SENSOR TECHNICAL SPECIFICATION

MODEL NAME: PARKING HUB SENSOR

1. OVERVIEW

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 Parking Hub Sensor, which works in conjunction with Parking Satellite Sensors (See VCT-STS-03).

The sensor is highly configurable to different environments, and therefore the exact operating frame rate and detection accuracy will be dependent on application.

2. LOCAL SYSTEM ARCHITECTURE

The Parking Hub Sensors contains a camera, which views an area of the car park, and a processor, which can take frames of video, and assess where individual cars are located.

The processor is able to takes frames of video at a higher frame rate than is necessary from a single camera. As a result, the Parking Hub Sensor is typically combined with Parking Satellite Sensors. These Parking Satellite Sensors can send frames of video to the Hub for processing over Wi-Fi, at a range of up to 40m. Each Hub can connect to up to 20 Satellite Sensors.

The Hub sensors is configured to process 1 frame of footage every X seconds, and then sends occupancy data to a cloud server over 3G data networks.

3. DETECTION SOFTWARE

Vivacity's Parking Hub Sensor detect vehicles within a field of view and compares this to a defined map of carparking spaces within the field of view.

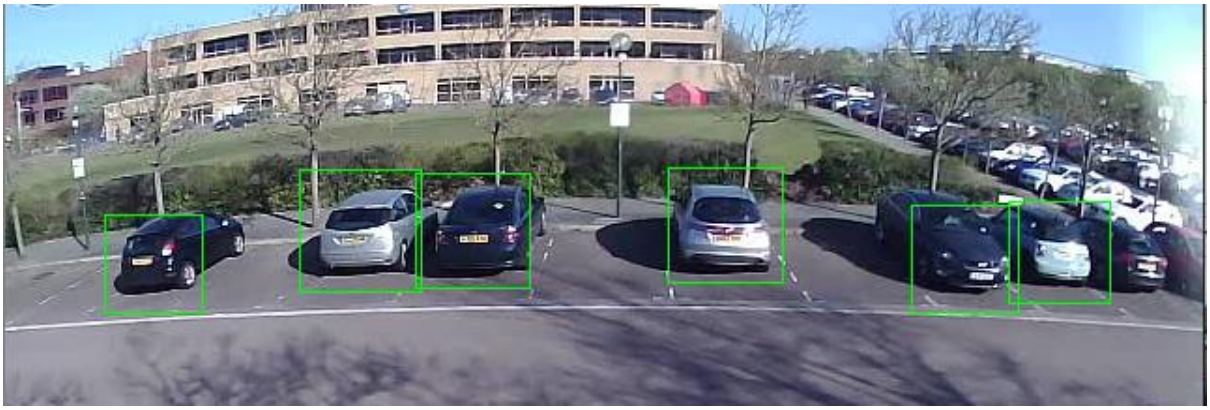

Figure 1: Detection of Vehicles in Car Park

2.2 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 depending on the environment.

4. DATA

3.1 DATA PROVISION & 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	Space ID	Occupied
1471276028349	1452	Yes
1471276028827	1452	Yes
1471276032214	1448	No
…	…	…

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

3.2 DATA TRANSMISSION AND BANDWIDTH REQUIREMENT

The sensor's connectivity bandwidth requirement is highly dependent on specific data output requirement & environment, but we typically require transmission of 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.

3.3 DATA ARCHITECTURE

The method of serving data produced to our clients can vary from project to project. Please discuss this with Vivacity's technical team, or consult our proposal.

All of the video processing is carried out on the sensor. As such, only data which is required is transmitted; all video is discarded during normal operation.

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.

