Opinion

The camera never lies, or does it?

The dangers of taking CCTV surveillance at face value

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The issues

How many of us question what we're shown via closed circuit television (CCTV) as being the truth of a situation? Can clear and easily identifiable images be wrong? And if they are, how can you argue against the power of the recorded image from a legal standpoint? Can Human Factors help us improve surveillance for society?

In this real example of UK traffic surveillance, can CCTV always be taken at face value? The simple answer is no, but how many people accept what they are shown without question and end up paying the penalties?

Case-study of bus lane contravention

In January 2009, my wife and I were driving through London on our way to a social function. My wife is from the area with navigational knowledge of the city that would rival a London taxi driver (these drivers are famous for their extensive knowledge of routes through the city). She is also a courteous and skilled driver with no penalties on her licence. She drove our car as she knew a few short cuts to beat the traffic which on this Saturday afternoon was particularly busy. In addition, we both remained vigilant for pedestrians and tourists crossing the roads unexpectedly and navigated our route by focusing attention on the multitude of road names, signs and traffic controls measures; all set against an increasing time pressure as our deadline for attending the function loomed. We arrived at our destination on time and thought no more of our journey. We were therefore very surprised, a week later, when we received a penalty charge notification (PCN) stating that we had allegedly contravened the Road Traffic Act 1984 (as amended) and the Road Traffic Act 1996 (as amended) section 34J for driving our car in a dedicated bus lane. The notification included an image of our vehicle (Figure 1) and a web-link to further images caught via CCTV of our apparent contravention (Figures 2 and 3). It also stated that the incident had been observed by CCTV camera operator identified as LH755.

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Figure 1: Our vehicle clearly identified (registration blanked out for confidentiality)

Figure 2: A vehicle of the same type as ours in a bus lane

Figure 3: A further image of a vehicle similar to ours in the bus lane

In the UK there are strict rules forbidding other modes of traffic from using dedicated bus lanes, and for good reason. In an attempt to make public transport more appealing to commuters, shoppers and tourists,

bus lanes provide privileged access through gridlocked road systems. CCTV has been used as a surveillance and policing technology along with automatic number plate recognition (ANPR) in order to capture anyone contravening these rules. However, within the UK, different stretches of road (usually governed by local councils or boroughs) may have different rules attached to them for their use in general or during specific times. In some areas, it is permissible to use a bus lane outside of stipulated controlled times (usually peak rush hour traffic), although not all authorities follow the same logic. It therefore places extra demands on road users (especially those unfamiliar with new initiatives) to discern when and where they are allowed to use certain routes on the road.

Given the ‘evidence’ of the contravention we felt we had no alternative but to pay the £60 fine. It was only when I investigated the situation further that a number of issues came to light from both legal and human factors perspectives.

The PCN stated that we had been observed via camera 156 on Norwood Road. Based on the images provided, my suspicions were aroused by the label C139 (visible in the top left of each image) which I took to refer to camera 139. If this was correct, it would seem to confound the information that we had been observed from camera 156. Furthermore, with my wife’s knowledge of the area we then traced our route using Google Earth satellite images and realised that Norwood Road was not close to where we had travelled that day (Figure 4). Coupled with my professional background in human factors I was then keen to explore the potential human-machine interaction (HMI) that underpinned the decision to proceed with an erroneous PCN.

Figure 4: Location of Norwood Road relative to where we actually were.

By comparing the satellite images with the CCTV images that accompanied the PCN, we identified that the camera appeared to be located at the junction of Clapham Park Road junction with Abbeville Road (Figure 5).

Figure 5: Higher detail satellite image of our location

Zooming in for further detail, it was possible to compare features from the satellite image against the PCN image (Figure 6).

Figure 6: Comparing the satellite and PCN images

It became apparent that the traffic light island, location of the bus stop, green space and trees to the left of the bus stop were identical. It was even possible to discern the shadows of lampposts in the satellite image (left hand image) and relate them to the lamp posts visible in the CCTV image (right hand image).

Appealing against the PCN

There was strong evidence that the images were not in the location stated in the PCN but from a legal standpoint it was not clear how to contest it. The CCTV images appeared to offer irrefutable evidence that a contravention had occurred albeit at a different location.

