Traffic Survey in Englishcombe Lane, Bath, June 2021

Introduction

This documents details the results of a traffic census carried out in Englishcombe Lane, Bath during June 2021

The information should be regarded as informative rather than definitive, but is intended to give a realistic view of traffic density and speed profiles across extended periods.

Background

Englishcombe Lane is a single carriageway urban road in Bath. It serves to connect Bloomfield Road in the East and Whiteway Road in the west, and is used as both a local connecting route and occasional commercial vehicle route into and out of Bath.

The entirety is within a 20 mph speed limit. While some sections are part of regular bus routes, the surveyed section, in front of number 93, is not. Some sections have speed humps, this section does not.

Anecdotal evidence suggests that this section is subject to occasional high-speed use, and heavy traffic density during School-run periods, the road serving Moorlands Schools Federation as well as routes for Beechen Cliff and to a lesser extent, Hayesfield schools.

The survey was intended to try to put some hard evidence to these notions.

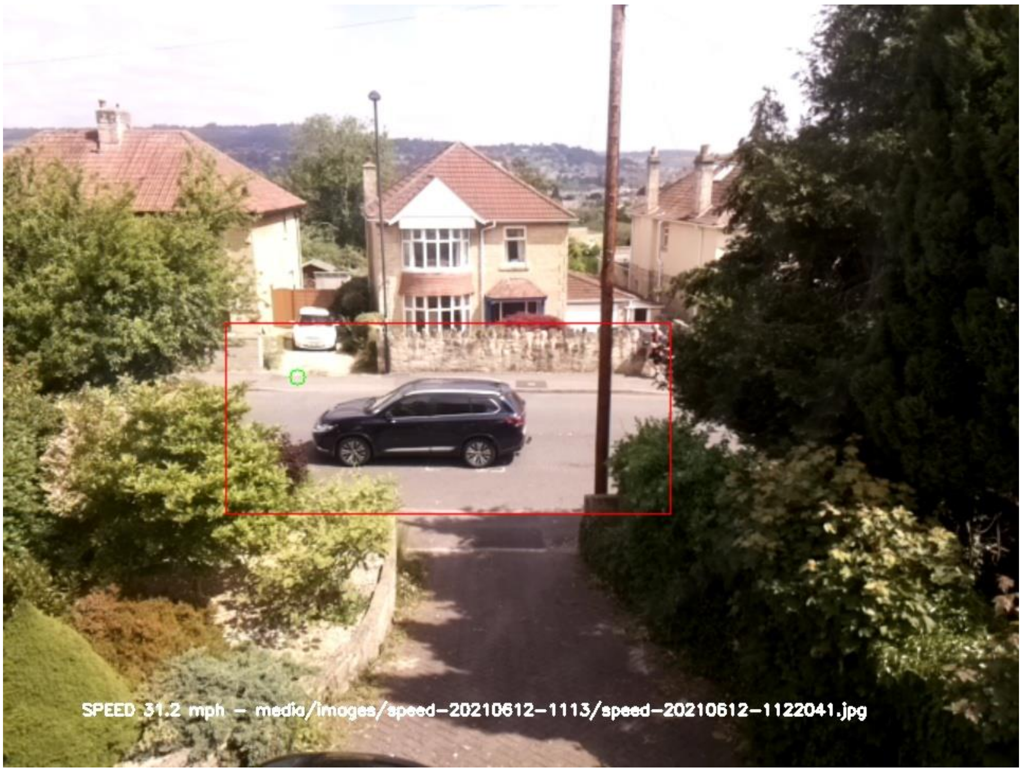
Equipment and Methodology

Detailed equipment design is discussed in Appendix A. In summary, the equipment uses camera and machine-learning software technology to capture and analyse images in real-time. Image analysis allows quantity, direction, speed and size of vehicle movement to be determined with suitable timestamping.

Post-processing analysis allows density and speed profiles to be presented for statistical consideration. Metrics available include vehicle movements per time period, tidal flow, vehicle speed profiling and some indication of vehicle size.

