To build the Ecosystem of AIoT Edge

Software

Technologies Whitepaper

ELITEUN

Contents

Technologies

Optical Character Recognition

Eliteun applied Optical Character Recognition (OCR) mainly in license plate recognition and analog & digital hybrid meter reading system. The team self-developed a strong platform and multiple sub-algorithms to optimize recognition accuracy and efficiency of Eliteun systems, enabling them to support different license format and different meters with an accuracy of 99%.

OCR refers to both technology and the process of reading and converting text, characters into machine-encoded text or something that the computer can process.

The entire recognition process includes a serious of extensive algorithms, but it starts with a very important task – preprocess. Preprocess refers to the process of improving image data that suppresses unwanted features while enhancing target features for further recognition. It contains steps such as image rotation, grayscale, noise reduction, binarization, character detection, segmentation and normalization. If the shooting angle of an image is crooked, it needs to be rotated first. Its background colors and target information colors are processed in the step of grayscale. Any irrelevant parts such as speckles and lines are eliminated by filters and image regularizer in deep learning. This step is called noise reduction and has a direct impact on feature extraction. Then target characters are separated from background in binarization and segmented by character. All images of a single character are normalized on size and contrast, which makes it easier to apply unified algorithms for feature recognition.

In order to be extracted, the feature must be defined for classifiers to learn. Classifiers need to be trained over the time to be accurate. Thus the applications of OCR are different for different targets.

Grayscale | Binarization | Noise reduction | Segmentation | Feature Recognition

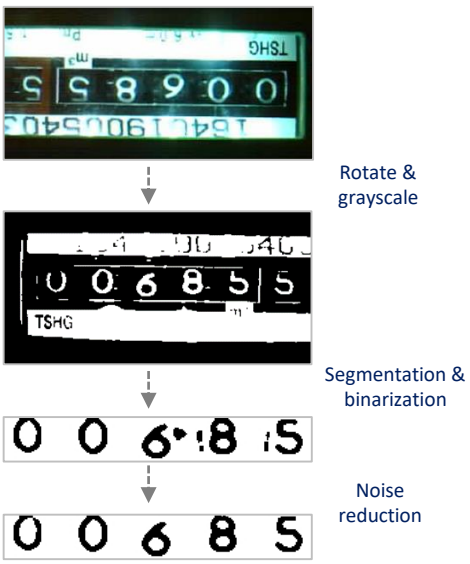
Computer Vision Algorithm for Pointer & Digits Meter

Eliteun team developed a series of algorithms for recognizing the readings of analog meters and digits meters. Embedded in Eliteun smart meter reading module is a low power industrial mini camera which takes photos of the dial plate. The photo is preprocessed first, such as resize, rotation, noise reduction, etc. Then Long Short-Term Memory (LSTM) derived from Recurrent Neural Network (RNN) and other computer vision algorithms are applied to extract information. For pointer meters, the angle represented by the pointer is recognized and calculated to produce the reading.

Original Preprocessed Angle calculation

Image preprocessing is completed mainly via OpenCV. It is a computer vision library that can run on different operation systems such as Linux, Windows, Android and Mac OS. OpenCV is lightweight and quite efficient as its optimized C coding helps to accelerate its operation speed. It supports interfaces for Python, Ruby, MATLAB and other languages, also provides various universal algorithms for image processing and computer vision. Its performance exceeds other major vision libraries, especially in image resize, optical flow and neural nets.

LSTM is an improvement based on RNN, which eliminates the classification issues caused by gradient disappearance in RNN. The design and structure of LSTM is fit for processing events with longer intervals and latency in time series, which helps to yield better accuracy and efficiency than RNN.



The excellent performance and efficiency of OpenCV enables smooth preprocess and excellent quality. The advantages of LSTM are fully leveraged in the scenario of meter reading. Thus Eliteun Hybrid Meter Reading System (HMRS) is powerful, fast and flexibly applicable in reading different meters such as pointer meters or digits meters; and in different industries such as water, electricity or gas; and in different scenarios such as metropolitan centralized meters, or distributed meters in remote areas.

