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A Closer Look at Camera and Sensor-Based Parking Systems

SUMMARY

An increasing number of municipalities, campuses, and private businesses have started turning to data-powered smart parking management systems to monitor and optimize their parking, and particularly their on-street and lot-based spaces. The data collected by smart parking solutions can include total number of spaces, occupancy, turnover rates, and dwell time, peak parking hours by various times and more. While this data is paramount to supporting any programs or planning, it is imperative to have accurate, 24/7 data, which should be at the forefront of any technology or solution decision. Accurate data enables better analysis and allows for strategic planning which can lead to less traffic, lower greenhouse gas emissions, improved quality of life for residents and visitors, and optimized operations for local economies.

When assessing the market for parking management systems, it can be difficult to pinpoint the fundamental differences between the systems and the effect these differences can have on overall operations. This paper looks at sensor-based and camera-based systems and evaluates them regarding five essential criteria: accuracy, cost, maintenance, privacy, and installation and infrastructure.

Five essential criteria to consider when choosing a smart parking system:

1) Accuracy
2) Cost
3) Maintenance
4) Privacy
5) Installation and infrastructure

ACCURACY

Since data collection is at the heart of any smart parking system, the accuracy of the data and method of collection is of utmost importance. Data accuracy is directly affected by how that data is collected: without a reliable data collection method, any data that is collected cannot be considered accurate or complete.

Cameras

The overall accuracy of a video-operated parking system is directly dependant on a direct line of site between the camera and parking stalls. Anything that can obstruct the view of the parking spaces, such as weather, trees, vehicles, bike racks, travel hitches, and dirty lenses, will impair or even block the ability to detect the state of a parking space. A 2022 study conducted in Bellevue, Washington, in which 5 different camera-based smart parking system vendors participated, concluded camera accuracy to range between a low of 6% and a high of 88% -- well below the city's goal of 95% accuracy.[i] The study also specifically mentioned the impact of weather on data collection, citing "sun reflection" as a barrier. The implications of the Bellevue study are clear: accurate data is difficult to attain with camera-based parking systems.

Sensors

For sensor-based parking systems (surface mount, inground, and below ground sensors), barriers to accurate data collection can include extreme weather and interference. However, there now exist sensors on the market that boast 99.7% accuracy along with the ability to withstand the harshest weather conditions. In addition, metal-induced interference is much less of an issue for on-street parking spaces and a sensor like eleven-x's SPS-X can filter out negative influencers such as electromagnetic interference and other factors for the most reliable and accurate stall monitoring. Surmounting these challenges allows sensor-based parking solutions to provide more accurate and complete data, without weather or other obstacles interfering. Additionally, stalls that are clearly delineated through line painting allow for more accurate data collection since cars will park over the sensor.

COST

When it comes to the costs associated with smart parking systems, there are costs that are paid up front for system installation and setup, and costs that are required on an as-needed basis for maintenance. For that reason, cost and maintenance are directly linked, as many of the potential costs of a smart parking system are directly tied to the need for maintenance.

Cameras

Initial costs are only part of the picture in terms of total costs for camera-based systems as there are many hidden costs included in installation and maintenance. For example, the initial setup cost for a camera-based system varies from location to location and depends on a range of variables including street layout, obstructions, and the level of camera accuracy required. On top of this, cameras require a fair amount of upkeep and maintenance to keep them running smoothly, which will be covered in a later section. As a result, it's important to keep in mind that setup costs are only the tip of the iceberg for camera-based systems and unavoidable additional costs can be expected to increase after installation. To add to this, although it may appear that camera-based systems are more cost-effective than sensor-based systems, due to their ability to monitor more than one parking space at a time, the installation and maintenance fees associated with these systems overwhelmingly outweigh those of their sensor-based counterparts.

Sensors

The up-front costs for installing a sensor-based parking system include in-ground sensor installation (units are priced per parking stall) and LoRaWAN gateway setup. In this case, sensors are priced per unit and costs do not vary depending on where they are being installed. A sensor like the SPS-X boasts a 10-year battery life which includes almost zero maintenance with some over-the-air software updates. This means that with a sensor-based solution, what you see pricewise is what you get: there are no hidden maintenance fees to be concerned about.

Surface Mount

Sub-Surface with no profile above ground

MAINTENANCE

Depending on the smart parking system, maintenance and upkeep can either be frequently necessary or nonexistent – no matter where the parking spaces are located.

Cameras

Once a camera-based parking system is set up, there is a fair amount of regular maintenance that needs to take place to keep everything running smoothly and camera sightlines clear. For outdoor parking specifically, this includes removing tree branches, clearing snow, and lenses being cleaned due to weather conditions and other debris. For both indoor and outdoor parking maintenance may be required when cameras themselves are vandalized or wires are cut, conduit gets crushed, or camera batteries expire. Outdoor systems that use solar-powered cameras face their own range of issues with maintenance and reliability. All of this means that maintenance fees can add up quickly, and they

aren't included in any system set up costs. This can make it difficult to predict or precisely budget for a camera-based parking system.