System limitations and accuracy are described in Appendix B, but in summary:
the system operates in daylight
the system cannot reliably detect speeds in excess of 45 mph
the system cannot differentiate between vehicles passing simultaneously in opposite directions.
system speed accuracy is of the order of +/-15% and is most accurate between 15 to 35 mph.

The system is not capable of, and does not try to, provide identification of vehicles or vehicle occupants. The exception is where commercial vehicles may carry some signage or branding, or where the vehicle usage is obvious such as blue-light vehicles, buses, etc.



An example of the image captured during speed analysis.

Presentation of results

Analyses are presented largely graphically, drawn from the raw database which can be made available for other analysis. The intention is to convey as simply as practicable the key results from the survey. In general results are presented as discrete interval periods, e.g averages over 30 minute intervals.

Results

The surveyed period is from Tuesday 8th June to Sunday 13th June 2021.

This includes 4 'working' days and one weekend.

Total vehicle movements counted over this period were 23,572.

Fig. 1 - Total vehicle movements by day

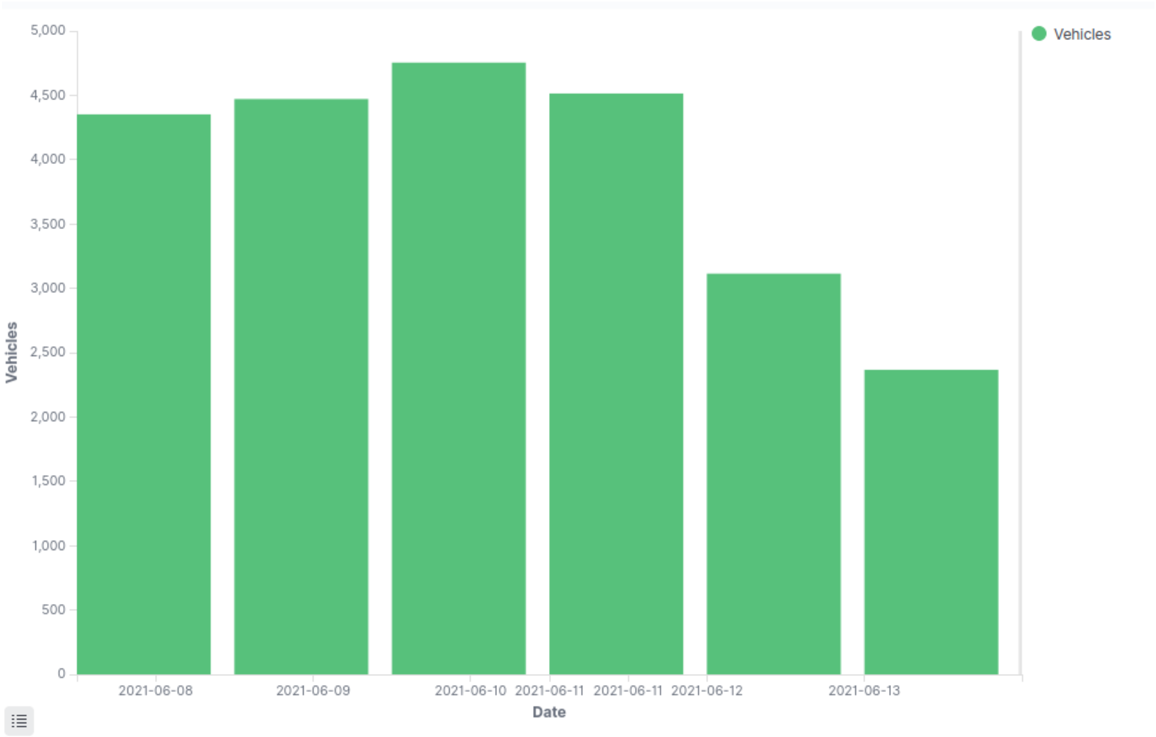


Fig. 2 - Vehicle movements per direction.

R2L is westbound, L2R is eastbound.

