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Research Article

An In-depth Analysis of Applications of Object Recognition

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Abstract: Image processing has become one of the most unavoidable fields of engineering. The way the applications are designed based on Image processing is simply superb. This study is drafted as a study paper aimed at reviewing the object recognition techniques supported in Image Processing Sector. Analyzing object recognition through the applications is a new approach and that is what we have tried through our paper. We have taken effort to check the utilization of Object Recognition techniques in the fields of Industrial applications which includes a. automobiles b. food and beverage sector and c. fabric sector. Then attention is paid towards robotic applications. Remote sensing is also observed to be one of the hottest sectors which deploys objects recognition techniques to a better extent. Finally it is ended up with medicinal applications.

Keywords: AdaBoost, appearance-based method, feature-based method, filters, fuzzy clustering, gaze determination, genetic algorithm, haar-like structure, head pose, histogram, hyperspectral, image stabilization, machine vision, model-based method, motion compensation, motion estimation, segmentation, SIFT (Scale-Invariant Feature Transform), spectral, spectroscopy, statistical, texture, thresholding

INTRODUCTION

Object recognition from the very beginning has been defined as the task of finding an object and identifying the object as what it is. This falls under one of the very happening fields in image processing, computer vision. Object recognition is one of the most preliminary steps in any application which deploys image processing into it. There are a lot of challenges associated with object recognition starting from lighting, view point, variation in pose, clutter, occlusion, appearance and shape. These challenges are not static and could be very much aggravated with respect to applications. It could be easier with one application where is not with another one. It is always daunting to decide on this. This study has been drafted by keeping in mind about the beginners/learners difficulty in understanding object recognition scenarios and its application areas. Keen attention has been given to sectors as Industrial applications, Robotic applications, Remote sensing and most importantly Medicinal applications. Clear vision is provided on the algorithms used, Pros and cons of the same with future prospects. Readers would get a clear idea on what not is object recognition, where not they can't use it. Also they would gain knowledge on where can OR be used. The main objective of this study is to get a clear-cut idea on the application sectors of object recognition paradigms. Since there are not many research articles of this pattern, we took it as a challenge to get it done.

MATERIALS AND METHODS

Literature review: The paper itself is aimed at drafting all the application areas of object recognition and this study is not based on any references. There are no many papers available or presented with the kind of comparison that we have drawn. We have given citation to the papers that we have referred based on applications.

Context and background of the work carried out: This study is very highly focused and it is of high importance because of increasing usage of object recognition techniques in the market. Right from the simple industrial application till the most complex medicinal application, we have object recognition a special place. This serves as a major motivation for us to do a complete review in this sector and to ready a research review article. This is also going to serve as major motivation for researchers to carry out their research in this area.

Industrial applications: Real-time object recognition is made use of in industrial applications. This mainly recognizing 3D objects. Object recognition is important

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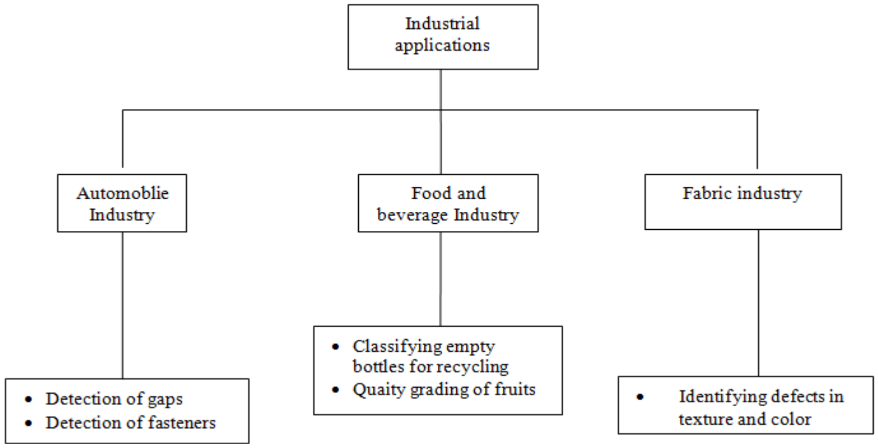


Fig. 1: Topics discussed under industrial applications

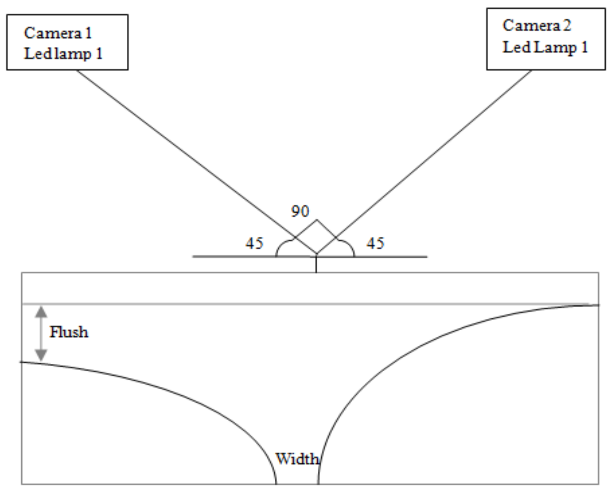


Fig. 2: Arrangement of cameras and LED lamps with respect to the object

here as the manufacturing process in most industries is automated. As industries grow they have to cater to larger demands. Consequently, industries increase their production. Increased production in turn results in chances of making errors. In any mass manufacturing industry, as the production scales are enormous, it is nearly impossible to implement a manual quality control. This is why object recognition has been gaining importance in industries. 3D object recognition is used to implement quality control.

For humans, recognizing and classifying objects is a trivial task. When it comes to computational object recognition, it is much more complicated. Objects often have to be recognized under varying illuminations, from different angles or may be undergone some deformations. Another constrain, is the involvement of complicated mathematical problems like relationship between different geometric shapes and the projection into 2D images. Good object recognition also relies on the diversity of the training images (Thomas *et al.*, 1995). Figure 1 has got the industrial application sectors represented in block diagram format.

Automobile industry: In the automobile industry, quality cannot be compromised. Therefore supervision at different stages in the production is absolutely essential. The main constrain here is that similar defects can be present at different stages of the production, but the defects have to be identified without fail. The algorithms used, should identify defects without failure under different orientations of the target object.

Couple of areas where object recognition is used in automobile industry is:

- Detection of dimensional gaps in the body of the automobile in later stages of assembly
- Detection of missing fasteners on steel stampings

Methodology:

- Edges of the gap are highlighted by two LED lamps. Two stereo calibrated cameras (as shown in Fig. 2) measure the gap as a 3D distance. This method depends on the reflected LED light.

