CONTROLLING USE OF A SINGLE MULTI-VEHICLE PARKING SPACE USING MULTIPLE CAMERAS

FIELD OF THE INVENTION

[0001] This invention relates to the use of cameras to identify vehicles and track and control the use of parking spaces by the vehicles.

BACKGROUND

[0002] Various municipal and private parking operators have extensive legacy parking management systems for managing the use of, and obtaining revenue for the user of, destination locations for vehicles, such as parking spaces for wheeled motor vehicles. The substantial rework and expense that traditionally has been required to upgrade such legacy systems to full automation poses a substantial up-front capital investment that prevents many parking operators from performing such upgrades.

[0003] What is needed is a fully automated and autonomous parking management system which easily integrates with existing parking payment systems, including systems that have already been installed and operational for some time. Doing so unlocks new revenue opportunities and efficiencies for the parking facility operators that are previously untapped.

SUMMARY

[0003a] According to an aspect of the present invention, there is provided a method of tracking use of a single multi-vehicle destination location and at least one restricted location within the single multi-vehicle destination location, the method comprising: receiving a plurality of vehicle images captured by a plurality of cameras, wherein: the plurality of cameras include a first identification camera having a first field of view, the plurality of cameras include a first destination camera having a second field of view, the second field of viewing being different from the first field of view and partially overlapping with the first field of view, the plurality of cameras include a second destination camera having a third field of view, the second destination camera being different from the first destination camera, the third field of viewing being different from the first and second fields of view, and the third field of view including a single multi-vehicle destination location and at least one restricted location within the single multi-vehicle destination location, and the plurality of vehicle images include: a first identification image captured by the first identification camera at a first time showing the first vehicle at a first location, a first destination image captured by the first destination camera at a second time showing the first vehicle at a second location, the second time being after the first time, the second location being different from the first location, a second destination image captured by the second destination camera at a third time

showing the first vehicle at a third location, the third time being after the second time, and the third location being outside of the single multi-vehicle destination location, a third destination image captured by the second destination camera at a fourth time showing the first vehicle at a fourth location, the fourth time being after the third time, and the fourth location being within the single multi-vehicle destination location, a fourth destination image captured by the second destination camera at a fifth time showing the first vehicle at a fifth location, the fifth time being after the fourth time, the fifth location being outside of the single multi-vehicle destination location, and the fifth location being different from the third location, a second identification image captured by the first identification camera at a sixth time showing a second vehicle at a sixth location, a fifth destination image captured by the second destination camera at a seventh time showing the second vehicle at a seventh location, the seventh time being after the sixth time, and the seventh location being outside of the at least one restricted location within the single multi-vehicle destination location, and a sixth destination image captured by the second destination camera at an eighth time showing the second vehicle at an eighth location, the eighth time being after the seventh time, and the eighth location being within the at least one restricted location within the single multi-vehicle destination location; determining a first unique identifier and a first characteristic of the first vehicle based on the first identification image; determining a second characteristic of the first vehicle based on the first destination image; determining that the first vehicle is present in the second field of view based on a comparison of the second characteristic of the first vehicle to the first characteristic of the first vehicle; determining a third characteristic of the first vehicle based on the second destination image; determining that the first vehicle is present in the third field of view based on a comparison of the third characteristic of the first vehicle to the second characteristic of the first vehicle; determining that the first vehicle is stopped within the single multi-vehicle destination location based on the third destination image; determining that the first vehicle has left the single multi-vehicle destination location based on the fourth destination image; indicating that the first vehicle began use of the single multi-vehicle destination location at the fourth time; indicating that the first vehicle completed use of the single multi-vehicle destination location at the fifth time; indicating the first unique identifier of the first vehicle; determining a second unique identifier and a first characteristic of the second vehicle based on the second identification image; determining a second characteristic of the second vehicle based on the fifth destination image; determining that the second vehicle is present in the third field of view based on a comparison of the second characteristic of the second vehicle to the first characteristic of the second vehicle;

determining a third characteristic of the second vehicle based on the sixth destination image; determining that the second vehicle is present in the third field of view based on a comparison of the third characteristic of the second vehicle to the second characteristic of the second vehicle; determining that the second vehicle is stopped in the at least one restricted location within the single multi-vehicle destination location based on the sixth destination image; indicating the second unique identifier of the second vehicle; and indicating that the second vehicle is stopped in the at least one restricted location within the single multi-vehicle destination location, wherein the steps of receiving, determining, and indicating are performed by one or more processors.

[0004] In an embodiment, there is a method of tracking the use of at least one destination location, the method comprising: receiving a plurality of vehicle images captured by a plurality of cameras, wherein each vehicle image includes an image of a first vehicle, the plurality of cameras includes a first identification camera, the plurality of cameras includes a destination camera, the vehicle images include one or more first identification images captured by the first identification camera, a plurality of destination images captured by the destination camera including a first destination image captured at a first time, a second destination image captured at a second time after the first time, and a third destination image captured at a third time after the second time; determining a first unique identifier for the first vehicle based on the first identification images; determining a first plurality of characteristics for the first vehicle based on the first identification images; determining a second plurality of characteristics for a vehicle based on one or more of the destination images; determining that the second plurality of characteristics correspond to the first plurality of characteristics; determining that an image of the first vehicle is included in the plurality of destination images based on the determining that the second plurality of characteristics correspond to the first plurality of characteristics; determining the first vehicle is stopped at a first destination location based on the first destination image and the second destination image; determining