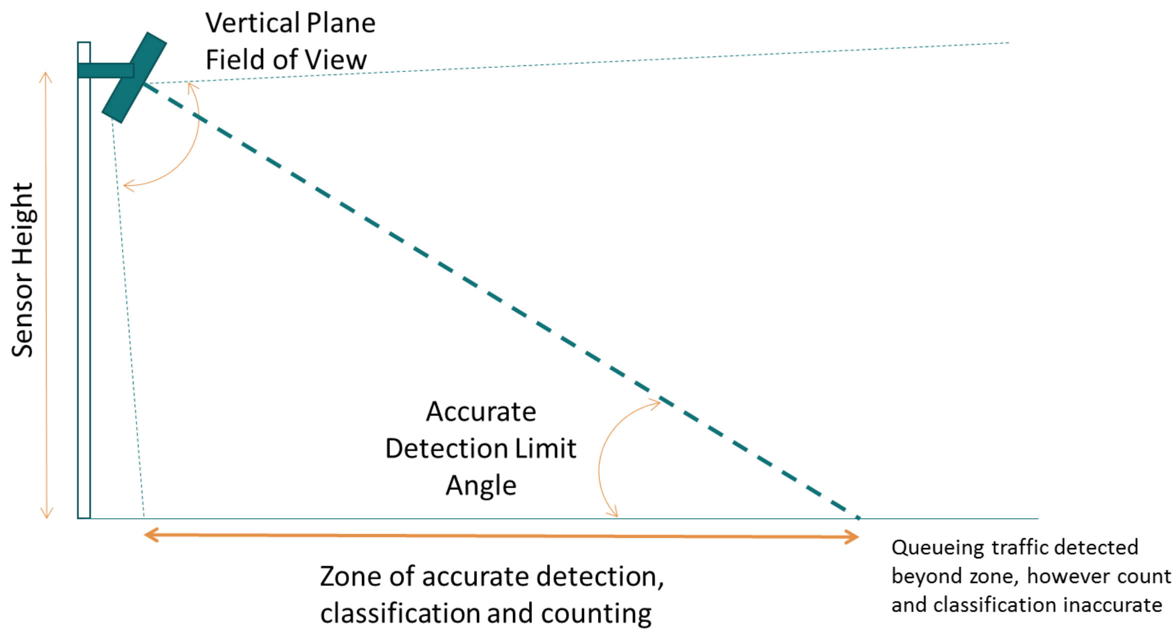

Figure 4: Vertical Plane Field of View

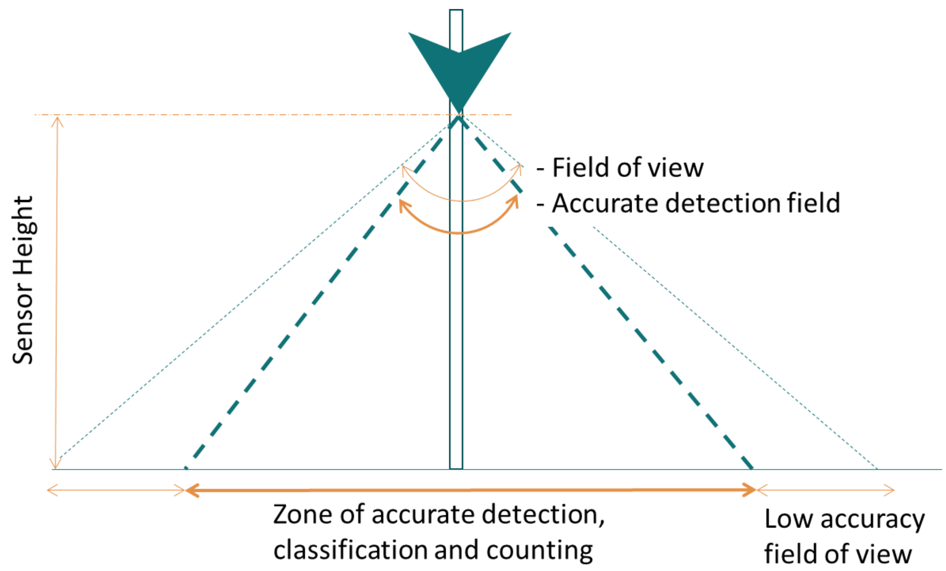

Figure 5: Horizontal Plane Field of View

Temperature Rating:

- Sensors can operate up to an ambient temperature of 50° C provided they are shielded from solar irradiation.
- The sensors can operate without a shield in the UK climate.

Connectivity:

- WiFi
- Bluetooth
- Optional 3G / 4G

Data Usage:

Highly dependent on specific data output requirement & environment, but we typically experience c. 1 kilobyte per second during the day, with a monthly total of c. 1 gigabyte per sensor.

During sensor calibration, there may be a need to send several frames of video to a central server. This will require transmission of around 2 megabytes of data. This can be downloaded locally over WiFi if insufficient bandwidth is available to upload over the network.

4. ARCHITECTURE DIAGRAM

All of the video processing is carried out on the sensor. As such, only data which is required is transmitted.

Data is sent wirelessly to a central server where it can be combined with data from multiple other sensors and the combined output can be post processed to produce detailed reporting, inform live decisions and flag alerts.

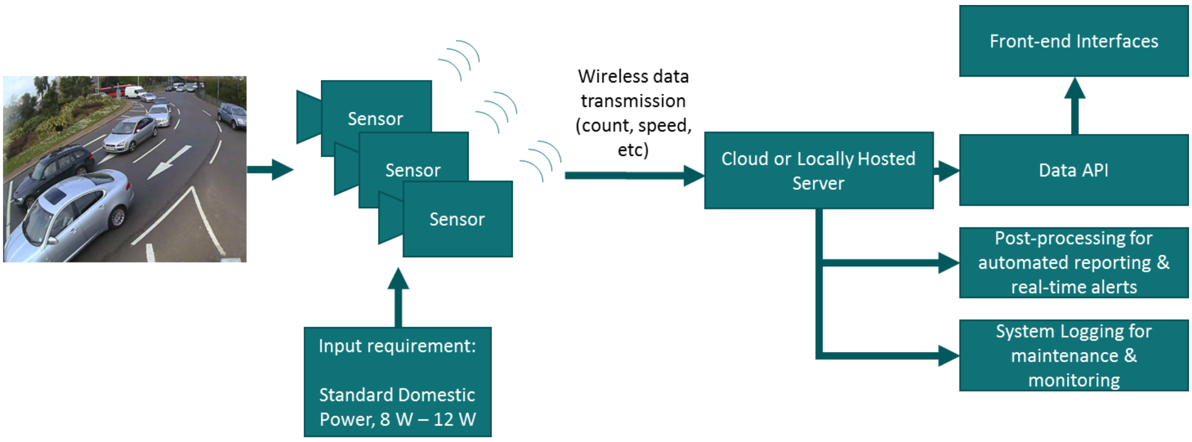

Figure 6: Architecture diagram showing data flow from sensor to server