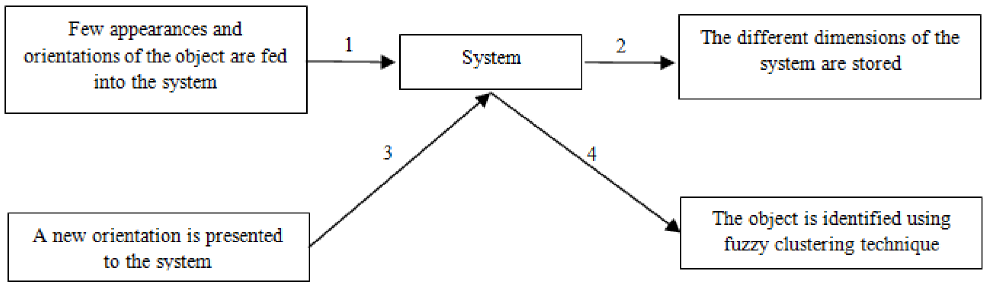


Fig. 3: Steps involved in a general fuzzy clustering technique

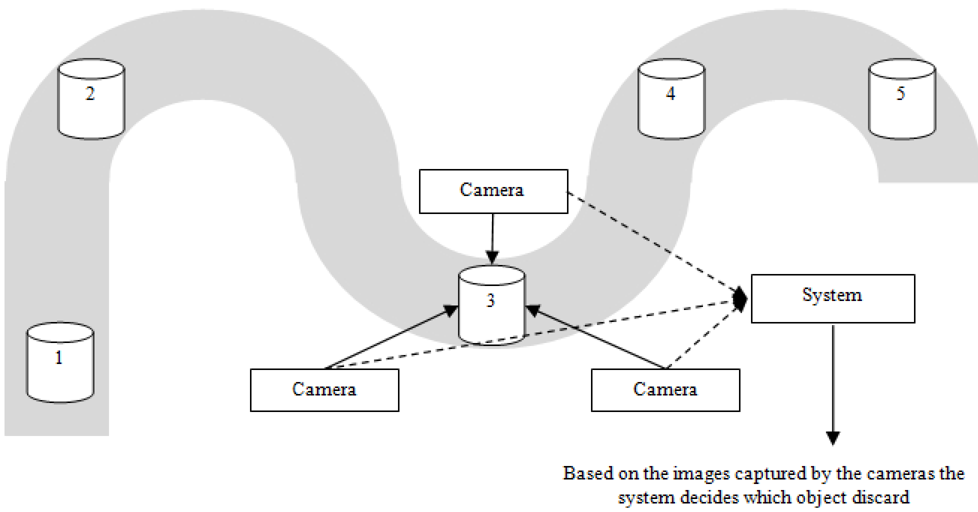


Fig. 4: Cameras at different angles to capture images of a single object moving along a production line

Therefore, it is color independent and has an edge over laser-based, gap-measuring systems because of this independence (Appearance-based Method = > We match the edges) (Kosmopoulos and Varvarigou, 2001).

- Image segmentation is achieved by setting adaptive threshold for input images using labels that are predetermined by fuzzy clustering techniques. The learning is not supervised and the output status of the network is described as a fuzzy set. Figure 3 shows the working of system that uses fuzzy classification technique. The potential edges are determined by a measure of the fuzzy entropy (Appearance-based Method + Genetic Algorithm = > First an initial understanding of the appearances of the object is made, based on which different inputs are clustered. This being an automatic system learns about the different possible orientation on its own and searches for fasteners) (Boskovitz and Guterman, 2002; Killing *et al.*, 2009).

Food and beverage industry: Quality and safety are of primary concerns of the Food and Beverage Industry. Inspection is difficult and labor intensive. As the industry grows in size; the need for accurate inspection increases. Manual identification in the industry is time consuming and, to an extend it is unreliable. This inaccuracy arises as a result of factors like inconsistency and subjectivity involved in human decision making. Apart from identifying the quality of the produce, the shape of the containers into which it is put also is important. This is why object recognition (machine vision) plays a major role in modern Food and Beverage Industry. Figure 4 represents the camera position to capture images in the production line.

Few of the applications of object recognition in this industry include:

- Classifying empty and non-empty bottles, useful during recycling of bottles
- Automatic quality grading of fruits and vegetables

Methodology:

- The system is fed with certain basic features that are relevant for the classification. The system identifies many different appearances of empty bottles and learns different possibilities under a supervised environment (Feature-based Methods + Genetic Algorithms) (Blasco *et al.*, 2003; Brosnan and Sun, 2004; Duan *et al.*, 2007, 2004; Liu 2010).

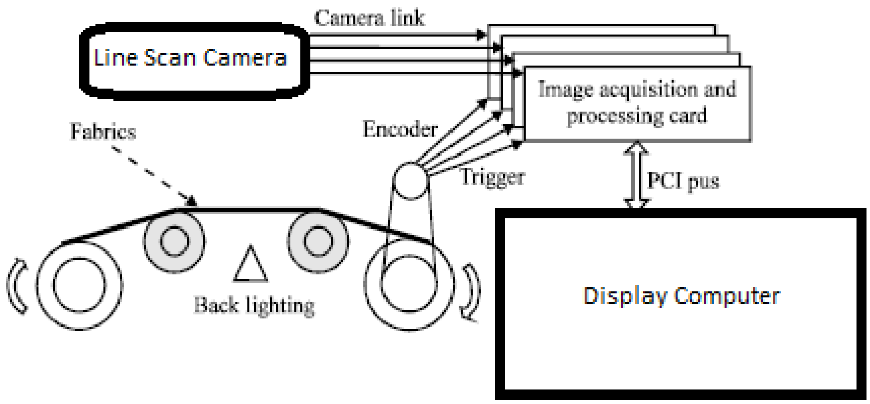


Fig. 5: Architecture of a defect detection system (image courtesy http://scialert.net/)

- Here, first the fruits or vegetables under inspection should be detected. After this, the matrices of detected objects are compared to certain acceptable standards. For this, there is a need to maintain a database with matrices that store acceptable values for all the objects (Appearance-based Methods = > first identify the object based on edge matching and then comparing with values in the database) (Patel *et al*., 2012).

Fabric industry: The main use of machine vision in Fabric Industry is to identify defected fabric. For long time, such identification processes were done manually by humans. This resulted in lack of efficiency and increased expenses. Computer vision can be used to identify defects by matching texture or color patterns. Most of the defects are vague and ambiguous. This emphasizes the need for efficient algorithms that can differentiate between normal and defected regions of fabric. There are three broad categories of approaches; statistical, spectral and model-based. Based on the type of features under inspection, one of the above approaches is chosen. The most important aspect in detection here is ability to identify local defects and have low false alarm rates (Bradshaw, 1995; Kumar, 2008; Stojanovic *et al*., 2001).

