Object Recognition Using a Smart Camera

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Abstract: This paper presents a general approach regarding computer vision and object recognition importance. The most utilized methods and the most common application which involves object recognition are also described. In this context an application it is created for identifying a few types of objects using Vision Builder for Automated Inspection software and a smart camera. The used method can be implemented in a further research for automated assembly operations with industrial robots.

Keywords: computer vision, object recognition, image processing, smart camera, objects identification.

1. INTRODUCTION

The main research in robotics is situated at the crossroads of the following areas: artificial intelligence, statistics, algorithms, geometry, differential geometry, algebra and system theory. There are also projects that include branches such as neuro-biology, psychology, medicine, physics and mechanics, etc., depending on the applications of robots in question.

It is fundamental for a robot to be equipped with its own sensor system with the ability of information acquisition, on which to be able to form an internal representation of the surrounding world, to make decisions and plan actions. Robot vision is an area that in recent years witnessed a scientific and technical remarkable progress and it represents a part of the computer vision domain. A large number of applications that includes robots are based on vision-guided systems (Haralick, 2002).

Computer vision is now widely applied in the field of robotic industry for identifying objects and for measuring the position and orientation of the objects that will be picked up by a robot arm and assembled.

Object recognition process is a typical task of the scientific discipline named computer vision that relies on a variety of important domains such as artificial intelligence, neurobiology, signal processing, physics, image processing, machine vision and pattern recognition. The recognition process for an object consists in two major steps: identification of objects and detection or categorization (Belongie 2002).

Comparative with object recognition of the natural vision system, in case of the computer vision system it seems difficult to accomplish the second step regarding the categorization of the objects which for a natural system is a quite simple task (Parker, 1997).

The paper is structured around four parts. In the first part is presented a short introduction regarding the importance of computer vision applications in the case of robotic industry. The second part of the article deals with the methods that are generally used in case of object recognition process and the main areas of application of this task. In the third part is described the application developed based on Vision Builder for Automated Inspection software and a smart camera in order to identify a few objects and the final part consists in conclusions.

2. OBJECT RECOGNITION

Nevertheless the object recognition problem has been studied for a large period of time and is still being treated in the present research attempts. The methods for solving this task are continuously improved and adapted to the new type of progressive applications that are current in industry and services.

Methods generally used in case of object recognition can be evaluated as:

- Geometry based approaches consists in fact that the geometric description of a 3D object under projective projection permit that the projective shape to be reproduced in a 2D image (Hartley 2000), (Ponce 2006);
- Appearance-based algorithms consists in developing various types of alghoritms for recognize 3D objects from 2D images such as neural networks with radial basis function (RBF), the eigenface approach, suport vector machine (SVM), and other (Blanz 2002), (Roth, 2008);
- Feature-based algorithms like the scale-invariant feature transform (SIFT) which is an algorithm developed by David Lowe was made to detect and

describe local features in an image. This algorithm is now implemented in a software program which identifies similar points in an image that can be recognized even if the object is rotated, moved or scaled. The program tries to match these points with a set of images that were previously taught (Lowe, 1999), (Lazebnik, 2004).

- Associative memory implementation for object recognition is another type of method used by few researchers that relies on two efficient associative memories like databases. In the first are embedded the key features of images while the second database is used for statistics regarding the clusters formed by the key features (Selinger 1999).

For an easy way of identification for the various number of methods were established few categorization criteria like: object representation that relies on geometry and appearance and the object is usually modelled in CAD, scope of object data which refers to the local properties (like the position of a corner of an object or the position regarding a coordinate system) and global properties (like area, perimeter, moment of inertia, position of the centre of mass). Another type of criteria consists in the expected object variations, image data quality which depends on the area of application, matching strategy where an affine transformation is used and scope of data elements that are used in matching are based upon the Canny edge detector (Laika, 7), (Trebier, 2010).

2.1 Areas of application of the object recognition process

As examples for application types in case of the object recognition technology can be evidentiate the following: position measurement (often used in industrial type of environment), inspection, sorting, counting, object detection, scene categorization , image retrieval. With the progress of industry and services the applications for object recognition evolved from traditional forms such as inspection for different kind of machines to modern form of tasks like video surveillance and face recognition.The main areas of application of object recognition process are presented in figure 1 (Treiber, 2010).

For each application are developed few requirements and constraints like evaluation time that has to be a real time in case of industrial applications, accuracy in measuring the position of an object and recognition reliability in order to prevent errors of classification. Another important requirement consists in the invariance of the algorithm in which can be distinguished two types of variances such as inter-class variance (indicates diferences between objects from other classes) and intra-class variance (indicates objects that belong to the same category). For the second type it is necessary to minimize the sensitivity of the alghorithm for object recognition because the interest is to recognize objects that are different one of each other (Mundy 2006).

Among the three main areas of application, the most demanding for accuracy with a low rate of errors and real

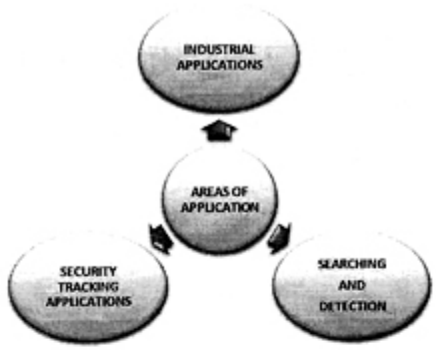

Fig. 1. The main areas of application of the object recognition process.

time processing operations of the objects images is the industrial one (Trebier, 2010).

3. A VISION BUILDER APLICATION

The application presented in this paper is an object recognition application whose purpose is to automate and improve the industrial identification process of certain objects by using elements of image processing and computer vision. Practically, the application, tries to detect three objects that in fact are three types of pipes, from an intensity image. This is done in order for the robots that usually are used in this kind of processes to be capable of recognizing the different objects in a scene before being able to manipulate them in any useful manner.

This application was made with the help of the software "Vision Builder for Automated Inspection" from National Instruments, software that is designed to solve visual inspection tasks that includes inspection, part presence, counting, gauging and guidance.

Fig. 2. Inspection state diagram.

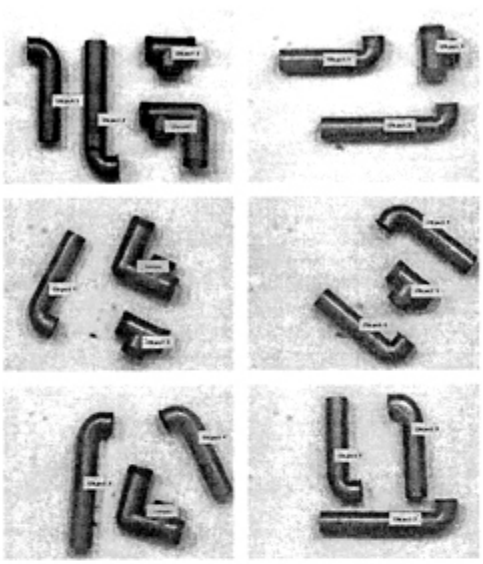

Fig. 5. Recognition results

The last state only displays results that are overlapped on the original image. Running this application through a number of images taken by the video camera gives us the following results that are illustrated in Figure 5.

6. CONCLUSIONS

In this paper, an object recognition system was developed. The performance of the application was demonstrated on number of images. It was proved that for a limited number of objects and not so complex shape, and in some particular condition, the system works. Additional research is planned in this direction in order to implement the system in a real-time robotic application.

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