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MATERIAL RECOGNITION USING CNN APPROACH FOR GARBAGE COLLECTION SYSTEM

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ABSTRACT

Material identification has been proved to be of important interest for different fields such as industrial automation, autonomous robots The autonomous robots for garbage collection, such as aquatic-cleaning [3] or garbage gathering [6] need the algorithm for identification of materials. Automatic conveyer identification for garbage collection and segregation also use algorithm for material identification. In this paper is proposed an algorithm based on Convolutional Neural Network.

KEYWORDS: material identification, waste management, convolutional neural network

1. Introduction

Material identification has been proved to be of important interest for different fields such as industrial automation, autonomous robots, autonomous navigation or autonomous car. In case of industrial application material identification resumes to find the exceptional cases where the material structure indicates there is the correct part selected. In recent years, using the latest computer vision algorithms, semantic description of the scene is taken in to account, where all the objects in the scene, such as tree, car, street, buildings are identified in order to identify the road and dangerous situation for driving. One of the components of the scene identification could be also the material identification of objects. For autonomous navigation, such in case of delivery autonomous robots already available for public use, the identification of an area with snow is very important, as this might cause blocking the robot. Researchers use classic computer vision algorithms, such as image filters and conduct quantitatively analyse of the material. For instance, a Canny algorithm filter followed by contour identification might indicate by the amount of certain dimension of contours a certain material.

Concerning Artificial intelligence there are various initiative for to develop different material databases: CUReT database or Flicker Material Database. Databases contain different material samples taken at different illumination levels. OpenSurfaces data base has more than 110,000 segmented materials. Understanding of the material composition of a scene is paramount in the scene understanding problem, such in case of automated system to collect garbage.

Fig. 1. *Example of material identification problem* [1]

The autonomous robots for garbage collection, such as aquatic-cleaning [3] or garbage gathering [6] need the algorithm for identification of materials. Automatic conveyer identification for garbage collection and segregation (Fig. 2) also use algorithm for material identification. While the shape detection is one of the phases of identification, there are objects that have the same shape but different material. In such a garbage collector system a robotic-like arm or actuator collects garbage automatically through a conveyer transporting different objects. For which we are designing an arena for the machine. The actuator is controlled by a software that is processing image from a camera located above the conveyer. The software send command to the robotic arm to collect the stationary waste [3].

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HDPE	Aluminum	PET Transparent	PET Dark	PET Green	PET Blue	PET Teal	PET Multicolor	Other	**Total**
4978	3411	1749	1477	511	1041	309	52	1007	14 535

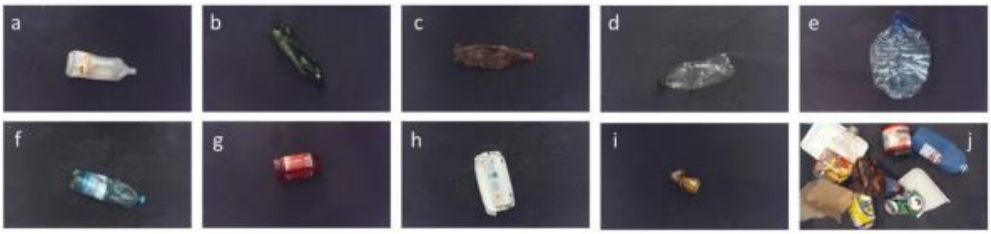

Fig. 2. *Examples of waste objects images from the created database: a) HDPE; b) PET green; c) PET dark; d) PET transparent; e) PET blue; f) PET teal; g) PET multicolour; h) 'other'; i) aluminium can; j) multiple objects scene*

2. Experimental procedure

We considered that different objects representing garbage, as in case of a garbage conveyer, are located 600 mm above the scene. The conveyer is transporting the garbage with the speed of 0.3 meters/s. Though the speed might produce a distorted image the algorithm is correctly identified the objects.

The algorithm is described in Fig. 3 The image is filtered in order to obtain blob analysis to identify parts in image with the same characteristics. The algorithm is using CNN (Convolutional Neural Network) to identify 3 types of material, namely paper, fabric and plastics. The test images consisted of 30 different images containing the 3 types of materials. As seen in Fig. 7 the false positive identification produces the identification the object made of metal as one in the three classes indicated.