Figure 5 gives a description of how computer vision is used in defect detection in fabric industry. The line scan cameras acquire images and the computer processes these images to make meaningful graphs based on which the fabric is classified defected or not.

The main application of object recognition in Fabric Industry is to identify defects in texture and color of fabrics.

Methodology (Mahajan *et al*., 2009):

Statistical approach: Uses spatial distribution of pixel values. Takes one (first-order), two (second-order) or more (higher-order) pixels at a time and works with estimates like the average and variance to identify defects. There are multiple ways to extract the texture features. These include first-order statistics, morphological operations, edge detection, fractal dimensions, co-occurrence matrix, rank order functions, eigen-filters and many local linear transforms.

Spectral approach: As the patterns in fabric are mostly reoccurring, it can be picturized as the spatial arrangement of certain texture primitives. In this approach texture primitives have to be extracted and then the spatial spacing of these primitives has to be generalized. This approach takes advantage of the high degree of periodicity in texture patterns and therefore cannot be used for detecting defects in random texture patterns. Fourier Transform, Gabor Transform, Wavelet Transform are used to extract texture features.

Model-based approach: It is used not only to create an image model of the texture but also to synthesize it. Essential perceived qualities of texture are captured by model parameters. Context dependent entities like pixels are modeled. The purpose of inspection is to gauge homogeneity (normal regions) and randomness (defected regions) in the material. This approach concentrates on detecting an alignment pattern in preprocessed images with the help of model based clustering. Defects can be detected by using approximate Bayes factor which involves statistical inference from the available data.

ROBOT OBJECT RECOGNITION

Robot Object Recognition deals with finding and understanding the identity of an object that is presented in the form of a video or image from a given set of labels or training examples. It is a daunting task to incorporate object recognition skills in a computer which matches the cognitive capabilities of humans. Still, substantial progression has been made in this field by the analysis of limited scope of distinct objects like

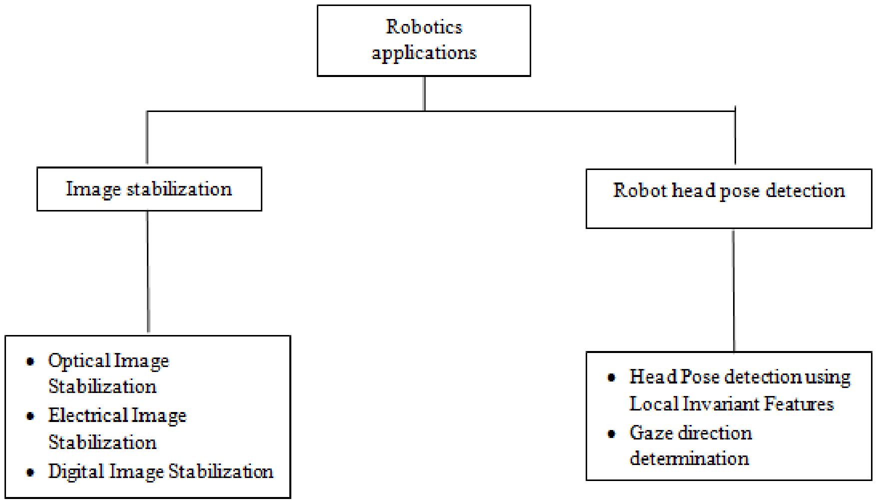


Fig. 6: Topics discussed under robotics applications

road signs, fingerprints, handwritten digits, faces etc. Object recognition is used in various robotics applications such as image stabilization, robot head pose detection (Loncomilla and Ruiz-del-Solar, 2005). Figure 6 has the application areas mentioned in block diagram.

Application of image stabilization in robot vision system: The vision system of a mobile robot makes use of the quantitative and qualitative features of the images obtained from the camera that is placed on the system. A robot achieves finest optimal performance when it satisfies both quantitative and qualitative features. Image stabilization is one of the most important qualitative feature that must be satisfied by a robotic system. It involves removal of unwanted motions in the frame sequences that are captured by the camera mounted on the robotic system. This helps in enhancing the efficiency of the image processing algorithms that are applied to the images captured by the camera. Figure 7 represents an example scenario. Figure 8 has the steps illustrated.
There are three major image stabilization methods.

Optical image stabilization (Cardani, 2006; Tokyo, 1993): The movement of the camera is measured using a two- axis gyroscope. These signals are directed by a micro-controller to small linear motors which are used to move the image sensors. These sensors are fitted with a prism assembly that moves in the opposite direction of camera shaking, thus compensating for the unwanted camera motion.

Electronic image stabilization (Oshima *et al*., 1989; Kinugasa *et al*., 1990): Same methodology used in Optical Image Stabilization except for the change that instead of changing the prism directions, the image is provided with pixel transformations in the software.

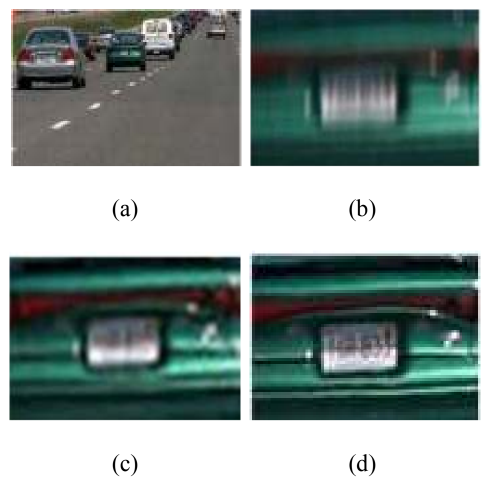


Fig. 7: An example of step by step image stabilization (image courtesy: http://cdn.intechopen.com/pdfs-wm/10608.pdf)

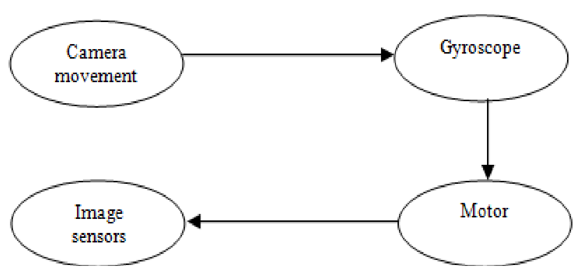


Fig. 8: Steps in optical image stabilization

Digital image stabilization: This makes use of image processing algorithms. It has motion estimation processing which determines global motion vectors with the help of local motion vectors. This is followed by the use of motion compensation processing which produces smooth images by generating motion compensation vectors.