License Plate Recognition

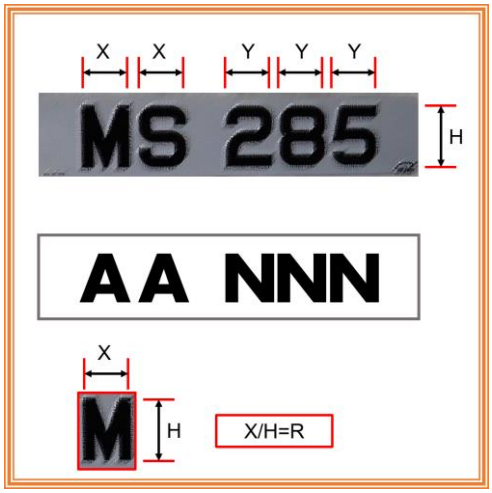
Eliteun applied OCR and Convolutional Neural Network (CNN) in License Plate Recognition (LPR), relying on self-designed “feature engineering” and multiple leaning model, the system achieved excellent performance even in outdoor scenarios with challenging weather or lighting conditions, such as:

- 99% LPR accuracy
- supports different license plate format in 8 countries
- instant recognition of license plate within 5 meters (or 15 feet) with the LPR camera set at a height between 1 ~ 1.5 meters (3 ~ 4.5 feet)

Pic 1. Localize license plate

Pic 2. Data after preprocess

The recognition accuracy of LPR is mainly impacted by two factors: 1. the software platform bearing the algorithms, 2. quality of acquired data which is the image of license plate. The capacities of applied algorithms not only determine the final recognition accuracy, but also affect the diversity of license plates the system supports. License plates follow different plate structure and different format in different countries, creating different plate syntax for computer to analyze. Therefore, recognizing different license plates with both accuracy and efficiency is very demanding. The final recognition result is the multiplication of a series of sub-algorithms such as plate localization, contrast normalization, character segmentation and so on. In addition, the entire process needs to be trained to yield consistent accuracy.



Example: plate geometry and basic syntax

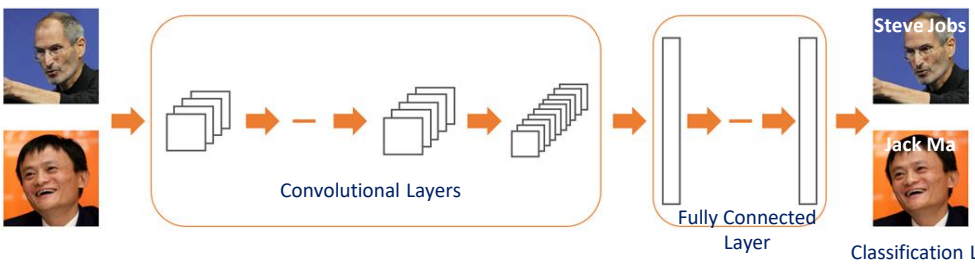
Face Recognition based on Deep Learning

Face Recognition (FR) is currently applied in two of Eliteun systems: Lightweight IoT Access Control System (LIACS) and Multi-factor Vehicle Surveillance System (MVSS). The storage of a single FR camera can be extended to 50,000 photos. With great capacity and fast processing, the technology will be applied in more IoT scenarios to fulfill the requirements for lightweight, easy to deploy and instant response.

Face recognition has a longer history with more developed technologies and more realization methods. In the earlier period, manual modeling was popular, but engineers had to handcraft all features for further coding and classification. The development of cloud computing and big data reveals manual model's inadequacy for fast process of mass data. Thus deep leaning is applied to optimize face recognition. Deep learning is part of a broader family of machine learning methods, which identifies data distribution characteristics and learns via artificial neural networks. Features in an image are extracted and filtered through multiple layers in CNN (Pic 1) This automatic model remarkably simplifies the process of complex classification, so the efficiency rises.

Basic CNN structure contains input, convolutional, pooling, fully connected layer and output layer (classifier). However, the application of CNN can differ greatly in modeling, training and optimizing in different scenarios. Eliteun team adopted OpenCV for preprocess of face images including face detection, grayscale and image resize. (Pic 2) Preprocessed images are sent to CNN for feature extraction, classification, and matching with existing data. Therefore, preprocess and modeling training both impact recognition accuracy and speed. Adopting neural networks in deep learning significantly simplifies the process, reduces the load on system and increases the speed.