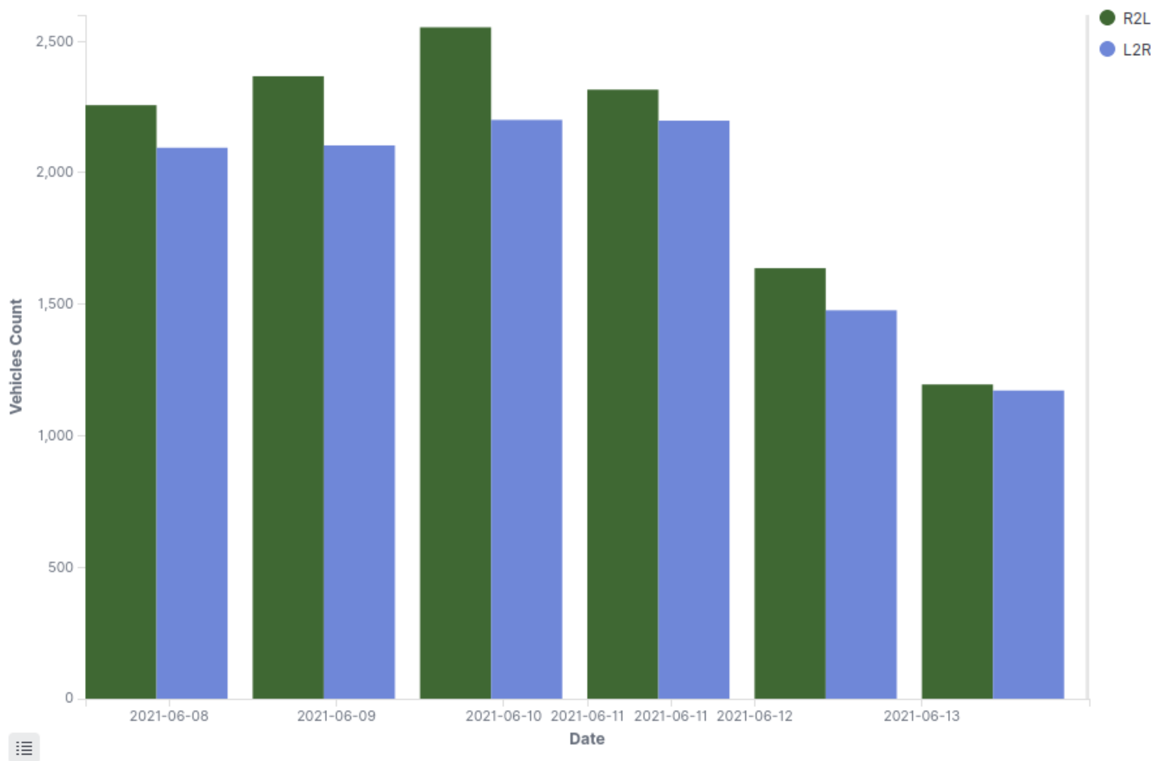


Fig 3 - Vehicle Movements by time of day

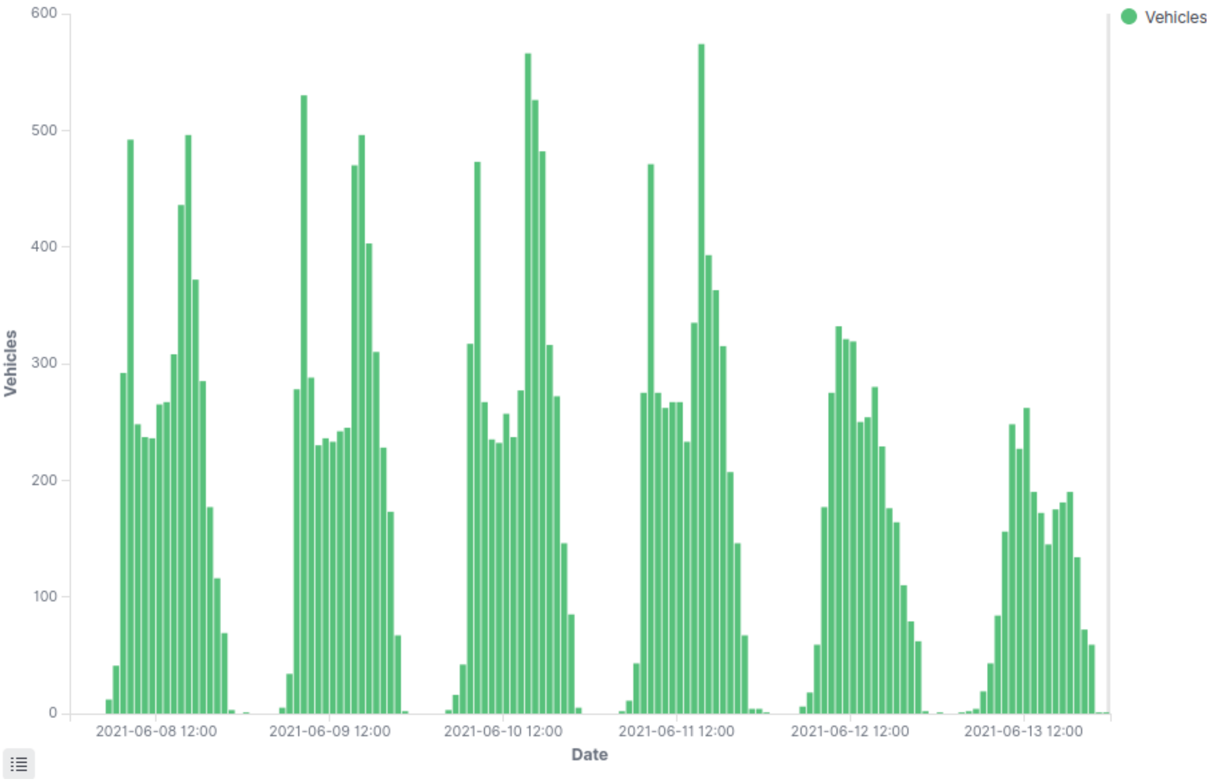


