

**SYSTEM FOR STATIC OBJECTS DETECTION IN VIDEO  
WITH DIFFERENT ROADWAYS AND CLOUD TECHNOLOGIES USAGES**

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*This article deals with the main points in the architecture of static objects detection in video with different roadways system using Amazon Web Services (AWS) cloud services. The author considers what parts this system includes and what protocol will be used in order to send video to the server.*

Currently, computer vision is used to solve various problems: self-driven vehicles, identification of objects on photos / videos, facial recognition, etc.

Computer vision is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.

Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions [1].

In order to implement a system for static and dynamic objects detection on a video sequence, we need to define the necessary steps of the algorithm:

1. Pre-processing video. At this stage, it is necessary to stabilize the frame of the video sequence.
2. Road Detection on a video:
  - a. Highlighting edges on the road. For highlight edges on the video frame usually Sobel operator is used, that can solve the task well [2]. The highlight edges process is necessary to determine the threshold values for the perspective transformation of each frame.
  - b. Perspective transformation of a frame of a video sequence. For this is used transformation of a video frame into a bird's-eye view:



( a ) a video frame before applying the transformation, b) the resulting frame

**Figure 1. – The perspective transformation of a video frame**

- c. Detection of road lines. Sobel operator can easily solve this task in order to detect road lines.
- d. Detection of the road curvature. In order to find the curvature of the road, it is necessary to use a second-order polynomial. The formula is described in expression (1).

$$f(y) = Ay^2 + By + C, \quad 1)$$

where A , B , C are variables of the function y.

In order to find the radius of curvature, it is necessary to solve a differential equation of the 2nd order by the formula (2):

$$R_{curve} = \frac{[1+(\frac{dx}{dy})^2]^{3/2}}{|\frac{d^2x}{dy^2}|} \quad 2)$$

After solving this equation, the radius of the road curvature is obtained, thereafter this value can be applied to the original video frame. Figure 2 shows the highlighting of the road on the video frame:



Figure 2. – Obtaining the road curvature and highlighting it on the original video frame

### 3. Detecting objects on the road.

Image segmentation process. For image segmentation, the WaterShed algorithm is used, which is already implemented using the OpenCV library. The result of segmentation is illustrated in Fig. 3.

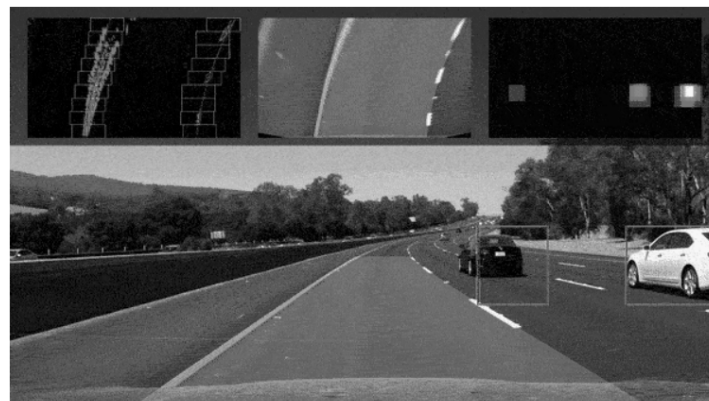


Figure 3. – Detect objects on the road using image segmentation

Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. If the connection to the user is relatively close, it may be designated an edge server [3].

The system for static objects detection on a video with different roadways will be distributed system of multiple applications: the client side of the system (a program that performs general video processing from the device), the server side (represented AWS services). Figure 4 shows the entire system architecture.

The client side is represented by an application that performs the following actions on an incoming video stream from the device inside a vehicle:

1. Pre-processing:
  - a. Aligning color balance.
  - b. White balance.
  - c. Noise reduction.
2. Video compression. This operation is necessary to reduce the transmitted traffic between cloud services and the client side.
3. Post-processing.

- a. Getting the resulting video frame from cloud services.
- b. Showing the frame on the device screen.

AWS cloud services are presented as the server side that performs video processing and object detection, so that the load of the client side can be decreased:

1. AWS Cloud Front. This service is necessary to receive all incoming requests from the client. It is a design template "Facade", which closes the entire system from external sources of exposure.
2. AWS Route 53. This service is necessary to redirect requests from the client to the appropriate subnet within the AWS network.
3. AWS EC 2 instance. It is a virtual machine with a pre-installed operating system to perform various kinds of actions. This type of machine is used for the video processing, its segmentation and objects detection, etc.
4. AWS Elastic Load Balancer.

The process of transmitting a video stream between the client and the server will be implemented via the RTSP protocol, which serves to transmit streaming video to the server.

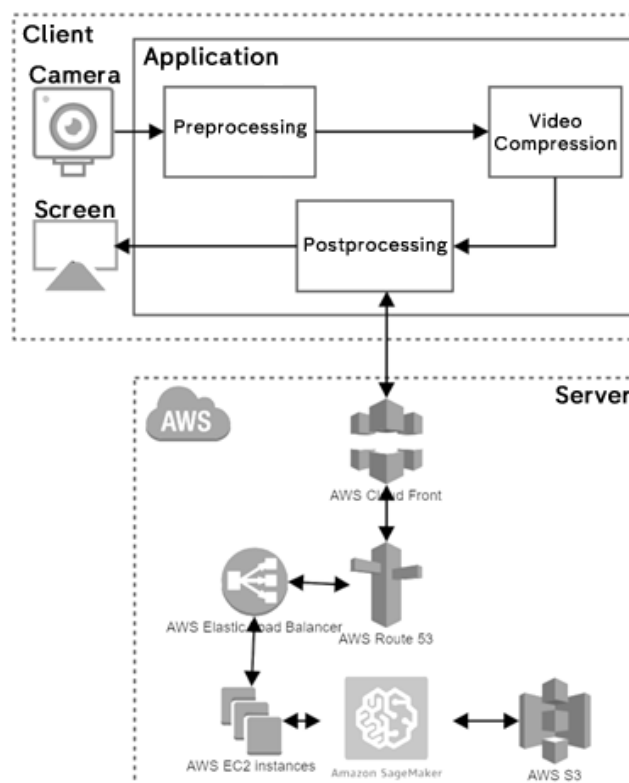


Figure 4. – System architecture

In conclusion, the architecture of this system is complex, but on the other hand, it allows several clients to use it at the same time. While analyzing the system, simple ways to implement load balancing between several AWS EC 2 instance were defined. The main difficulty in the implementation is the transmission of the client-server-client video stream, because the server needs to do a full analysis of the video stream, which requires additional time. Based on this, the resulting video stream containing all objects will be transferred with a little delay.

#### REFERENCES

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