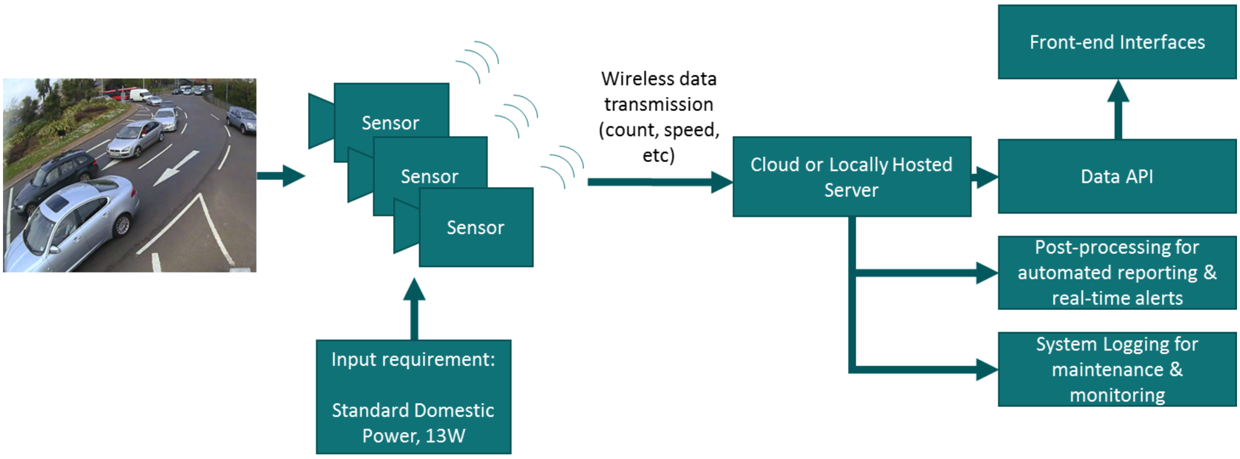

Figure 2: Architecture diagram showing data flow from sensor to server

5. SENSOR HARDWARE

Figure 3: Sensor Mounted to Lamppost

Sensor cover: White (Other colours available for high volume orders)

Sensor back and heatsink: Brushed aluminium

Sensor Bracket: Stainless steel

5.1 PROCESSING SPEED

The processor has been specified to run our software at a rate of 2 frames per second.

5.2 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.

5.4 IP RATING

IP66 (Internally tested by Vivacity; external certification to follow in the next few months)

Vivacity Labs Limited, International House, 24 Holborn Viaduct, London, EC1A 2BN. Company Number: 09924516

6. SYSTEM EXTERNAL REQUIREMENTS

6.1 CONNECTIVITY

- 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.

6.2 POWER REQUIREMENTS

- Continuous power supply required
- A battery buffer solution is available when power is only provided at night. The Charge Code provided below is not applicable for the battery buffer version of the sensor.
- Power draw between 10 W to 13 W for normal operation

7. EXAMPLE GENERAL ARRANGEMENT

For lamppost mounted sensors, the general arrangement below indicates a possible mounting and electrical interface.

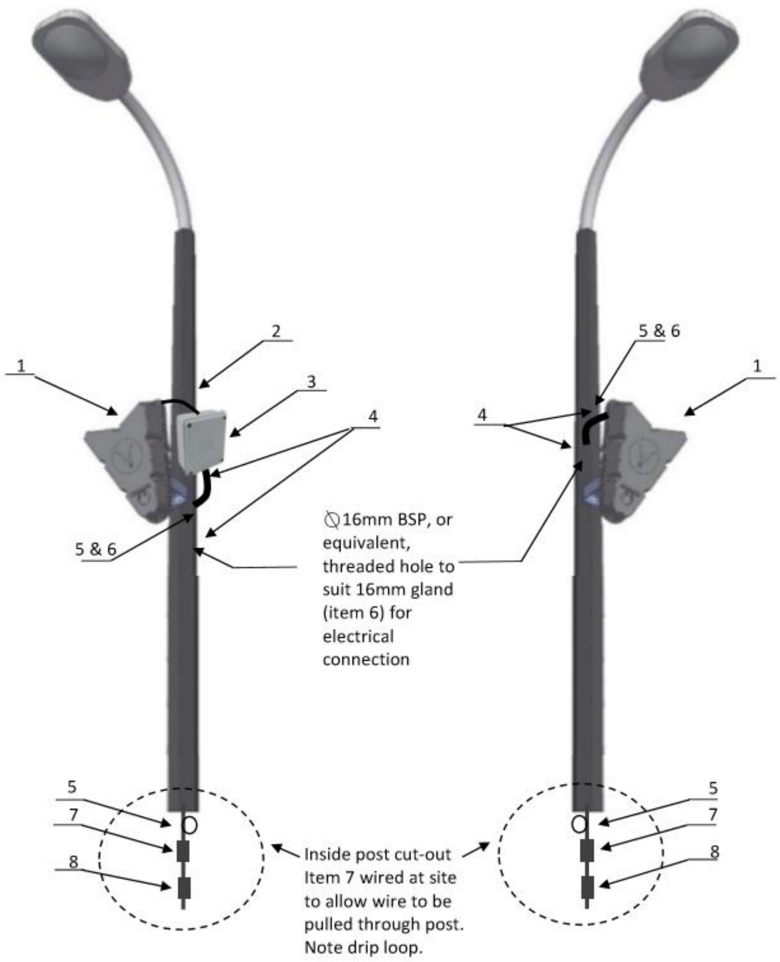

Figure 4: Mounting and electrical general arrangement, with battery buffer (left) and without (right)