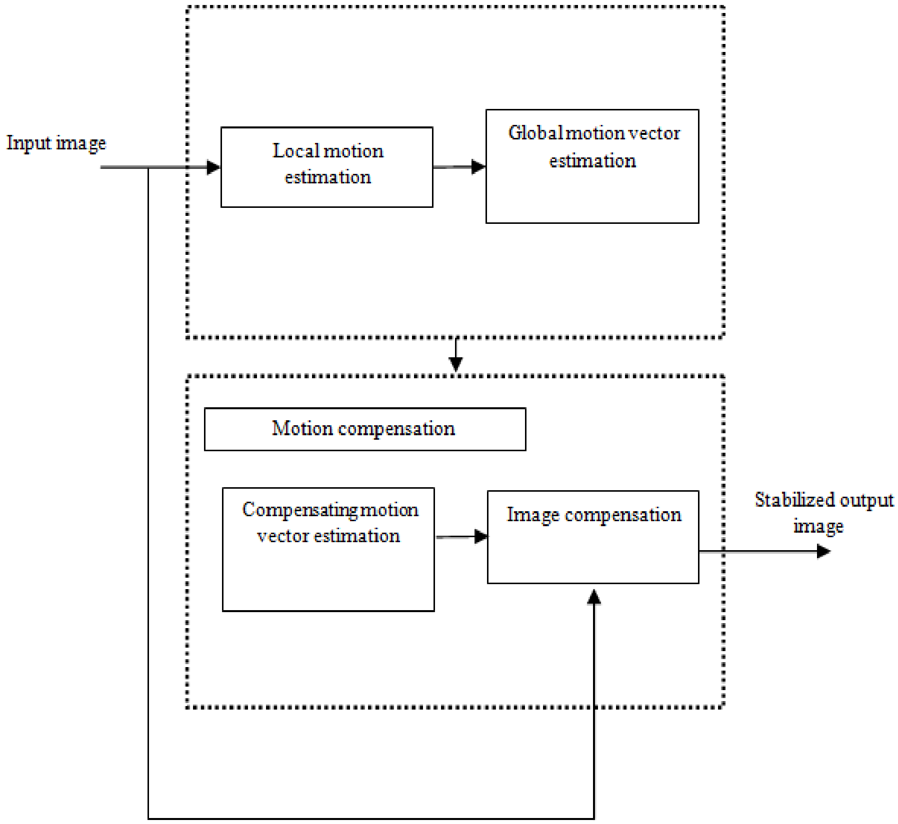


Fig. 9: DIS architecture (image courtesy: http://cdn.intechopen.com/pdfs-wm/10608.pdf)

Methodology: When a robot moves in its visual field, there will be positional changes in the objects encountered by it, as a result of its locomotion. A local control loop (Fig. 5) is used in the robotic head as a replication of the Vestibulo-Occular Reflex in human brain. This strategy is used to predict changes in the images in the robotic head. An inertial sensor measures the horizontal component of the disturbances in the image. This signal is used by the look-ahead controller to generate the control signal for degree of freedom control pan (G_c) (Amanatiadis *et al*., 2010). This in turn produces an opposite order against the movement of G_p. This way, the rotational component of the disturbances is avoided. Then, using a differential technique on two sequential image frames, the horizontal retinal slippage is computed. This is used as a feedback signal that optimizes image stabilization. Similar methodology is used for vertical disturbances. DIS architecture is represented in the Fig. 9.

Robot head pose detection: Robot Head Pose Detection is a major functionality of robot gaze direction determination system. The process of determining where another robot is looking at is termed as Robot gaze direction determination. This technique is helpful in situations where the robots' situational analysis ability is important so that the competitive, co-operative and synchronization skills of the robots are enhanced (e.g.: Robot Soccer). The robot head pose detection system has two major processes. Every observed scene will have certain scale invariant local descriptors. These descriptors (robotic head prototypes) are computed first. Then these are matched against those descriptors that are already stored in a database. The robot heads are pictured under different view angles (Fig. 10). The prototypes that are matched correspond to each of these images. After the robot head pose detection, the factors such as the head model of the observed robot, the robot head pose that is detected with respect to the observing camera and 3-D pose of the observing robot's camera are used to find the robot gaze direction (Fig. 11).

Detection of head pose using local invariant features: A database is stored with robot head prototype images. These image descriptors are compared with that of the input image so as to obtain the robot head pose. The prototypes are based on the various angular views of a robot head. The matching process is carried out in 4 different stages (Lowe, 2004):

- Local interest point generation
- SIFT descriptors computation

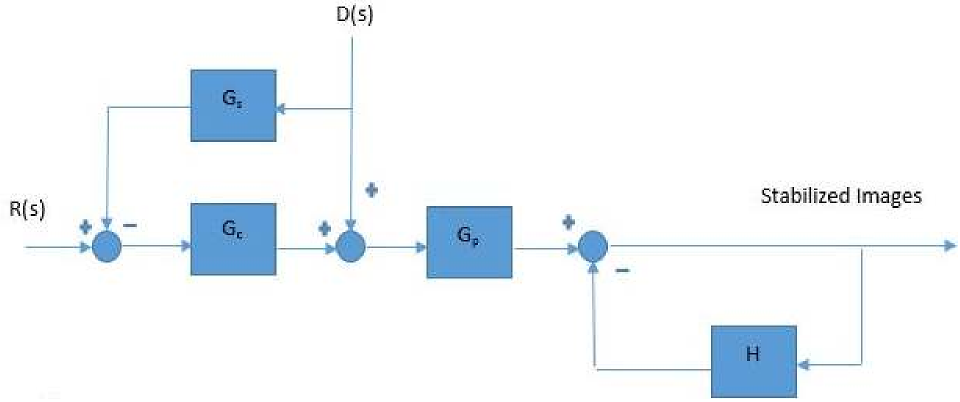


Fig. 10: Block diagram of closed loop control scheme
R(s): Input; D(s): Disturbance; G: Controller; G_p: Pan Motor; G_s: Look-ahead controller; H: Horizontal retinal slippage

Fig. 11: Robot head prototypes with their SIFT's (image courtesy: Loncomilla and Ruiz-del-Solar (2005))

Observing robot's camera pose → Known a priori

If camera is fixed in global co ordinates, using the techniques of self-localization and joints information, the robot estimates it on its own.

View angle of the prototype → Define and fixed along with the creation of model database

Distance and rotation angle of observed robot → Using information of head detection process resolution and angle of view of observing camera

Fig. 12: Gaze direction determination

- SIFT matching using closest descriptors
- Transformation computation and hypothesis rejection test

After applying these stages, the highest probable affine transformation is performed on the robot heads, if found any. This transformation and matched reference image identity together is used in finding the robot head pose.

Gaze direction determination: The direction at which an observed robot is gazing is determined using the following information:

- Position and orientation of the observing robot's camera in global coordinates
- The angle at which the prototype is viewed
- The observed robot's angle of rotation and distance

The methodology is given in Fig. 12.

