VIVACITY

Vivacity Sensor Platform

sales@vivacitylabs.com www.vivacitylabs.com

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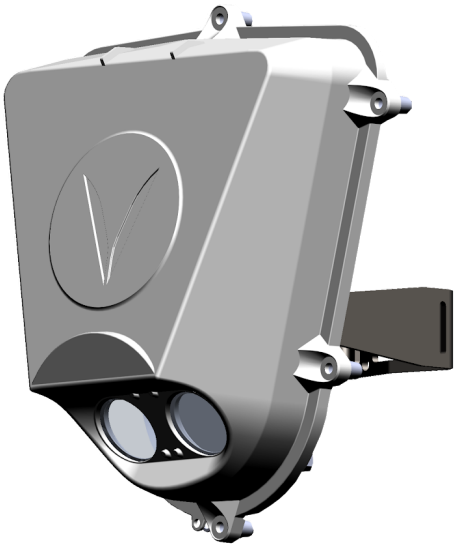
Product Overview

The Vivacity Sensor Platform is a road space usage monitoring service which combines an IOT Sensor, Cloud Database and API or Web Application to give clients a real time and historic view of how many different types of road users use the space, and how they interact within the field of view a sensor. To date we have installed over 800 devices, predominantly in the UK, and with a growing international presence. Our clients include TfL, Highways England, Oxfordshire County Council and Cambridge City Council.

Sensor

Our sensor contains a camera and a processor which allows us to collect real time, anonymous data on how the road space is being used. The data is sent to the cloud, and the video is discarded at source.



API

The data is fed securely from the sensor to a cloud server for storage and backup, enabling access to live and historic data via an API which 3rd party systems can integrate with.

Dashboard

We also provide a cloud-based dashboard which allows clients to log in from anywhere and view the live and historic data being generated by each sensor. It provides access to classified count data, accessed on a map view showing the locations of each of the sensors and road direction of data.

Sensor Data Capabilities

Counts

This data represents the number of road users travelling along a road in each direction. To allow us to get accurate count data, we create a virtual countline within the sensor field of view, and road users are counted as they cross the countline. Count data can be provided as the time each individual road user crossed the countline, or as an aggregate count per time period (typically 5 minutes). Multiple virtual countlines per sensor can be specified.

Class Counts

Count data can be expanded upon with class counts, where our software provides a classification from the following classification set for each count data point:

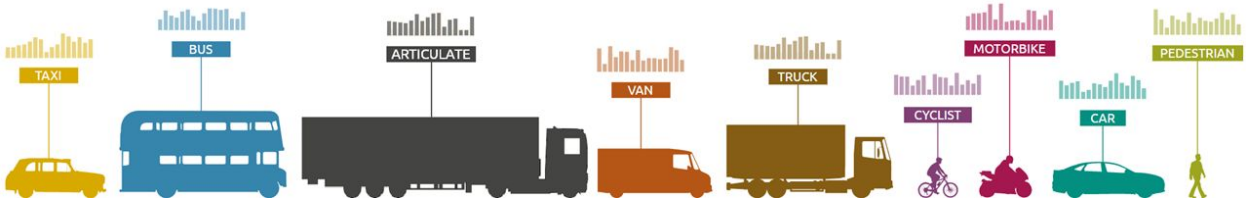


Figure 1: 9 Class Classification Set

Speed

The sensors can provide the approximate speed of each individual road user. This is suitable for congestion detection and typical driver behaviour, but not enforcement of speed limits.

Path

The path that a classified road user takes through the field of view can be reported. The path data is defined by the bottom centre of the vehicle at each frame processed while the road user was present within the field of view (Figure 3). This “image space” path can be transformed into GPS space, thereby reporting the GPS coordinates of the road user at the time stamp for each frame that a vehicle is within the field of view (Figure 4).

Journey Time

The average journey time of road users (excluding pedestrians and cyclists) between two sensors.

Zonal Occupancy

This capability allows us to give the number of classified road users in a zone or multiple zones within the sensor's field of view. A zone is an area that can be defined on the sensor view or by GPS polygon(s). These counts are sent approximately every second. This is reported as each instantaneous occupancy for each zone at a time requested or the average occupancy during a time period for each zone. This capability can be used to understand queuing behaviour by counting the number of vehicles in a known queuing zone.

How Does It Work?

Sensor Hardware

The sensor contains a local “edge” processor which takes video from the inbuilt camera and runs our patent-pending Machine Learning algorithms in order to extract useful data from the scene. During normal operation, each frame of video is deleted immediately after processing, and only the anonymous data extracted by the algorithms is stored and transmitted.

The sensors have 3G/4G connectivity, enabling the data gathered to be sent to the cloud, and also giving us remote access to all sensors at any time. This enables a full, real-time view of sensor up-time, remote debugging and maintenance, and remote updates.

Sensor Software

Our Machine Learning algorithm processes each frame of video to extract the location and classification of each road user. Only anonymous features are stored at this point and the video frame is deleted. The output generated from a single frame of video is shown in Figure 3, demonstrating road user detection and classification.