1. V-City sensor

2. Low voltage cable (12 V)
3. IP66 Enclosure containing battery buffer (additional power draw from battery not included in Charge Code)
4. Nickel Plated internal and external threaded gland
5. Three core double insulated cable (240V)
6. Galvanised steel flexible conduit with PVC coating
7. Inline 2A fuse inside connection box for ease of site assembly
8. Lockable connection socket

6.1 MOUNTING BRACKET

Two mounting brackets are available:

1) Kinked – for use mounting to cylindrical columns
2) Flat – for use mounting to flat walls and surfaces

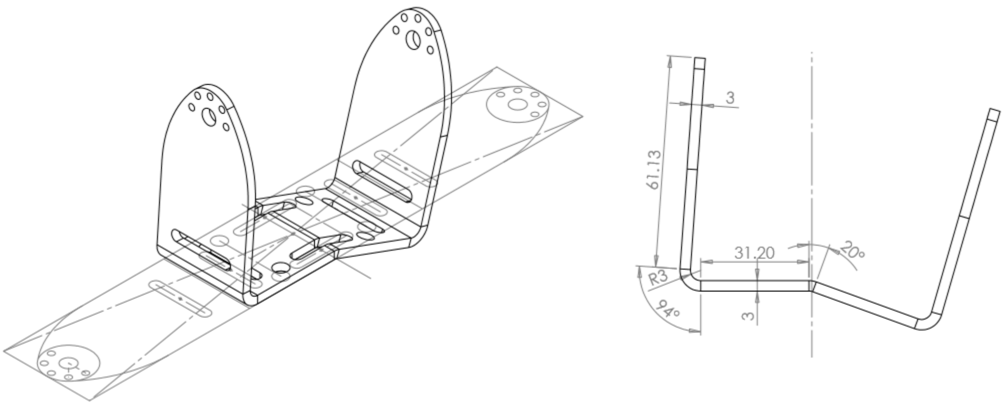

Figure 5: Kinked Bracket