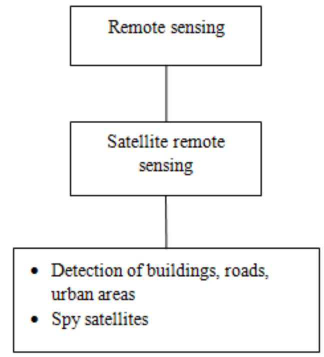


Fig. 13: Topic discussed under remote sensing

REMOTE SENSING

Remote sensing is the one of the most important areas in which object recognition is used. The reason for this is simply because of the fact that in remote sensing there is no contact required to study the target object. Detection and classification of objects is achieved by the processing of propagated signals.

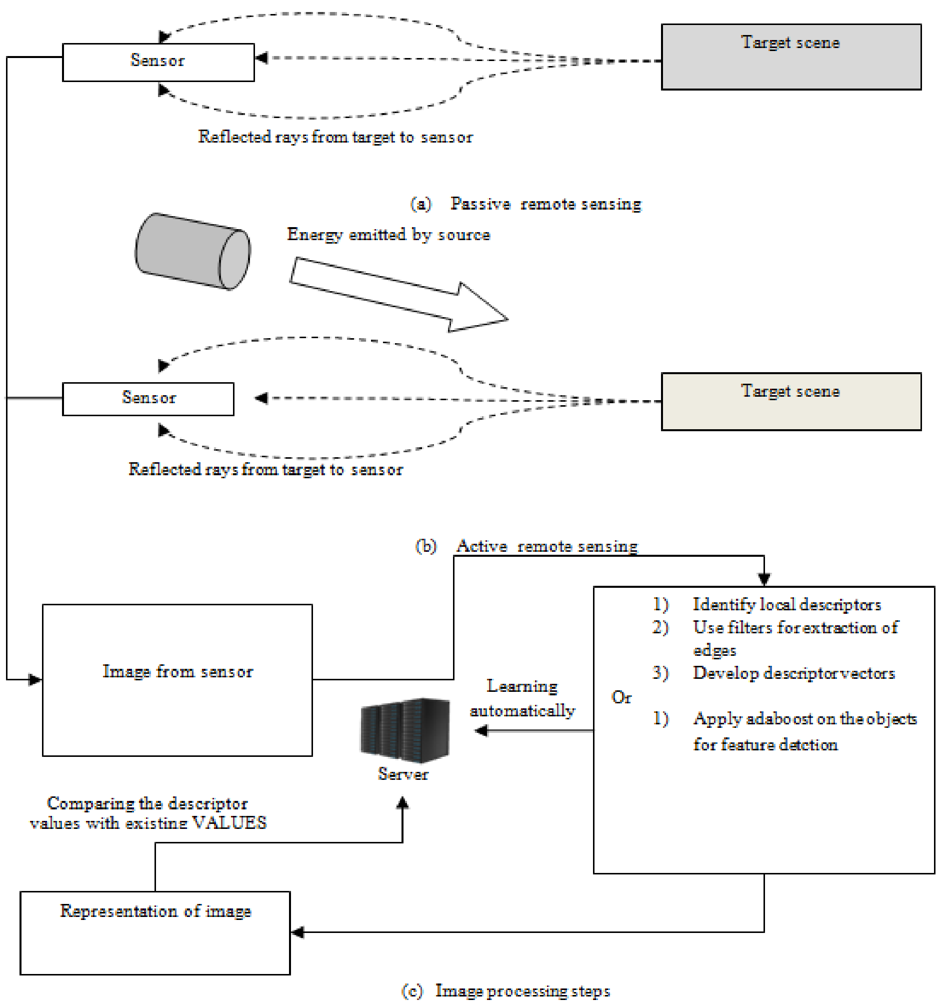
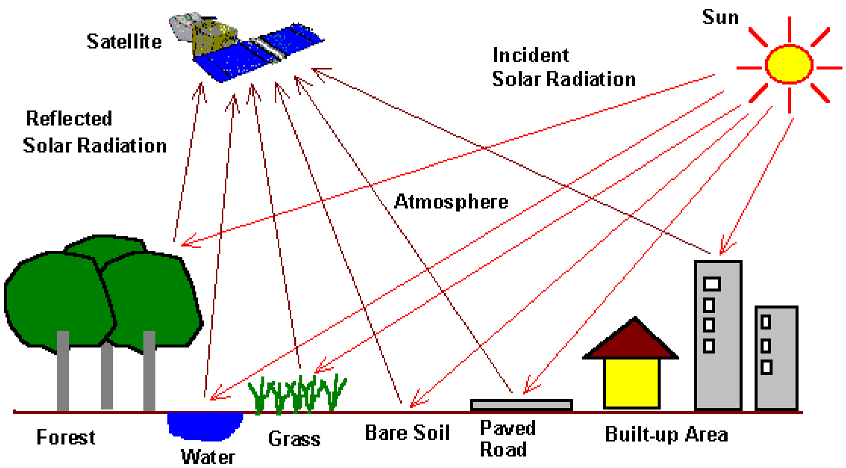


Fig. 14: Different types of remote sensing

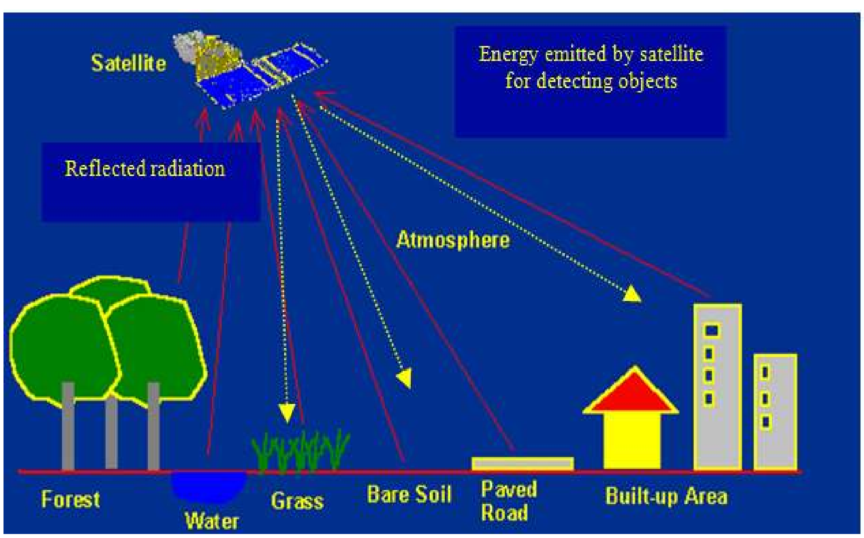
This technique is used to study planets and stars in the galaxy. It also helps in studying and monitoring resources like forests, agriculture and water in remote locations and measuring sea surface temperatures. Figure 13 will help reader in understanding the areas we touched in this section.