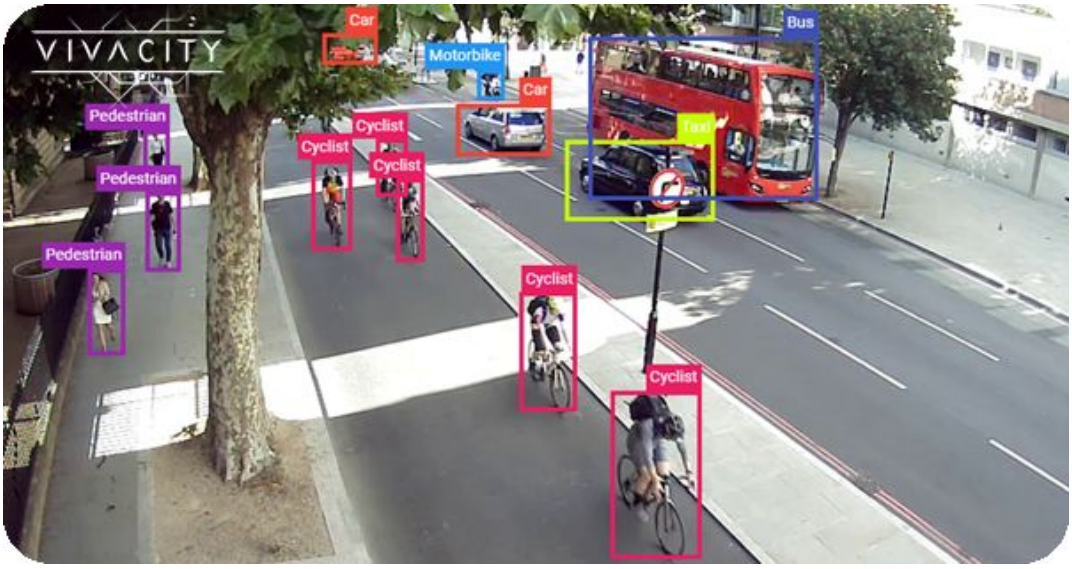


Figure 3: Road User Detection and Classification Software

These video analytics algorithms are similar to those used in driverless vehicles and autonomous drones, using cutting-edge artificial intelligence techniques.

The detection data can be used directly to determine the occupancy of zones within the field of view. In order to extract other data types, each road user is tracked through multiple frames as they pass through the field of view. The tracking output from 30 minutes of sensor operation is shown in Figure 4, enabling an assessment of how the road space is being used. Virtual count lines are drawn within the field of view, and road user flow is extracted each time a path crosses this line.

Figure 4: Vehicle path data from tracker - showing 30 minutes of vehicle flow; red = car, purple = pedestrian, turquoise = van, blue = HGV, yellow = taxi, and pink = cyclist

Privacy and GDPR

Vivacity's sensor system was designed using data protection by design principles and is compliant with GDPR. The system does not produce any personal data when it is not necessary.

Normal Operation – No Personal Data

Under normal operation, the system processes all video locally, produces anonymous data feeds and discards the video immediately. As such, during normal operation, the system produces no personal data and therefore presents no privacy or personal data risk.

Software Training - Optional

Our machine learning algorithms have been trained on images gathered from manual traffic surveys and from our deployed sensors. We are continuing to grow our image training set, as this will help us to continue to improve the accuracy of the system. In order to achieve this, and with the permission of our clients, we may choose to extract a few sample images from each new sensor installation to add into our training set.

We will always provide temporary signage in the vicinity of a sensor before gathering images for our training set. These signs state "*New road space usage sensors installed, once fully operational they will only produce anonymous data. Video may be intermittently recorded at this location during this initial project phase, for the purpose of system development and testing*".

Vivacity are registered with the ICO to enable us to collect and hold image data for the purpose of developing software to extract anonymous data from video feeds. We act as the data controller for the software training process. We have carried out Privacy Impact Assessments for this work, which can be provided to clients upon request. If requested, we will not extract any training data from a given sensor and following such a request, no personal data will ever be generated by that device.

Maintenance – No Personal Data

In order to calibrate and maintain our sensors, we occasionally send an image from the sensor back to our office. In order to ensure the maintenance images do not contain any personal data, we follow the following process:

- The sensor takes a photo and blurs a copy of the image prior to transmission.
- The blurred image is manually screened by an operator to ensure no possible personally identifying features may be present in the original image
- If there is a risk that personal data may be in the unblurred image, the image is deleted and the operator will request a new blurred image
- Once an image is confirmed as having no risk of containing personal data, the original unblurred image can then be transmitted to the operator. This image can then be used to confirm whether the camera lens requires cleaning.

This process is covered by our privacy impact assessments.

Journey Time - Hashed Number Plates, Deleted Seed

In order to calculate journey time, the same vehicle needs to be re-identified at a second location, making it a requirement to send a unique ID for the vehicle. By hashing the number plate before transmitting, it anonymises the number plate. By deleting the hash seed every 24 hours, it prevents vehicle journey patterns being used to infer the identity of any journey within the database.