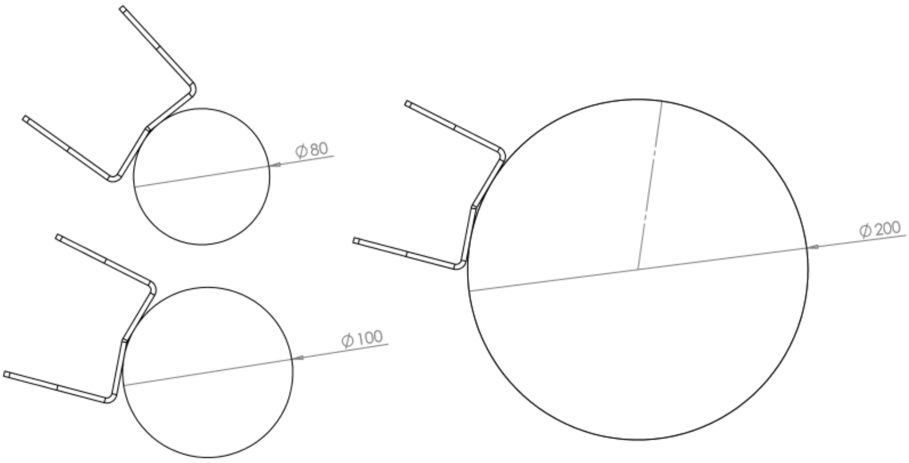

Figure 6: Kinked Bracket Mounted onto range of diameter cylindrical sections

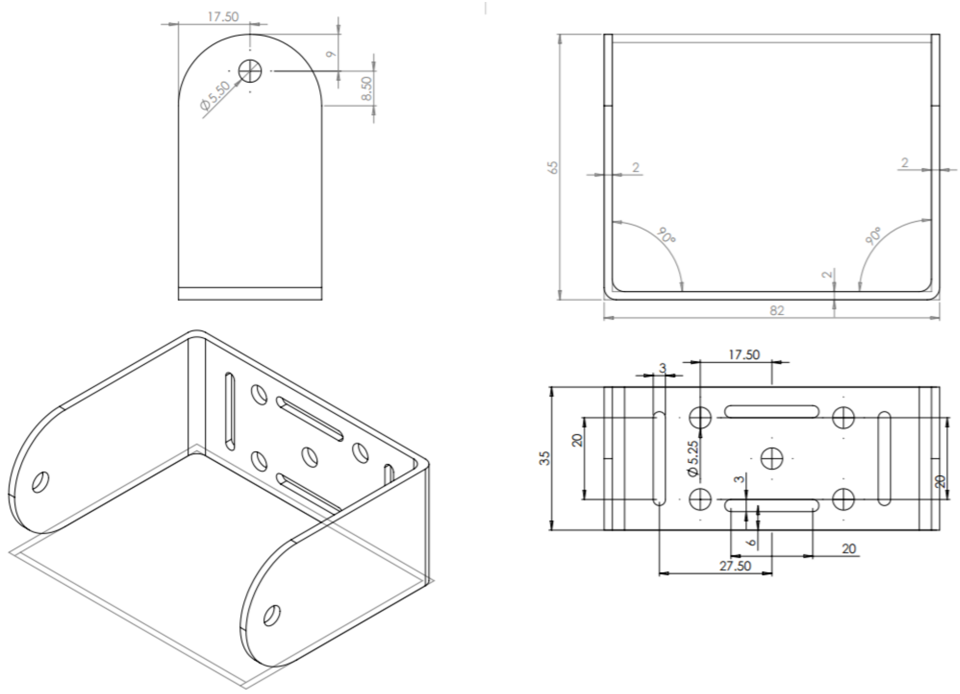

Figure 7: Flat Bracket

8. 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 15 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 8)**	80°	>20° Elevation from ground
Horizontal Plane **(Figure 9)**	130°	110°

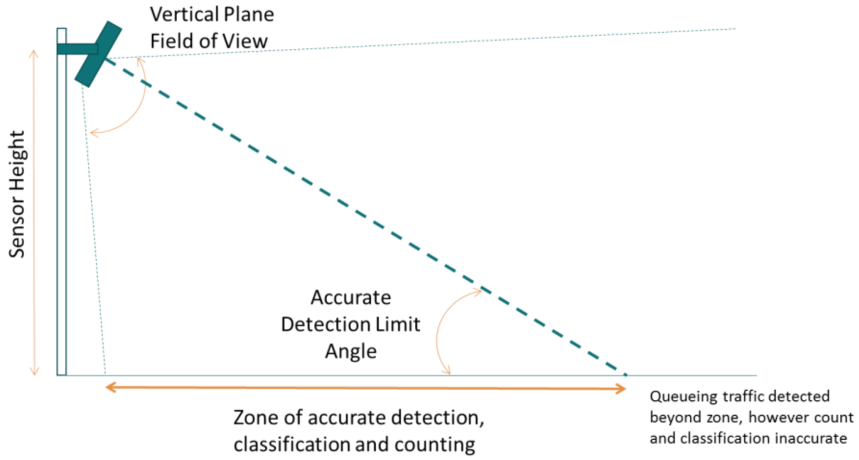

Figure 8: Vertical Plane Field of View

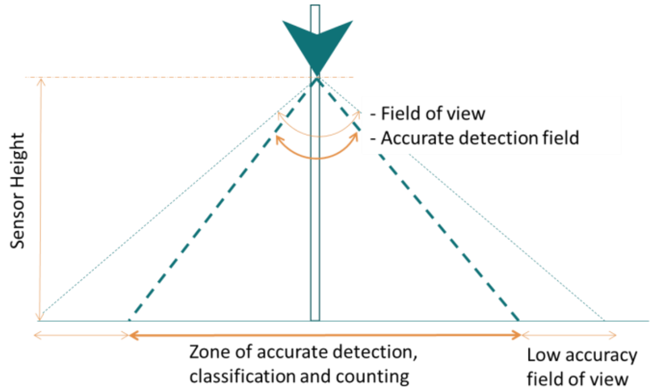

Figure 9: Horizontal Plane Field of View

A sensor positioned 6 m back from a row of perpendicular parking, at a height of 4m can cover 10 spaces.