The method for providing of parking location guidance service in a smart parking lot

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***Abstract*— We proposed a parking location guidance service method using deep learning model in a smart parking lot. License plate image detection and character recognition are required to guide the parking location, and both of these steps use machine learning methods. In particular, the edge system and the server are mounted with a learning model so as not to generate a lot of traffic by transmitting all vehicle images to the server, and the edge system cut only the license plate image using the vehicle license plate detection learning model and transmits it to the server. In the server mounted with the recognition learning model, only license plate images are collected to recognize license plate characters. Rather than performing both license plate image detection and license plate character recognition in the server, it will be much more efficient to cut the license plate image in the edge system and transmit only image information necessary for character recognition to the server as it can reduce the traffic load.**

Keywords*— *License plate(LP) Recognition, Deep learning model, Smart parking lot

I. INTRODUCTION

Recently, there is a trend of increasing smart parking lot technology that adds user convenience such as automatic electronic bill settlement and parking induction in parking lots. Currently, the services provided by the smart parking lot include a parking status notification and guidance service indicating the available parking space and the number of available parking spaces, a parking fee charging service that automatically calculates the parking fee by recording the entry/exit time of a customer vehicle, and an entry/exit vehicle recognition service and parking location information service.

The first thing customers who use parking lots are curious about the number of available parking spaces when entering, and this can be solved with a notification board on the number of available parking lots.

The second question of customers is about the location of their car parking, and many parking lots recently provide parking location guidance services to customers. Parking location guidance service requires license plate recognition (LPR) technology.

The vehicle license plate recognition technology has been developed for a long time, but there is still a high need for improvement in terms of performance.

In particular, in the method of providing all of the image information to the server for license plate recognition, since the traffic load to the server may be concentrated, another method to solve this problem must be prepared.

Usually, an ultrasonic sensor indicating parking induction, an LED, an IoT camera, and an entrance vehicle recognizer are installed in parking lots. The ultrasonic sensor and LED are connected to the controller, and the controller and IoT camera transmit sensor data to the server through the gateway.

The gateway uses the ultrasonic sensor data to take a picture of the location when the car is parked by the IoT camera. The IoT camera transmits the captured photos to the server through the gateway.

In this paper, in order not to concentrate the traffic load on the existing server, the learning model of the vehicle license plate image detection stage is lightened and mounted on the edge system in the actual smart parking lot, so that only the detected license plate image is transmitted to the server, not the entire vehicle image.

II. LICENSE PLATE RECOGNITION

In order to provide a parking location guidance service, it is necessary to know the area in which the customer parked. In the past, the motion of an ultrasonic sensor that guides parking is detected to determine whether or not to park, and the camera takes a picture of the surrounding area and transmits it to the server. The image transmitted to the server detects the license plate recognition of the vehicle by the license plate detector, stores this information in the DB, and uses it for the parking location guidance service.

Recently, automobile recognition technology is the technology most actively researched and utilized in the field of machine learning-based image recognition.

Parking location guidance service requires license plate recognition (LPR) technology. LPR technology consists of three steps(Fig 1): car detection, license plate detection, and character recognition. Commercially detecting the car may use an ultrasonic sensor, a loop sensor, or the like, but recently, detection is also performed through image recognition.

Similar to this method for license plate recognition, this paper is divided into license plate detection and recognition steps.

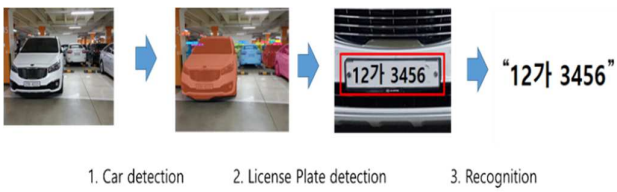

Fig. 1. Three steps of License Plate Recognition

Yolact[1] proposes a method of separating an object by dividing the instance segmentation into the entire image and each instance and performing it in parallel, which can be used for parking vehicle recognition. WPOD-NET[2] is a method available for license plate detection.

III. HIERARCHICAL STRUCTURE FOR PARKING LOCATION GUIDANCE SERVICE

In this paper, we proposed a hierarchical structure for providing parking location guidance service based on machine learning model. Fig 2 shows the concept of a smart parking system using machine learning in a smart parking lot.

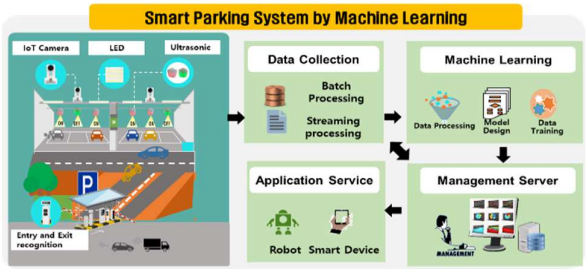

Fig. 2. Smart Parking System Technology

Smart parking system includes IoT camera, LED, Ultrasonic sensor, Entry and Exit recognition device, etc. These are connected to the server using internet or Wi-Fi.

