WHITE PAPER

# Vehicle Detection Sensors: Accuracy & Testing

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## Executive Summary

While vehicle detection sensors can be a great asset to a City's parking program, the fear of installing less-than-perfect sensors can be paralyzing. This white paper is intended to provide a historical overview of past and present testing techniques, dispel myths regarding accuracy percentages, and provide a baseline of knowledge to help City officials determine a course of action.

### Key Challenges

1. Historically, accuracy testing methods have relied on two methods: 1) video capture, which requires months of data analysis, and 2) human observation, which can lead to unreliable data.
2. In the past, the market did not present a technologically-advanced method of testing sensor reliability. For that reason, many vehicle detection sensors on the market are minimally tested, but highly rated.
3. As a result, purchasing sensors to serve your City's needs can be a daunting process. There can be a domino effect of consequences if a city installs a sensor that is accurate less than 90% of the time. Many city officials have chosen not to maximize their current infrastructure by avoiding sensors entirely. As a result, cities that choose to install sensors require strong policy to govern the stance on dealing with sensor data.

### Recommendations

1. Do your homework. It's important to understand what accuracy testing commonly entails and what an ideal test situation looks like.
2. Understand the accuracy percentage and how aggressive testing might impact the sensor's capabilities. While many companies claim a vehicle detection sensor that is 99% accurate, that percentage may have been generated in the laboratory as opposed to real world scenarios. As a result, a sensor that is not tested aggressively may not react appropriately in new environments and situations.
3. Investigate your options. Rather than trusting percentages and jargon, ask your current parking provider to describe how their sensors are tested. This will either help ease your concerns, or motivate you to adjust your path.

## Sensor Applications

The Internet of Things (IoT) is transforming the technology landscape. Sensor technology is a key component, increasing the capabilities of smart devices in every field. In Smart Parking, sensors reliably detect the presence or absence of a vehicle in a parking space, which provides parking professionals with the ability to:

- Access real-time and historical occupancy data
- Reset the meter to zero time when a vehicle leaves a parking space
- Prevent meter feeding, thereby promoting space turnover

 

- Offer courtesy time, resulting in positive public perception of the meters
- Enable demand-based and progressive rate structures

These features can drive parking policy and maximize the parking asset, contributing to an intelligent parking system. However, with sensor data influencing a City's enforcement, alongside the high visibility of parking programs, the need for accuracy is critical.

**Key Definitions**

**Algorithm**: the step-by-step set of instructions that determine the sensor's behavior.

**Parking Event**: an occurrence at a parking meter.

**Accuracy Testing**: the process of analyzing sensor events and solving issues.

**Event Capture**: the process of capturing and documenting each parking event.

**Accuracy Percentage**: A percentage developed to gauge a sensor's accuracy.

## A Sensor's Algorithm

Vehicle detection sensors most commonly utilize magnetic or radar-based techniques to sense movement and objects. When installed on a city street, as opposed to remaining in a closed and controlled environment, the variables increase. On-street parking is far more complex than off-street because there is more activity to influence the sensor. Consider the life of a parking space. Within the course of an hour, multiple objects may pass through, including trucks, motorcycles, smart cars, bicycles, and even people. A car may drive through the space on route to an adjacent parking space. An individual may even park in such a way that two parking spaces are impacted. These are all considered "events." Which events should the vehicle detection sensor be registering? Ideally, only the events in which a car parks and leaves. However, with so many different events on the city street, how does the sensor know which events to log and which events to ignore?

The answer is easy to understand, but difficult to implement. Simply, the sensor needs to be "intelligent" enough to understand the difference. This can only be accomplished by programming the sensor's algorithm, the step-by-step set of instructions that dictate the sensor's behavior. To refine that algorithm, the sensor is exposed to hundreds of events and tested to ensure a proper response. The process of analyzing events and solving sensor issues is called accuracy testing. This process essentially tests a sensor's algorithm to find out if, when in a certain situation, it reacts in the desired way.

## Accuracy Testing

While accuracy testing helps develop the sensor's algorithm, it also helps determine the value of the product. In order to test the sensor's data (whether or not it is logging the events correctly), the test environment must include a second, infallibly-accurate set of data to compare against. The number one method of generating accurate data is through event capture, the process of capturing and documenting each parking event, either through human observation or time-stamped video.

## Historic Measurement Techniques

Until now, event capture was performed though two techniques: observation and video capture.

### Observation

In this method, a human observes the same parking space being monitored by a sensor. The observer then logs all the parking events and compares that data against the sensor's data set.