Sensors

A sensor-based parking management system requires little to no maintenance once installation – which takes around 5 minutes for each sensor – has been completed. This is due to both the strength of the product as well as the fact that it relies on fewer physical components (only the sensors themselves and the gateways installed to collect data and connect to servers), and therefore offers a lower chance for failure. In the case of eXactpark, the system's SPS-X sensors can stay functional in-ground for up to 10 years without needing servicing.

PRIVACY

In the modern climate, there are many public concerns about the way personal data is collected and used. This makes privacy an extremely important factor to consider when selecting a smart parking system.

Cameras

Although cameras used for parking management can potentially have the added value of providing some basic security-related functions wherever they are installed, they also raise many privacy concerns. On top of the fact that camera feeds can be hacked by unauthorized parties, drivers may be wary of personal information being collected from them – such as their license plate number – when they are simply parking their cars. For cities, this can particularly be an issue, as drivers may raise concerns over how this data will be used or why it is being collected. In addition, drivers may demand to see the video feed as evidence in the case of traffic accidents, which may become administratively challenging.

Sensors

Sensor-based parking systems do not collect any identifying information about drivers or their cars. Instead, data is focused on the stalls themselves, tracking when and how they are being used. This allows for high level analysis and strategic planning for any parking-related decisionmakers, without compromising privacy concerns. In a world where ubiquitous video monitoring and data privacy are major concerns, the privacy inherent in sensors' data collection can lead to an increase in public trust. The impact of COVID-19 has brought about the start of a new approach when it comes to building monitoring and management. Inconsistent data via singular-focussed technologies simply is not enough to ensure occupant safety and the best experience. Building monitoring now requires real-time capabilities to not only provide peace of mind for the occupants to ensure tenant retention, but to also improve efficiencies and manage indoor spaces in a better way overall.

INSTALLATION & INFRASTRUCTURE

Perhaps the biggest differences between camera- and sensor-based parking systems lie in their installation and communication infrastructure. These differences, in turn, have a major effect on the systems' reliability and overall efficacy.

Cameras

Camera-based parking systems connect to existing electrical power sources through wires and depend on a reliable internet connection to record and store video. Solar options are available; however, this adds another element to maintain, and it will impact the system reliability. Depending on where they are being installed, the setup process can be complicated, time-consuming, and expensive – particularly when infrastructure such as lamp posts are involved. Although installing fewer cameras may appear as a way to circumvent a more complex and costly installation, this could lead to lower accuracy and, therefore, less useful data. Data can be even further compromised if the cameras are running on a cellular connection and the nearby area is oversaturated with many people using the same network. In this situation, connectivity issues abound and can lead to high system unpredictability. Additionally, many camera-based systems rely on university or municipal networks, and the bandwidth required for the cameras can drastically impact already heavily taxed networks.

Sensors

Parking sensors are installed below the asphalt surface with minimal disruption of the surrounding area. There are no wires attached to the sensors and models such as the SPS-X have a 10-year battery life. Sensor-based parking solutions like eXactpark™ utilize LoRaWAN gateways to transmit the data collected by the sensor to the operator's servers. LoRaWAN is a low-power, energy-efficient platform, and this, combined with zero wiring, means that sensor-based parking systems consume less energy overall than their camera-based counterparts. In addition, eXactpark's LoRaWAN network is dedicated solely for this specific use. So, unlike a cellular-connected camera system, the system won't see diminished speeds that fluctuate depending on the number of people in the area.

How eleven-x's fully embedded SPS-X sensor appears when installed

SUMMARY

Smart parking systems utilize data to provide municipalities, campuses, and private businesses with the tools to optimize their current parking assets and strategically plan for future initiatives. Without a reliable, accurate method of collecting this data, the smart parking system fails to deliver on what it promises. Our analysis shows that sensor-based parking solutions are invariably more reliable and accurate than their camera-based counterparts. In addition, they present a much more cost-effective solution without the headache of frequent maintenance or intrusion into drivers' privacy. Altogether, this makes choosing a sensor-based smart parking system an intelligent, future-conscious decision.

To learn more about eXactpark™, eleven-x's award-winning sensor-based smart parking system, visit us at www.eleven-x.com.

[i] "Curbside Technology Performance Assessment Report - City of Bellevue." City of Bellevue, Washington, 7 Feb. 2022, bellevuewa.gov/sites/default/files/media/pdf_document/2022/curbside-management-pilot-assessment-report-020722_2.pdf.

About eleven-x Inc.

eleven-x is an industry leading IoT and Smart City technology company specializing in accurate, real-time stall occupancy monitoring. Its award-winning, smart parking technology solution, eXactpark™, is comprised of the patented, wireless SPS-X space occupancy sensor and a comprehensive software platform that provides real-time stall data. eXactpark reduces traffic, improves safety and lowers GHG emissions by helping drivers quickly and easily find parking. The solution is being utilized by cities and institutions across North America to successfully address mobility challenges. eXactpark's accurate and reliable 24/7 data enables numerous use cases including curbside management, demand-based pricing, and compliance, helping optimize parking resources. Customers rely on the company's world-renowned expertise for an easy-to-use, fully scalable smart solution to deliver better services.

Visit eleven-x.com for more information.