Fig 4 - Vehicle Movement for one day by 30 minute intervals

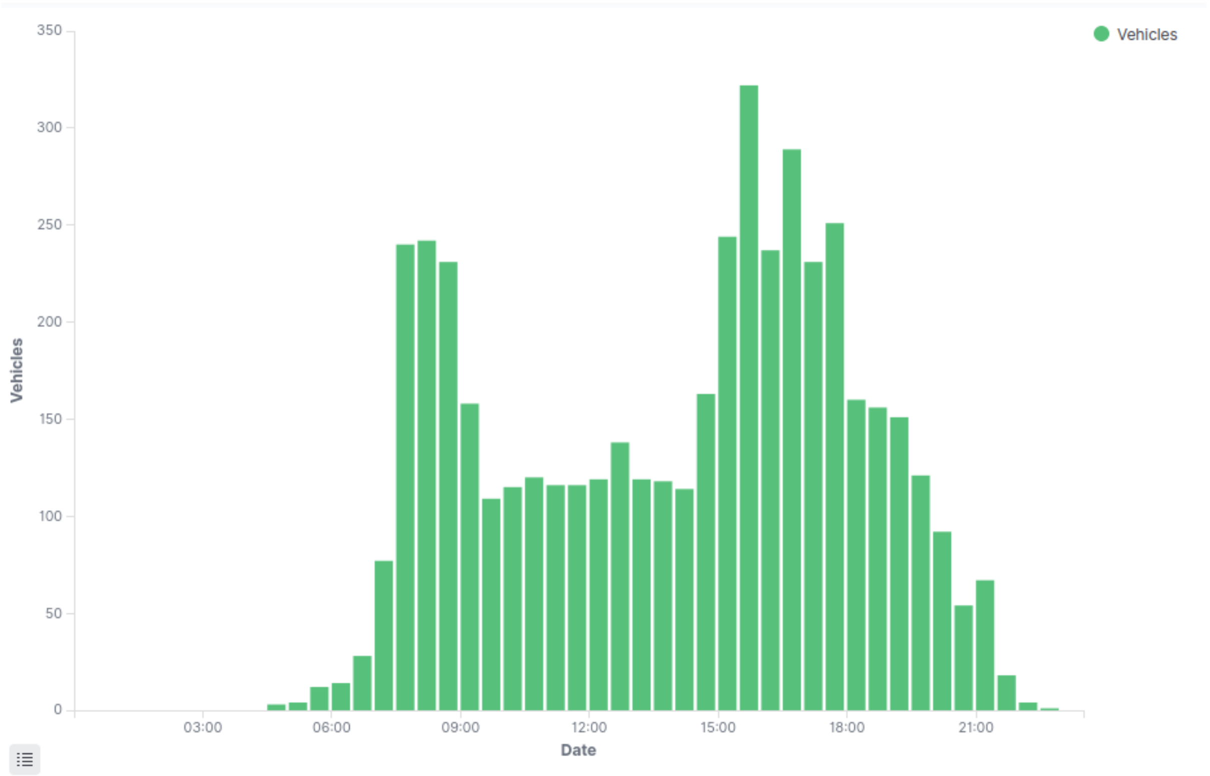