Remote sensing is broadly categorized into Passive and Active remote sensing. Passive remote sensing detects the reflection patterns of sunlight to interpret the scene, whereas Active remote sensing emits signals that are reflected by the objects in scene. These reflected signals are processed for an understanding of the scene. In general, the sensors are likely to aerial, so that large geographical areas can be covered. Role of Image Processing comes after the images are obtained by the sensors. The systems have to use algorithms to recognize patterns in the image based on the initial input given. If genetic algorithms are incorporated, the System can update information about objects. Figure 14 represents different types of remote sensing techniques.

Satellite remote sensing: Satellite Remote Sensing deals with sensors on satellites. These sensors observe Earth all the time. These satellites are either stationary or revolve around Earth. It collects visual data about Earth and its atmosphere. Different aspects such as the distribution of natural resources such as forests, water and even minerals can be obtained from Satellite Remote Sensing. Information regarding the terrain can also be acquired. On observing the atmosphere, weather patterns can be predicted and also volcanic ash can be observed in case of a volcanic eruption. Reflected Infrared rays are used to detect surface temperatures. This way, Satellite Remote Sensing helps in studying



(a) Passive remote sensing



(b) Active remote sensing

Fig. 15: Different types of satellite remote sensing (image courtesy-http://www.crisp.nus.edu.sg/~research/tutorial/intro.htm)

and monitoring the planet we live on. The source of energy used should be carefully determined as absorption and scattering can take place in the atmosphere. Figure 15 represents types of satellite remote sensing.
Few areas where satellite remote sensing is used:

- Urban area, road and building detection (Object detection in general)
- Spy satellites

Methodology:

- In general, object detection from remote sensing images is carried out by using the local descriptors and functions to detect edges. Local descriptors include color, shape and texture of images. Occlusions and global geometric distortions are over come as local descriptors are used. Filters such Gabor filter can be used for extraction of features such as edges. Filters with different frequencies and orientations are used to achieve this. The main advantage with Gabor filter is that its working is analogous to the human visual system. Hence, can be efficiently used for representation and discrimination of textures. Features are represented by descriptor vectors and therefore appropriate values for different objects must be initially stored in the system. The obvious disadvantage with this system is that of considering every possible case for differentiation of objects. (Feature-based Methods + Template Management system = > Compares the descriptor values of the detected objects with the values in the system to differentiate between objects).
- Another approach to this problem is using AdaBoost (Adaptive Boosting) classifier. In this approach Haar-like structures are used to interpret features of the image. Haar-like features are digital image features. AdaBoost classifier selects a fixed number of these features depending on the ease to differentiate objects based on these features (Feature-based Methods = > Identifying Haar-like features and using it to differentiate between objects) (Ke *et al*., 2009).

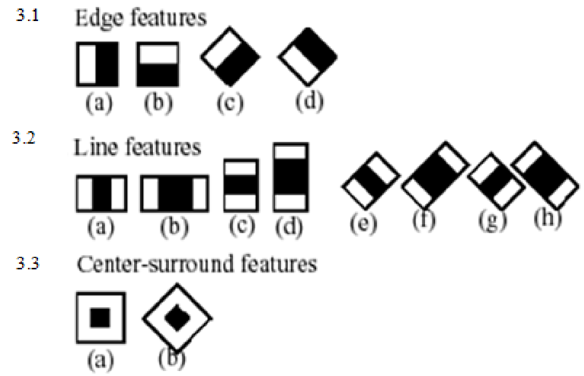


Fig. 16: Haar-like features (image courtesy-http://docs.opencv.org/http://docs.opencv.org/)

Figure 16 shows the different Haar-like features that can be used for feature extraction.

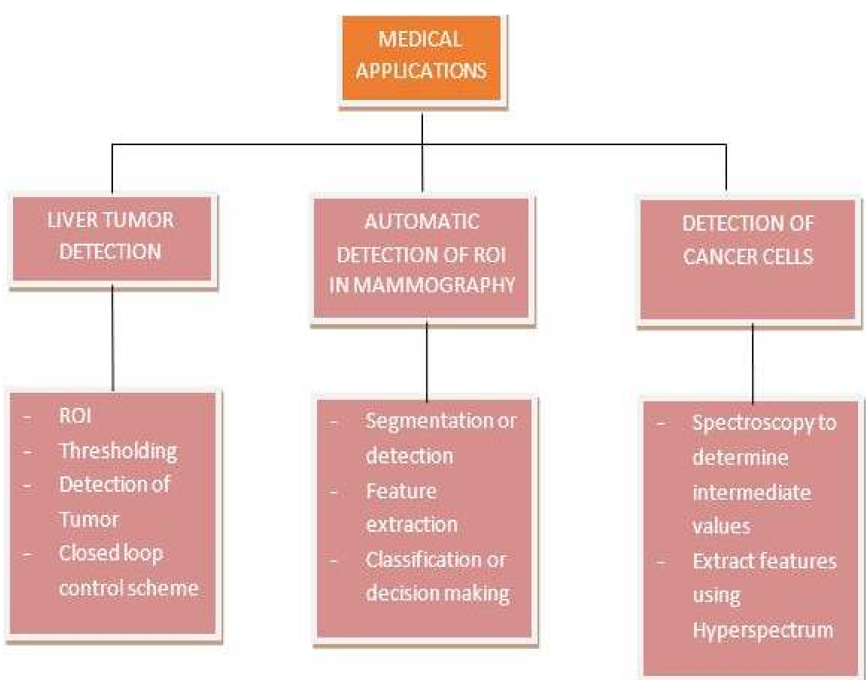


Fig. 17: Topics discussed under medical applications

The system is initially fed with objects of interest (buildings, roads and urban areas) also called positive images (all images are scaled to a predetermined size) and also few arbitrary images called negative images. The trained classifier applied to the input will return 1 if the input plausibly shows the object, otherwise it returns 0. After several stages of applying the basic classifier, certain regions are rejected if it has no chance of containing the object. The AdaBoost classifier is used to not only to select features in manner that the system is fast, but also to increase the accuracy.