Reference was made to the Bus Lane Enforcement Camera Handbook (Lewis 1996), which states the operational requirements for positioning of cameras and recording of data:

- **Section 5.1.1** – the camera shall have an angle of view sufficient to ensure that the offending vehicle is clearly identified in relation to the measuring zone and other vehicles that may be nearby and to include all possible extenuating circumstances that may cause a vehicle to be in the bus lane.
- **Section 5.1.2** – every image of the offence shall show, in addition to the offending vehicle, in the order given: the date in days, month, and year, the time in hours, minutes, and seconds, the day of the week, location and frame count from the beginning of the recording. The data shall be imprinted on the image or included in the violation record at the time the offence is recorded.

We were also advised that once a PCN is issued it cannot be re-issued if the stated location and photographic location are inaccurate. This meant that if it was possible to illustrate legal discrepancies in the PCN, a further notice could not be issued. With this knowledge my wife and I appealed against the PCN on the following grounds:

- **Contravention of section 5.1.1** – the images did not clearly identify the vehicle registration number or all the possible extenuating circumstances that may have caused the alleged offence. Although Figure 1 identified our vehicle registration number it did not provide any evidence of the vehicle in relation to the measured zone or alleged offence. Figures 2 and 3 illustrated a vehicle in the bus lane but did not identify the vehicle as ours. None of the images in isolation provided any evidence that identified our vehicle in any alleged offence and could not be used for imposing a penalty charge.
- **Contravention of section 5.1.2** – the images did not represent all the required data and the data shown was not in the correct order. The time appeared before the date and there was no record of the day of the week or location. Failure to show the correct information in the correct order was inadmissible evidence of any alleged offence.
- **Incorrect location** – the PCN stated that the alleged offence took place on ‘Norwood Road – Camera 156’ but the image was of the Clapham Park Road junction with Abbeville Road. Furthermore, there was a reference number of ‘C139’ which could indicate the image is not from Camera 156. Looking at satellite images there was no junction on Norwood Road similar to the one in these two images of the alleged offence. The PCN was inaccurate and therefore invalid.

With these points in mind, we felt there were sufficient grounds to contend the PCN and we requested that it be cancelled immediately. After a few weeks, we received a brief response stating that our representations had been accepted. With this response, we then contacted a well known BBC consumer rights television programme who were very interested in our situation and the impact it could have on other members of the public who were less willing or able to investigate the basis of such PCNs for themselves.

There is, of course, the issue of whether we had committed an offence and it would appear that in a different location to that stated on the PCN we had accidentally taken the wrong route at a junction and moved into a bus-lane. Referring back to Figure 2 it is interesting just how much information is present in the street scene (e.g. bus lane signage, transport information signage, road markings, traffic lights/controls, conflicting cues of lamp posts and traffic light stalks, the apparent cognitive conflict of proceeding ahead to turn left when there is a left hand lane which was the old left traffic turn before the bus lane was implemented). Of course, none of these are excuses for using the bus lane inappropriately, but they do offer an insight into the complex nature of driving in a cluttered visual landscape. Although from a legal standpoint we were not guilty of an offence, we felt a moral obligation to pay a forfeit and gave the equivalent payment to a charity we support.

The moral of this episode is: do not contravene bus lanes as there is legislation in the UK governing other traffic's access to these restricted zones. However, if you are accused of an offence and it has been caught on CCTV, take time to make sure the data is accurate as there may be guidelines stipulating how data should be captured and reported. Recent legislation suggests that CCTV is not an ideal tool for evidence gathering in traffic violations. In particular, CCTV evidence is not permissible for Regulation 10 vehicle driven away PCNs (Montague 2010). Furthermore, in the London district of Enfield only 45-50 per cent of PCNs are paid; 50 per cent are challenged and most of these prove difficult to uphold due to lack of evidence (Montague 2010). This example also highlights the issues associated with the reliance on such technologies and the human-machine interface that fundamentally governs the enforcement of such legislation.

The role of human factors in CCTV surveillance

Over the last 20 years, CCTV surveillance systems have been increasingly deployed in towns and cities around the United Kingdom with an emphasis on crime control (Wood 1997; Armstrong and Norris 1999). As illustrated in the case-study, along with increased surveillance technology, street scenes have become more complex environments (from a visual, temporal and cognitive perspective) due to ever increasing levels of traffic, signage, technologies and regulations governing the use of specific areas at specific times. More recently the introduction of a daily 'congestion charge' within the inner London area has led to widespread use of surveillance technologies (especially CCTV and ANPR) to monitor the traffic. Along with this, there have been significant increases in road signage informing road users of this initiative. This degree of surveillance inevitably places demands on the human side of the HMI equation (especially for CCTV operators) but also the increasingly cluttered visual scene places further demands on road users.