Pic 2. Preprocess



Pic 1. CNN

Image Stitching in Vehicle Undercarriage Scanning

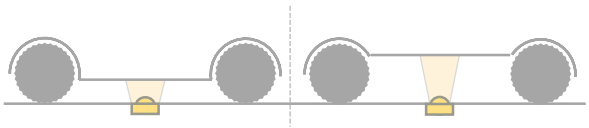
Image stitching is one of the successful applications of computer vision. This technology is applied and optimized in vehicle undercarriage scanner, a sub-system of Eliteun MVSS (Multi-factor Vehicle Surveillance System). The optimized functions enable Eliteun system to scan undercarriage of vehicle in motion at a speed up to 30km/h.

Image stitching is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama or high-resolution image. The process briefly refers to image preprocess, image alignment and image fusion.

Images of the same object but captured from different angles would differ in position, brightness or in contrast,

Pic 1. [1] Differences in position and contrast

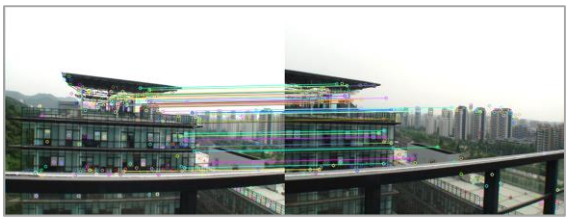
(Pic 1) affecting extraction of feature points, crop of reference images, and composition of the final image. In the scenario of undercarriage scanning, the height of which would influence significantly on brightness and contrast



Pic 2. Undercarriage height affects captured scope and brightness.

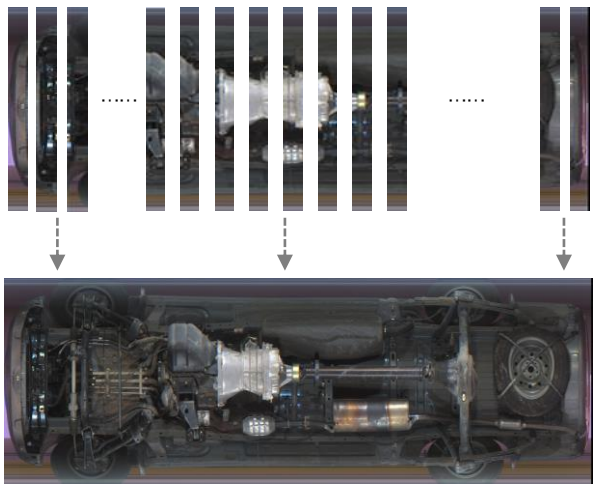
of snapped photos (Pic 2), thus posing great challenges on algorithm development, optimization and engineering.

As the core of the entire process, image alignment determines how quickly and accurately the final image is stitched. Specific algorithms are applied to find and match feature points in two images. (Pic 3) Parameters can be calculated either by pixel-to-pixel contrast or by gradient descent algorithm, to finally complete image alignment.



Pic 3. [1] Finding and matching feature points

In Eliteun MVSS undercarriage scanner, sub-images are aligned, cropped along the recognized boundary, then sent to back-end server to compose a complete and clear image of a vehicle undercarriage. (Pic 4)



Pic 4. Composition of the final image

[1]Sample image 1&3 source: https://www.cnblogs.com/skyfsm/p/7411961.html

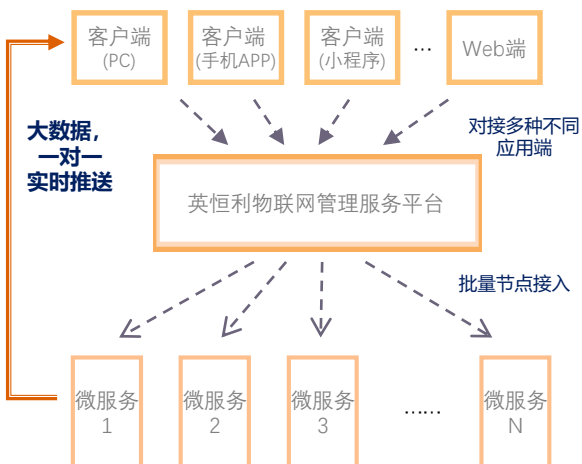
Microservice Based on Docker

Eliteun IoT platform is constructed on a microservice architecture deployed via Docker. Microservice architecture specifically fits for agile development as applications running on it are separated from one another to avoid any possible interference. Docker technology greatly simplifies the deployment of microservice architecture, making it easier to reduce performance overhead and to deploy thousands of microservices on the same server. Since Docker containers require much fewer computing resources than virtual machines, it is perfect to be adopted for Eliteun IoT systems to upgrade, iterate, deploy and scale up quickly.