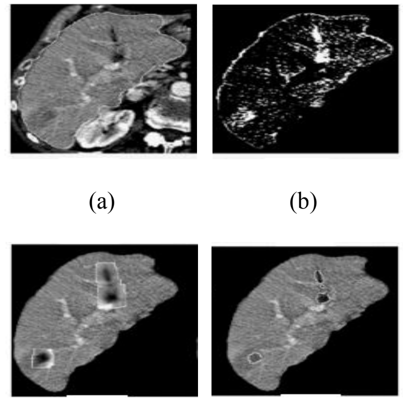
MEDICAL APPLICATIONS

Due to low signal to noise ratio, manually segregating the medical images is out of the question. Moreover, the presence of imaging artifacts makes this task even more difficult. Medical imaging systems are used to mainly to detect tumor cells, cancer cells and lesions in the human body. This task is accomplished by Magnetic Resonance (MR), X-ray, ultrasound scan, CT scan. Sometimes a combination of these techniques may also be applied to various internal organs. This is done by measuring the volume and shape of the organs in 3D imaging. Usually a Region of Interest (ROI) is defined beforehand to separate the relevant details from the background details (Bick and Doi, 2000; Jim and Park, 1993). Figure 17 summarizes the set of applications covered in this sector.

Liver tumor detection from CT scan images: Human liver is something that is very delicate. It should be given utmost care and is easily vulnerable to diseases. Here we use the computer aided diagnostic of the liver to detect tumors, lesions and vessels. This computer aided diagnostic image is obtained from a CT- Scanner. The detection method is applied to the image that is obtained from the CT scanner. One limitation of the image that is obtained directly from the CT-scanner is that, it may be blur. So we use image smoothening and thresholding techniques to enhance the quality of the image (Fasquel *et al*., 2001).

Here is an image that is obtained from the CT-Scanner. Various operations are performed on it. Figure 18 reveals CT scan image over which spatial operations are performed.

Methodology: The ROI containing the tumor is searched and identified. Tumors generally come in different sizes. Hence it is difficult to identify the region containing the tumor. After identification, the image is thresholded. As a result the granular aspects of the image are enhanced. In order to remove the grains in the image, a morphological alternate sequence filtering is performed on it. The resultant binary filtered image is closed using a much larger structuring element. This method is applied to all ROIs. Once the entire image is processed, regions that are tumorous can be identified based on comparison with empirical data.



(a) (b)

(c) (d)

Fig. 18: Spatial operations performed on CT-scanned image of liver, (a) the image obtained from the CT-scanner, (b) image after thresholding, (c) image obtained after adding A and B, (d) the dark regions could be a tumor (image courtesy: Fasquel *et al*. (2001))

Automatic detection of regions of interest in mammography based on histogram and texture analysis: Breast cancer has become one of primary causes of women mortality. Thus early screening and detection is necessary if the numbers are to be brought down. Early detection of breast cancer increases women's chances of survival. It can also be cured easily. The number of mammograms a specialist analyses is large and among them only a few of them contain malignant tumor. The problem lies in detecting lesions less than 1 mm in diameter. So to improve our chances of detection, we bring in texture and histogram analysis and use it to detect lesions.

A computer aided diagnostic system may come in handy for radiologist and can be used for early detection of breast cancer. Figure 19 illustrates the

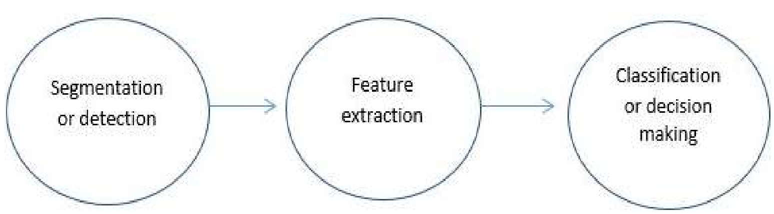
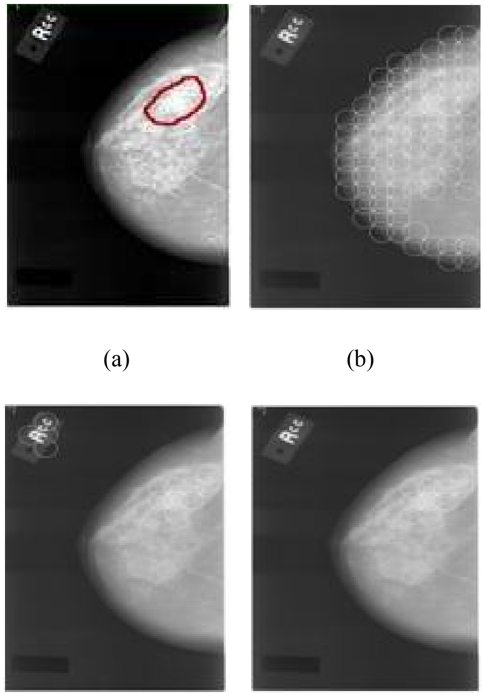


Fig. 19: Methodology followed in mammography



(a) (b)

(c) (d)

Fig. 20: Mammography analysis, (a) mass type lesion marked by radiologists, (b) texture analysis, (c) histogram analysis, (d) joined analysis (image courtesy- Tweed (2002))

methodology followed in mammography. Figure 20 has the analysis represented.

Methodology: In order to detect a suspicious region in a mammography, we apply masks on the image. The mask we use here is circular because we want detectors that are invariant in rotation. For each mammography, hundreds of texture and histogram features are extracted from the mask. Then this is compared with the features extracted from the region of interest.

For the selection of Region of Interest, we use Texture analysis and histogram analysis.

Texture analysis: Human eye has an amazing power to discriminate between objects and surfaces. In a similar way, computers can also be programmed to do the same. This task becomes challenging when the ROI is very small. Textures are repeated patterns. Each ROI contains texture. This texture is compared with empirical data for determining tumorous regions. For this we rely on various enhancement techniques such as smoothening and sharpening that can only be done by computers. On applying these processes the image is enhanced. Now it becomes easier to discriminate the regions containing tumor from the normal regions.

Histogram analysis: Tonal distribution of an image is represented using a histogram. Histogram is a graphical representation of an image. The graph is obtained by plotting the no of pixels corresponding to each tonal value. A histogram provides full tonal distribution of an image to the viewer. The number of light pixels within a tumorous region is taken into account. For this two threshold values are used. One for determining the intensity value of the pixel and the other for determining the number of pixels in ROI having intensity greater than the threshold intensity.

Detection of cancer cells in brain: Biopsy is the only way known by humans for detection of cancerous cells in the brain. If there was a way to exactly pinpoint the location of the cancerous cells, it could decrease the no of biopsies to be performed on a human. But precise detection of cancer cells in the brain is extremely cumbersome provided the delicate structure of the brain. Scientist are working on a new imaging pen which can identify the Region of Interest (ROI) containing the cancer cells. Advanced research is still going on.

This imaging pen uses a combination of Raman Spectroscopy, diffuse reflectance spectroscopy and laser induced spectroscopy simultaneously to look into the lesion (Gardiner and Graves, 1989). Cancer is caused by repeated multiplication of cells. So a region where cancer cells are found will contain more no of cells compared to other regions. The ROI is found out by analyzing the oxygen consumption of the cells as it should consume a lot more Oxygen compared to the other cells around (Khoobehi *et al*., 2004). The imaging pen is connected to a computer which performs the image processing.