Fig 5 - Vehicle speeds average over 30 minute intervals

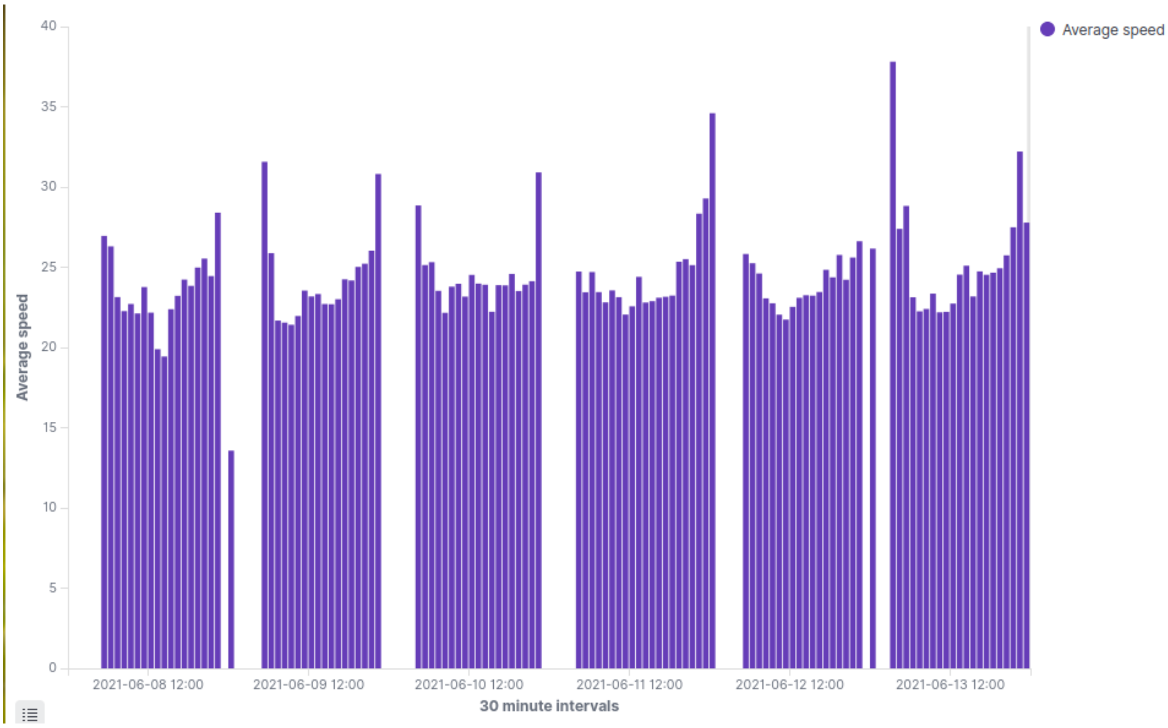


Fig 6 - Maximum vehicle