Docker contains a set of products to pack, transmit and deploy software. For each software, there is an auto-generated mirror system to support software operation. The isolation created by containers eliminates any trouble that may be caused by conflicted environment, operation system or access ports.

Scalability, flexibility and load-bearing ability are crucial to Eliteun development platform due to its responsibility to support multiple systems involving complex technologies. Docker plays a key rule in improving development efficiency. For example, it only takes one or a few commands to complete an environment that would cost days to construct otherwise.

Different from other service platforms, IoT systems usually are required to manage massive edge devices in many scenarios. The quantity and variety of these devices constantly require IoT system to be more stable and compatible. Therefore, a distributed IoT management system is often adopted. It can be vastly empowered by microservices. Each service is independently developed for specific business. Microservices written in any language can be reliably and quickly deployed in Docker containers on any operating system to any infrastructure, including public or private clouds. Microservices based on Docker can achieve clear internal structure and support IPC (Inter-Process Communication) or RPC (Remote Procedure Call) among services. All requests are forwarded by API gateway. Integration either by single application or by separating front-end application from back-end ones eventually saves development time and resources, boosting faster iteration and deployment.



英恒利物联网平台架构

IoT Access Control with Diverse Safety Authentication

Eliteun Lightweight IoT Access Control System (LIACS) offers multiple safety authentication methods such as face recognition, Bluetooth, fingerprint recognition, so customers could choose whichever method, or methods to deploy at various venues to maximize security efficiency.

- Face recognition
- Fingerprint recognition
- Bluetooth
- Dynamic password
- RFID
- Barcode

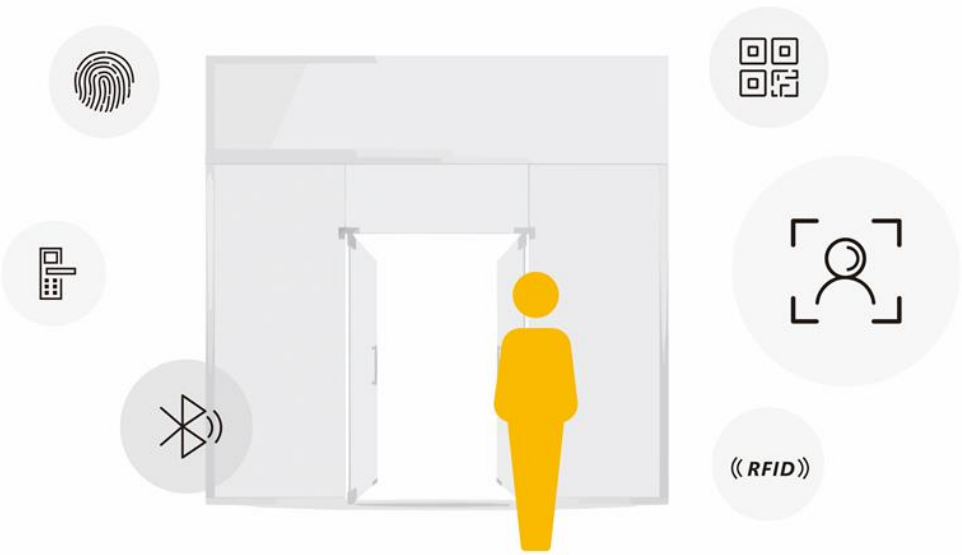
- Bluetooth Access Control

Eliteun LIACS communicates with a cellphone via Bluetooth protocol. Various smart devices set up at entrance are controlled by Bluetooth command, to either grant or deny access. The key is to apply general wireless air interfaces as well as software with open standards, which enables better communication between devices and software to realize the interaction and interoperability among portable devices from different manufacturers when cables or wires are unavailable.

✓ frequency-hopping spread spectrum (FHSS) helps signals to avoid external disruption and remain safe and stable.

✓ Bluetooth Low Energy (BLE) ensures low power consumption and easy maintenance.

✓ One-to-one communication and double encryption safeguard data security.



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