The server collects data from connected devices and performs data preprocessing, model design, and data training using machine learning models. Using this result, the management server provides a service to the customer's smart device.

A. *Configuration of smart parking system based ML*

In this system, there are several IoT cameras in the parking lot, several cameras are connected to the gateway and edge system. Several edge systems are connected to the server. In addition, ultrasonic sensors are connected to the gateway.

Fig 3 shows the configuration of a smart parking system.

we propose the use of a machine learning method for vehicle & license plate detection at edge system. Also Deep Learning model for license plate character recognition performs in the server for providing parking location guidance service.

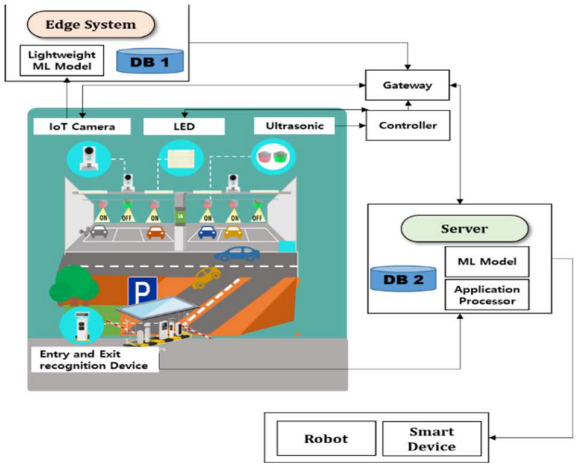

Fig. 3. Configuration of Smart Parking System by Machine Learning

In particular, not all of the servers are provided as machine learning (including deep learning) models, but vehicle recognition/license plate detection is processed using a lightweight learning model in the edge system, and only license plate character recognition is processed using the learning model in the server.

Fig 4 shows the flow of parking location guidance service.

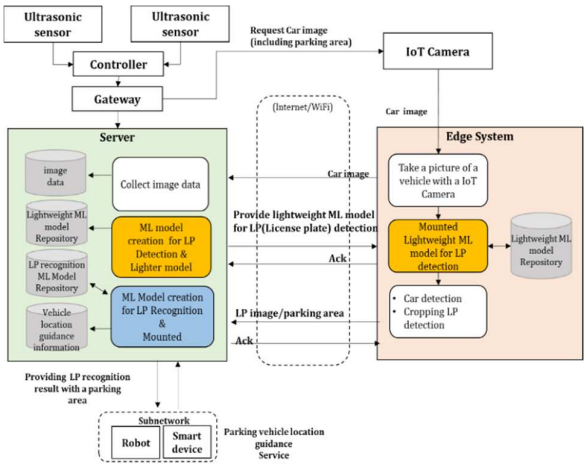

Fig. 4. The flow of the parking location guidance serivce

The ultrasonic sensors are connected to the controller, and the controller is connected to the gateway to transmit parking availability information to the server. The gateway monitors the ultrasonic sensor data and requests a photo from the IoT camera when parked. And the IoT camera transmits the taken photos to the server through the edge system. Photographs are taken using ultrasonic sensor data, and these photos are collected and used to create a machine learning model. When the machine learning model makes it possible to determine whether or not to park, the ultrasonic sensor will only be used as a parking guidance indication to parking lot customers.

Various lightweight machine learning models can be mounted on the edge system according to service provision. For example, a parking recognition model and a license plate detection model.

If the edge system can determine whether or not the car is parked, the edge system can independently determine and take a picture without receiving a parking signal from an ultrasonic sensor. In addition, instead of transmitting the entire image of the recognized vehicle to the server, this method can reduce the traffic load to the server because only necessary license plate images are detected and transmitted to the server

B. *License plate detection*

The edge system detects a parked car and the parking plate of the car using a lightweight learning model. The lightweight learning model is generated by the server and transmitted to the edge system. To do this, it is first necessary to create a lightweight learning model. Fig 5 shows the process of creating a lightweight license plate detection model.

The ultrasonic sensor sends an sensor data to the edge system whether the vehicle is parked or not. The edge system requests a picture with an IoT camera. The photographed picture is transmitted to the server through the edge system.

Using the collected image data, the server detects a parked car and creates a learning model that detects a parking plate. After saving the generated learning model, a lightweight learning model is created through a lightweight engine. The generated lightweight learning model is transmitted to the edge system.