speeds in 30 minute intervals

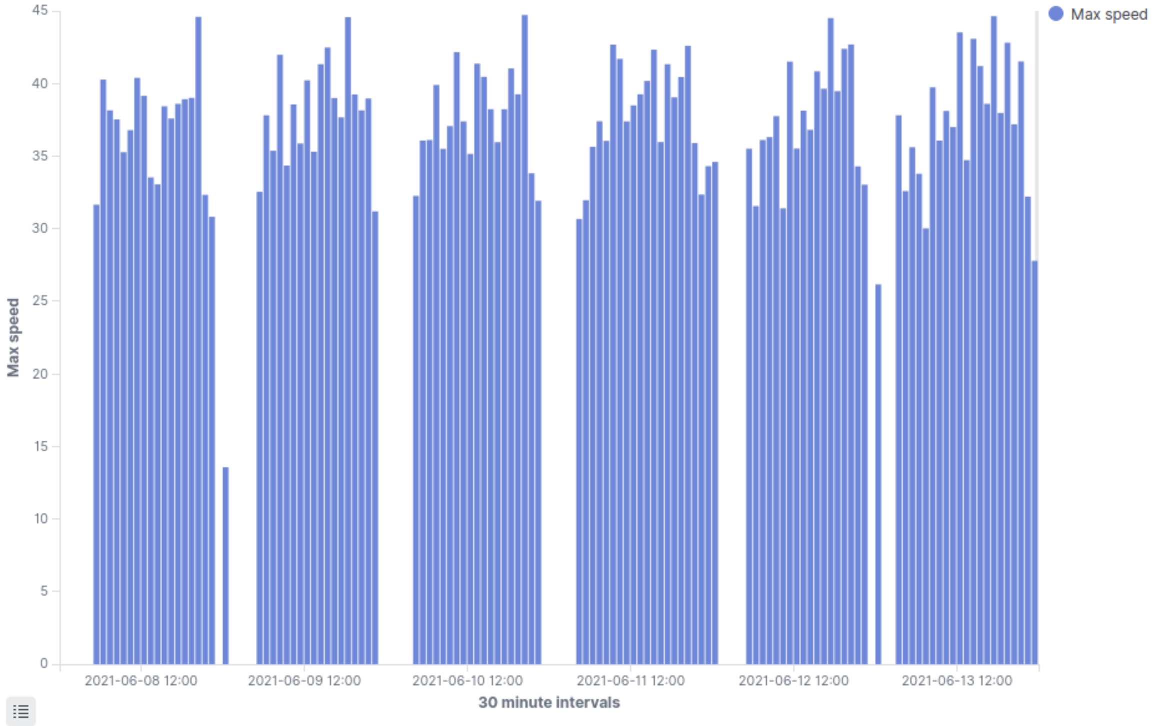
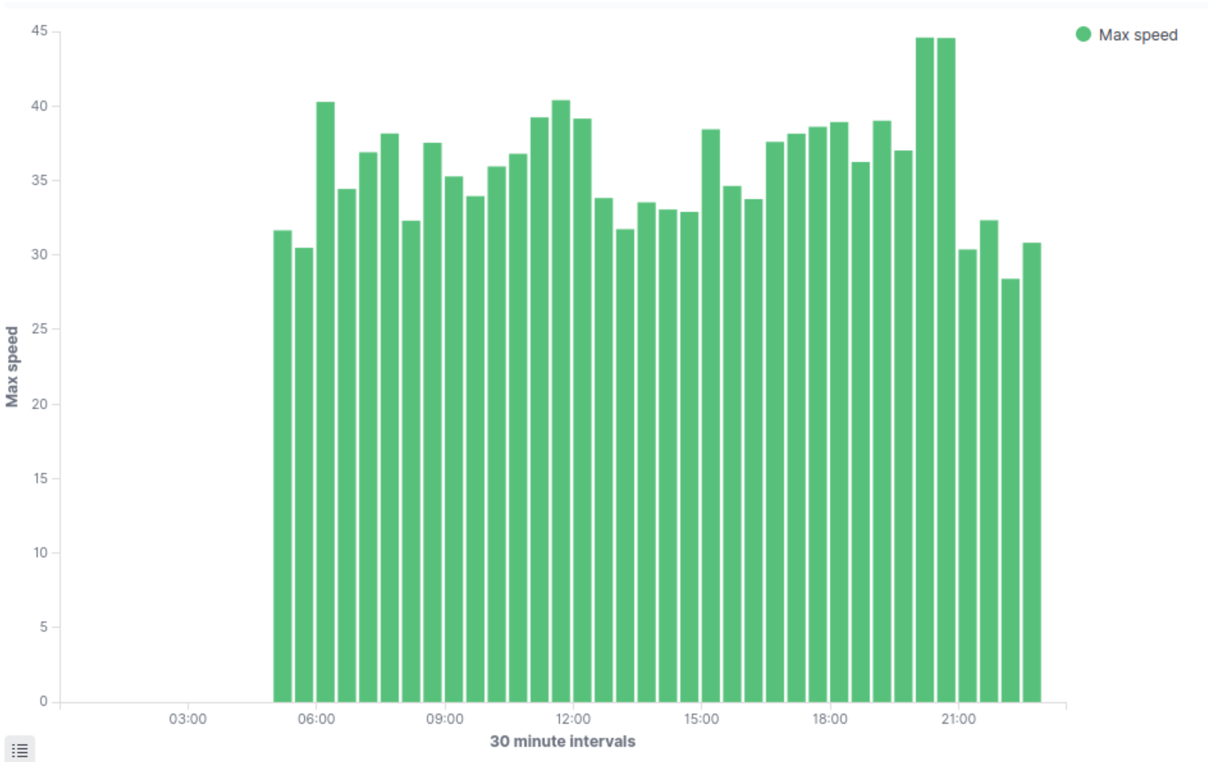