### Video Capture

In this method, a video camera films the same parking space being monitored by a sensor. A human observer then watches the time-stamped video, logs

 

the events, and compares the data against the sensor's data set. Because this method requires human observation of hundreds to thousands of events, it often takes several months to generate data and analyze sensor performance.

The number of times the two sets of data match up, compared against the total number of events, provides a percentage to gauge that sensor's accuracy, also called an accuracy percentage.

## Why Traditional Event Capture Fails

While both observation and video capture techniques provide data to compare against overall sensor performance, both include shortcomings that have contributed to the inaccuracy of traditional sensors.

Because the observation technique relies solely on human observation, it is inherently unreliable. When relying on the human eye alone, the test environment allows human error to guide important data. Likewise, the video capture method relies on the human eye to process large sets of data. This method similarly allows human error to corrupt the critical test environment. Additionally, because both methods require a human to observe either the parking space or the time-stamped video, both procedures are incredibly time consuming, requiring months to complete one test. With such a time-consuming test environment, it would take years to accumulate the quantity of data needed to perform thorough accuracy and algorithm testing.

Currently, IPS has analyzed terabytes of data equivalent to over one billion sensor events—more data than a digital Library of Congress—to refine sensor technology.

## A New Generation of Vehicle Detection Sensor

While traditional, observation-based testing techniques are wrought with issues, the parking industry's recent innovations are heralding the age of a new vehicle detection sensor, based on breakthrough accuracy/algorithm testing techniques. These software-based techniques eliminate the human component, control variables through data-driven approaches, and automate data-generation.

## Breakthrough Testing

IPS Group, a leading R&D company in Smart City technology and Smart Parking, has developed a breakthrough form of sensor accuracy testing that will transform the way sensor technology is evaluated within the industry.

1. In a test environment, cameras are set up to monitor metered parking spaces.
2. Using time-lapse imagery and video analysis, newly-developed software captures images over several days.
3. Proprietary video analysis software run on a powerful computer creates a data output detailing vehicle activity. With this software-based approach, the data output can be created in a matter of minutes.
4. Time-lapse data is then compared with IPS Group's vehicle detection sensor data from the IPS Data Management System.
5. Through computational analysis, the sensor's algorithm is refined and the sensor is "taught" to handle new events.

IPS Group's breakthrough video analysis provides the most efficient method of analyzing large quantities of data in the industry, while adding the ability

 

"IPS Group's breakthrough video analysis provides the most efficient method of analyzing data in the industry, while adding the ability to hone accuracy through real data. Through computational analysis, IPS Group has developed the most accurate sensor on the market."

to hone accuracy through real data. Currently, IPS has analyzed terabytes of data equivalent to over one billion sensor events—more data than a digital Library of Congress—to refine sensor technology. Because the human observer has been eliminated from the test environment and replaced by a software-based approach, the sensor's algorithm now registers events within the second that they occur.

### Accuracy Percentages and Parking Variables

On average, most parking variables are due to inconsistencies in the ways that people park. By running as many simulation exercises as possible and modifying the sensor's algorithm, IPS Group has overcome most variables encountered on the street. While the Sensors provide accurate data no sensor system can be 100% accurate because of many variable conditions such as inaccurate parking, line of sight interference, weather conditions, human intervention and many other factors not associated with the Sensor operation.

Through computational analysis, IPS Group has refined the algorithm in the decision-making part of the sensor and has developed the most accurate dome sensor on the market. Additionally, IPS Group is utilizing its breakthrough technology to actively improve sensor technology—continuing to exceed industry standards—and to generate image-based evidence that demonstrates accuracy with ***real data.***

## IPS Group: the Leader in Smart City Innovation

IPS, Group is a design, engineering, and manufacturing company focused on low-power wireless telecommunications, payment processing systems, and parking technologies and has been delivering Smart City technology solutions for over 20 years. The company offers a fully integrated smart product suite comprised of single-space meters, multi-space pay stations, pay station upgrade kits, vehicle detection sensors, smart cash collection systems, and SaaS management software with advanced data analytics. IPS is delivering the Internet of Things (IoT) and Intelligent Parking Systems to transportation and parking operations all over the world.

Through dome-mount, pole-mount, and in-ground vehicle detection sensors, IPS Group is helping cities maximize their most important resources. The IPS sensor uniquely directs all sensor events to the IPS parking meter cellular communications backbone, saving customers the hassle of installing additional network equipment and dramatically reducing the cost of ownership. All sensor data integrates with the IPS Data Management System (DMS), creating a powerful system for monitoring real-time occupancy, managing parking compliance, measuring the elasticity of pricing structures, and analyzing parking trends over time.

For a free Smart Parking assessment to learn how adding sensors can affect your bottom line, visit ipsgroup.com/SensorAccuracy.

 