Whilst little research has been conducted in this context on the impact of increased visual demands on drivers, investigation into the design and operation of CCTV control centres has revealed significant problems with how the systems are set-up, managed and used (Stedmon, Harris and Wilson 2011). Whilst the implementation of CCTV can be extremely expensive (£21bn between 1985 and 1999 in the UK), this does not guarantee its effectiveness and all CCTV systems rely to some extent on the competence of the human operator (Norris and Armstrong 1997). As a consequence, as with all technology, there is always a risk that too much attention is paid to perfecting the technical solution rather than studying how humans will interact with it (Stedmon, King and Wilson 2007). For example, cameras poorly positioned and

located inappropriately produce low quality images in the control room, which in turn lead to difficulties for operators in trying to identify an object or recognise a person (Keval and Sasse 2006). Similarly, when operators are typically expected to view a high number of monitors simultaneously, vigilance deteriorates as a function of the number of screens being attended to (Donald 1998).

These issues identify fundamental aspects of HMI where the user is overwhelmed by information or processes to the point where they cannot perform their usual tasks effectively (Wickens 1992). It also highlights issues of trust and transparency of automated systems and aspects of team-working between users and technology. The CCTV operator and surveillance system interact, forming a working team, and just as a conventional team of humans operate, modern automated systems are characterised by trust in the system, functionality of team members, communication within the team, and where authority should be invested in the team (Taylor and Selcon 1990). It is crucial that the operator remains 'in the control loop' and aware of the overall situation at all times (Weiner and Curry 1980). To achieve this, a certain degree of transparency must exist, which relates to the user's ability to understand what the automated processes are doing and 'see through' the system (Norman 1990). Thus, the lower the transparency, the more removed the user is from the information processing, which might have serious implications for their overall awareness of a situation. Situation awareness can be defined as the user's knowledge of both the internal and external states of the system, as well as the environment in which it is operating (Emerson, Reising and Britten-Austin 1987).

Given the case-study above, it is apparent that, at the moment of image interrogation, the CCTV camera operator (identified only as LH755) did not possess the relevant awareness of the situation to understand that the location was incorrect. Such an awareness of the situation may have been compromised by a lack of local knowledge affecting the user's own mental map of the surveillance area. Although this is may appear a trivial point, as surveillance technologies become ubiquitous, the potential to monitor locations from distant control centres (possibly even from control centres abroad), means that gaps in spatial knowledge and a lack of local knowledge could impact on many aspects of successful surveillance and public safety. The failure may also have been affected by the nature of the working environment as temporary or general task demands may have led to an error of judgement being made. The lack of relevant information in the recorded image points towards more of an organisational weakness in knowing and following correct procedures.

There is a wealth of guidance and recommendations on the design and set-up of control rooms, focusing on factors such as the number and arrangement of monitors to be viewed, operator viewing distance and image presentation (Donald 1998). However, many of these recommendations lack supporting empirical research and there is currently little evidence of their effectiveness in the 'real world' with operators performing a range of tasks using modern surveillance technologies (Heath, Luff and Svensson 2002). As the design of CCTV interfaces can affect how successfully the human-machine surveillance system operates, it is important that CCTV images are displayed in a structured and logical arrangement for the operator who is viewing them as this is likely to increase operational effectiveness, facilitate incident detection and improve general surveillance (Wallace and Diffley 1998). However, in reality, CCTV control rooms are sometimes an ad-hoc set up of monitors which have evolved over time (as new cameras have been installed) and where the experienced observer often builds their own strategies for monitoring them (Harris et al. 2008). The science of surveillance is a complex equation of human machine interaction and as well as gaps in knowledge, there are clear limitations to how technology can be harnessed to support the user.

Conclusion

How many of us question what we are shown via CCTV as being the truth of a situation? Can clear and easily identifiable images be wrong? And if they are, how can you argue against the power of the recorded

image from a legal standpoint? Can Human Factors help us improve surveillance for society? For the moment, the questions remain but hopefully in the future we will have a few more answers. Real world examples of surveillance gone wrong highlight the need for more fundamental research in this area to understand the technical complexity and error issues. Without more knowledge of the operational environment that CCTV operators work within, it is difficult to assess how the human-machine interface might fail, as it did in the case-study above. Such failures reinforce the need that checks should be made regarding the integrity of the data before PCNs are issued. When errors occur and they are identified, it highlights issues of poor system design and reliability, frustrating the legal process as well as undermining the public's trust in such technologies for the greater good of surveillance and society.

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