Fig 7 Maximum speeds recorded in 30 minute intervals over one day



Interpretation of results

From Fig 1, weekday traffic movements are fairly evenly spread at 4000-4500 per day.

This approximately halves at weekends, to 2000 – 2500 per day.

From Fig 2, there is a consistent bias towards more westbound traffic (leaving the City), 57% to 43%. This is consistent across all the days of the week.

Fig 3 shows the vehicle movement across the days. Most movements are around commuting/school run times, i.e. 8am to 9:30 am and 3 pm to 6pm. Fig 4 shows the distribution across a typical workday.

Fig 5 shows the median speeds per 30 minute interval across each day.

This breaks down as 11.3% of all speeds were above 29mph, 42.8% of all speeds recorded were above 24 mph, and 75% of all speeds were above 20mph.

Fig 6 shows the maximum vehicle speeds detected in a 30 minute period. These show that in virtually every time period, at least one speed in excess of 30 mph was detected.

Fig 7 shows a typical day. Early in the morning and late in the evening show the highest speeds recorded, between 6am and 8 am, and between 7pm and 9 pm.*

* The maximum speed detectable by the system is 45mph, and the system only operates in daylight. So very high speeds and high speeds after dark are not detected.

Summary and Conclusions

While this survey can only be regarded as indicative, there is a clear pattern of speed limit violation, with over 70% above the speed limit. Traffic density may also surprise some, this is a busy road especially around the time of the school run, when it may be considered there are vulnerable children using and crossing the road.

The author believes there is sufficient grounds to conduct an official survey, especially positioned at the highest speed points, with a view to introducing more traffic calming measures.

Appendix A

Detailed equipment description

The initial system uses a Raspberry Pi 4B single board computer hardware running the Linux operating system and bespoke image capture and analysis software.

Hardware

The Raspberry Pi 4B single board computer is a small but powerful platform, with a 4-core high-speed ARM processor and 2GB of onboard ram. The hardware also includes a 8Mp direct connection digital camera with capture capability to 30 frames per second at the chosen resolution.