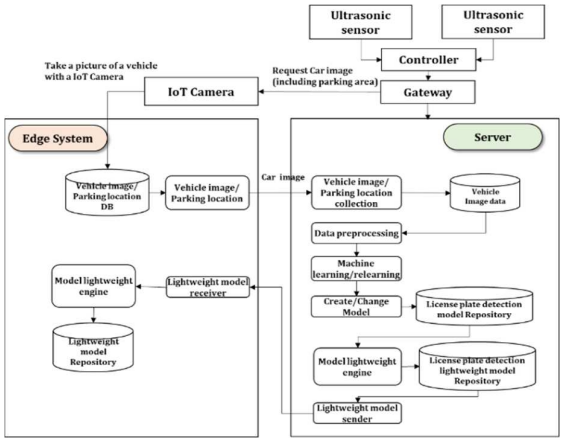

Fig. 5. The Process of LP detection Lightweight model creation

When the parking plate detection learning model is stored in the edge system in this way, the edge system can know whether the car is parked from the image collected from the IoT camera, so it no longer needs to rely on the ultrasonic sensor data. And the parking plate detection independently is possible. When the edge system automatically detects the parking presence or absence of a car using an IoT camera, the role of the ultrasonic sensor in the future will only serve to inform the parking presence or absence to the parking customer. In addition, not all parking images are transmitted to the server, but only the license plate images of parked vehicles are transmitted to the server, thereby reducing the traffic load.

C. License plate recognition

The image recognition-based machine learning (deep learning) model is used to find the parking location by recognizing the parking license plate instead of parking recognition device.

For license plate recognition, a learning model for license plate recognition is first required. Fig 6 shows the learning model creation process. The server receives the detected parking plate image from the edge system. The server generates and stores a parking plate recognition model through data preprocessing and model learning using images.

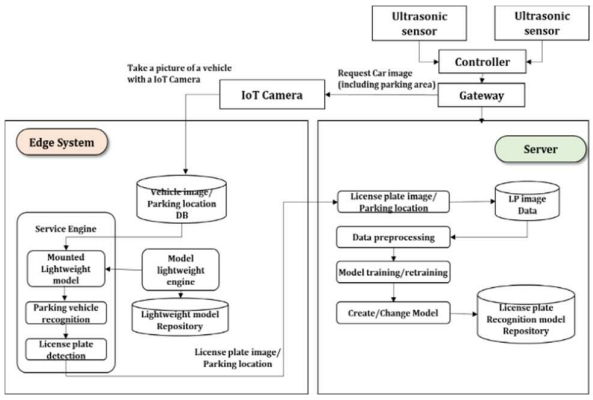

Fig. 6. The process of LP recognition model creation

D. Parking location guidance service

The learning model engine of the server mounts the generated license plate recognition model, and recognizes the vehicle number parked in the corresponding parking area.

Fig 7 shows the process of recognizing the vehicle number for providing the parking location guidance service.

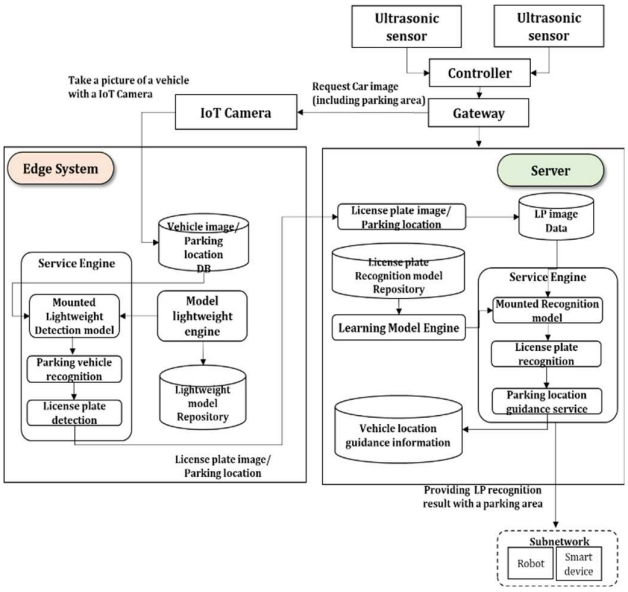

Fig. 7. The process of providing for parking location guidance service

Parked vehicle's LP number and parking area information are stored in DB. If the vehicle's LP number and smart device number are registered as customer information in the DB, the service can be provided to the customer's smart device or guide robot by using the information. In addition, it will be possible to provide services through a guide robot connected to the server.

IV. CONCLUSION

We proposed a method of providing parking license plate detection learning model and recognition learning model for parking location guidance service. In particular, the two learning models were not run on the server, but separated, and a lightweight license plate detection learning model was used in the edge system, and the license plate recognition learning model was provided in the server. This method can recognize a parked vehicle regardless of the ultrasonic sensor and reduce data traffic to the server.

Future research will need to study learning models that can have high accuracy for vehicle LP recognition. It is also possible to provide new services such as parking recommendation services by finding out customer parking preferences using the preceding parking location information of a customer. If the parking space is recommended at the parking lot entrance and the parking space is notified to the customer in advance, the customer's satisfaction will also increase.

ACKNOWLEDGMENT

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