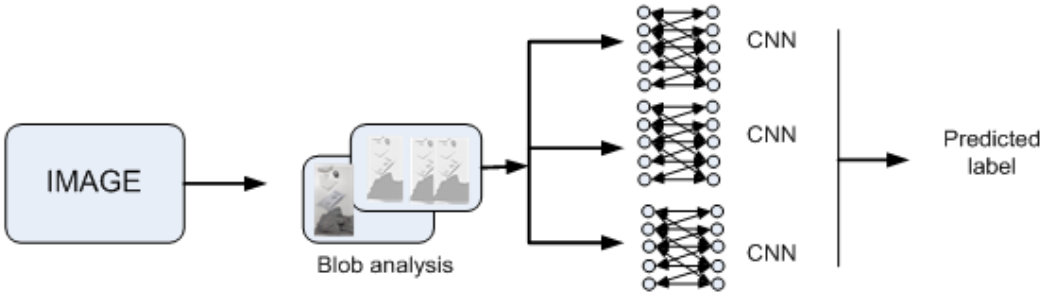

Fig. 3. *Algorithm for material recognition*

3. Results and discussions

We used own set for training of 100 images for each type. The recognition rate is about 80% and the false positive detection rate is 15%. The trained set included objects that are different from the testing test set. The trained set was obtained using different illumination. The algorithm needs lower computer resources. We used an i5-11260H processor on a computer with 16 Gb. The image is acquired with a Logitech C505 webcam. The resolution used is 1200 X 800 pixels. The processing speed is in the range 200-300 ms. We note that not all images acquired in the video stream is processed as some are blurred and are not processed. We used own algorithm to detect blurred images, with a speed of 20-30 ms per frame. In case a blurred image is detected the algorithm for detection of material is not used and we skip to the next image. The blob analysis is applied to each image in 5 different filters in order to identify materials with the same texture. The texture with many information is quite hard to detect. Using blob analysis followed by CNN network we obtain satisfying results. However further development needs to use several filters in order to obtain better results. Also, better results should be obtained using a higher number of images to be trained. In figure 6 is depicted the scene acquired by the camera to be processed by computer. Several materials are on the scene. In Figure 7 is shown the identification results. In this picture is shown a false positive identification, the software identifies as plastic the metal part on the conveyer.

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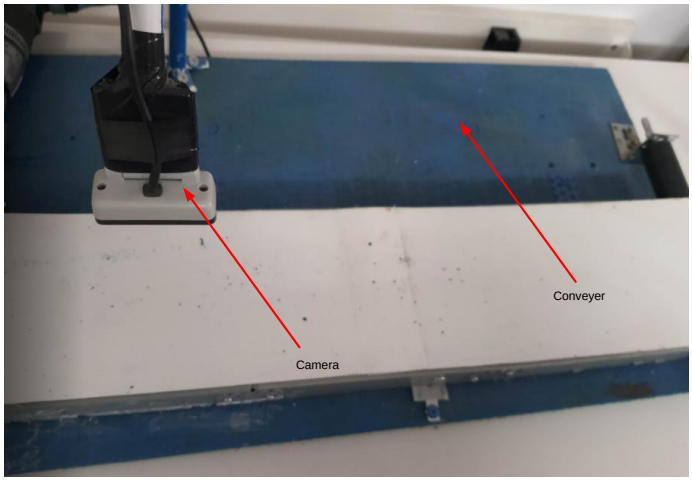

Fig. 4. *Conveyer used for material identification*

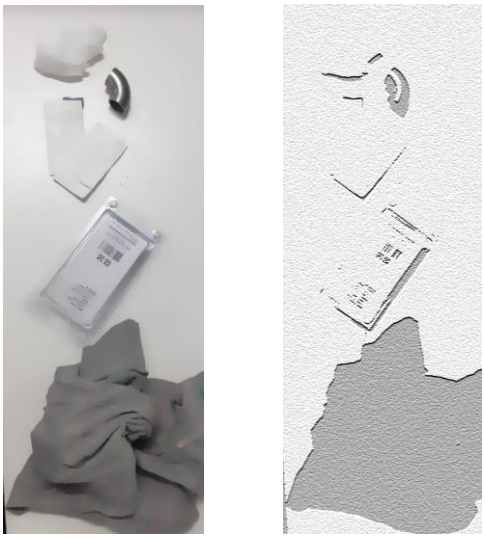

Fig. 5. *Blob analysis result of the image*

Fig. 6. *Detection of different materials*

Fig. 7. *Detection of different materials*

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4. Conclusions

The study of material detection for garbage collection shows that the task of identifying materials in garbage is a challenging task. Using blob analysis followed by CNN network we obtain satisfying results. However further development needs to use several filters in order to obtain better results. Also, better results should be obtained using a higher number of images to be trained.

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