The compact nature of the hardware means that it can be mounted virtually stand-alone, with control communication provided through the onboard WiFi connection. The whole is mounted tangentially to and above the area to be surveyed, at a suitable distance to enable sufficient transit distance to be viewed.

It is necessary to have a field of view that can capture sequential video frames without interruption. Mounting at a first floor window provides a good compromise between distance and height to avoid e.g. pedestrians passing. Since the mounting is indoors, no weather-proofing or special measures are need to provide power to the device.

It should be noted that potentially any hardware platform running Linux could be used, since the system also support IP cameras of the type commonly used in domestic CCTV systems.

Software

All software used is open source and freely available.

The operating system is Linux for speed and reliability and the software application is written in the Python programming language.

The key part of the software is the industry-standard image capture and analysis system OpenCV. This library suite is capable of sophisticated image analysis at high-speed allowing for example, vehicles to be differentiated from people.

Nevertheless, the software is process intensive and ultimately is the limiting factor in detecting high-speed vehicle movement.

The application includes calibration and environmental parameter settings which require a little time to get right and depend on the exact dimensions of the field of view. In practice, speed calibration verification is carried out by the simple trial and error process of driving at a known speed in front of the camera and adjusting parameters until the indicated speed accords with the actual speed.

Data capture consists of recording key parameters in a CSV delimited format, one record per line. Alternatively, a SQL Lite database can be invoked. Each vehicle detection is also recorded as a jpg image with annotation including detected speed and time. These can be used to verify assumptions about vehicle type, or investigate apparent anomalies.

Post-processing and Software analysis

Once a database of movement records has been captured, it is imported into the Elasticsearch engine.

Elasticsearch, together with its graphical front-end, Kibana, are tools to analyse and present time-based data in an easy-to visualise form. These tools allow aggregation, averaging, filtering and sorting of data to present histogram, bar charts, pie charts and so on. Only a selection of these are presented in this report, as images.

The raw data can be re-interpreted as required to present more detailed or more over-arching reports.

Appendix B

Limitations and Errors

The equipment used is subject to a number of error sources.

These are principally image recognition accuracy and image tracking accuracy.

Image recognition accuracy

The software-based image recognition mechanism relies on generally good raw image quality, with general form consistency, ie vehicles all look about the same. Recognition depends on pixel difference calculations using subtractive mathematics on arrays of pixel points. Filters are used to

a) remove the fixed background as far as possible, to reduce the calculation intensity
b) limit the size of image to be greater than a minimum, to prevent e.g pedestrians being falsely registered as vehicles.
c) limit the time between image processing to prevent vehicles being counted twice.

However, the proximity of vehicles closely following each other will usually result in the count being under-reported if the distances are small. This usually happens with slow-moving queued traffic.

The image processing cannot reliably distinguish between vehicles crossing in opposite directions simultaneously.

Overall, these limitations tend to an under-reporting of vehicle numbers.

Image tracking accuracy

The system works reliably with individual vehicles or groups of vehicles in deciding the rate of travel. This is in part due to the setup, in general, variations in the y (vertical) position of the image are small for any particular vehicle track, since vehicles tend to stay in lane. Thus the principal change of position is in the x-axis (horizontal) portion of the image.

The system uses a high-accuracy timer to generate timestamps per image capture and these allow a reliable timebase to be established.

Processing speed is limited by hardware and software, with the software portion being variable depending on the complexity of the images. This sets the upper limit on speed detection, since fast-moving vehicles will have crossed the field of view before image processing is complete.

For speed calculations, a minimum of 4 consecutive frames is required which are averaged to produce the speed calculation.

Empirical observation suggests that speed detection is unreliable above approximately 40-45 mph, so speeds above this are not reported.

Overall speed reporting is most accurate between 15 and 35 mph, approximately +/-15%, so should be regarded as indicative, rather than definitive.

Future systems will address this limitation by improving hardware and software processing speeds.