Methodology:

Spectral approach: Vibrational, rotational and other low-frequency modes are recorded with the help of scattering and reflecting of particles in the electromagnetic spectrum. The representation of the brain is made pixel by pixel, giving each one its spectral values. Using Hyperspectral Imaging in conjunction with the values obtained from spectroscopy, composition of the scene can be measured. Hyperspectral Imaging gives fine details of the scene as it uses a wide range of wavelength. In this case, composition of oxygen is measured (Chang, 2003). The values obtained have to be compared with the available standard values. This way the system detects presence of cancer cells in brain (Grahn and Geladi, 2007).

This technique has a certain advantage as it allows for accurate segmentation and classifications. At the same time, it is time consuming and complex. Figure 21 states the steps involved in detection of cancer cells.

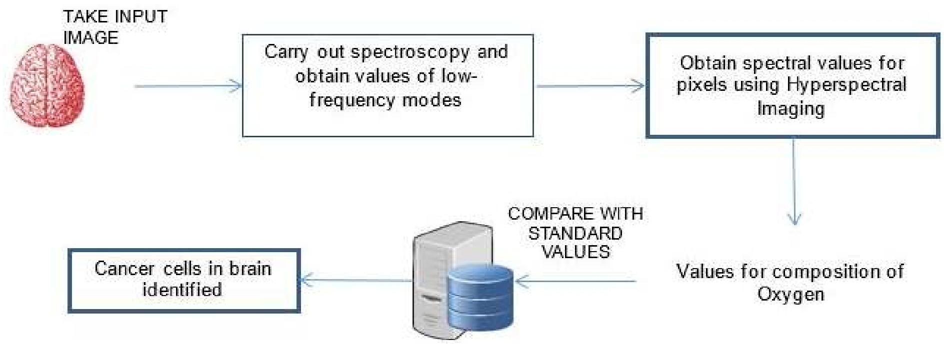


Fig. 21: Steps involved in detecting cancer cells in brain

RESULTS AND DISCUSSION

Since this is a review paper, there is no concrete section to be included as results. Object recognition is one strong area of research which has a lot of application sectors and few of them are discussed in this study which is of utmost importance.

CONCLUSION

This study analyzed application fields of Object Recognition starting with Automobile, Food and beverage and Fabric sector. Then the attention has been moved to Robotics where Image stabilization and robotic head pose detection are all carried out with object recognition techniques. Then possibility of using object orientation concepts in the field of remote sensing has been analyzed. Medical field has always been a beneficiary from the object recognition area with identification of tumor, cancer cells etc., can be achieved with object recognition methods. This study can further be extended as a book with paying more attention to object recognition implementation details.

REFERENCES

Amanatiadis, A., A. Gasteratos, S. Papadakis and V. Kaburlasos, 2010. Image Stabilization in Active Robot Vision. INTECH Open Access Publisher, ISBN: 978-953-307-077-3.

Bick, U. and K. Doi, 2000. Computer Aided Diagnosis Tutorial. CARS 2000 Tutorial on Computer Aided-Diagnosis, Hyatt Regency, San Francisco, USA, June 28-July 1, 2000.

Blasco, J., N. Aleixos and E. Molto, 2003. Machine vision system for automatic quality grading of fruit. Biosyst. Eng., 85(4): 415-423.

Boskovitz, V. and H. Guterman, 2002. An adaptive neuro-fuzzy system for automatic image segmentation and edge detection. IEEE T. Fuzzy Syst., 10(2): 247-262.

Bradshaw, M., 1995. The application of machine vision to the automated inspection of knitted fabrics. Mechatronics, 5: 233-243.

Brosnan, T. and D. Sun, 2004. Improving quality inspection of food products by computer vision-a review. J. Food Eng., 61(1): 3-16.

Cardani, B., 2006. Optical Image stabilization for digital cameras. IEEE Contr. Syst. Mag., 26(2): 21-22.

Chang, C.I., 2003. Hyperspectral Imaging: Techniques for Spectral Detection and Classification. Springer Science+Business, Media, New York, ISBN: 978-0-306-47483-5.

Duan, F., Y. Wang and H. Liu, 2004. A real-time machine vision system for bottle finish inspection. Proceeding of 8th Control, Automation, Robotics and Vision Conference (ICARCV, 2004), 2: 842-846.

Duan, F., Y. Wang, H. Liu and Y. Li, 2007. A machine vision inspector for beer bottle. Eng. Appl. Artif. Intel., 20(7): 1013-1021.

Fasquel, J.B., M.M. Bruynooghe and P. Meyrueis, 2001. Hybrid opto-electronic processor for the delineation of tumors of the liver from ct-scan images. Proceeding of SPIE the International Symposium on Optical Science and Technology, San Diego, USA.

Gardiner, D.J. and P.R. Graves, 1989. Practical Raman Spectroscopy. Springer-Verlag, Berlin, Heidelberg, ISBN: 978-3-540-50254-8.

Grahn, H. and P. Geladi, 2007. Techniques and Applications of Hyperspectral Image Analysis. John Wiley and Sons, New York, ISBN: 978-0-470-01087-7.

Jim, J.K. and H.W Park, 1993. Statistical textural features for detection of micro-calcifications in digitized mammograms. IEEE T. Med. Imaging, 12(4): 664-669.

Ke, Y., J. Zhao, C. Qu, S. Han, Z. Zhang, X. Jiang and G. Liang, 2009. A rapid object detection method for satellite image with large size. Proceeding of the International Conference on Multimedia Information Networking and Security, 1: 637-641.

Khoobehi, B., J.M. Beach and H. Kawano, 2004. Hyperspectral imaging for measurement of oxygen saturation in the optic nerve head. Invest. Ophth. Vis. Sci., 45(5): 1464-1472.

Killing, J., B.W. Surgenor and C.K. Mechefske, 2009. A machine vision system for the detection of missing fasteners on steel stampings. Int. J. Adv. Manufact. Tech., 41(7-8): 808-819.

Kinugasa, T., N. Yamamoto, H. Komatsu, S. Takase and T. Imaide, 1990. Electronic image stabilizer for video camera use. IEEE T. Consum. Electr., 36(3): 20-28.

Kosmopoulos, D. and T. Varvarigou, 2001. Automated inspection of gaps on the automobile production line through stereo vision and reflection. Comput. Ind., 46(1): 49-63.

Kumar, A., 2008. Computer-vision-based fabric defect: A survey. IEEE T. Ind. Electron., 55(1): 348-363.

Liu, H., 2010. Empty glass bottle inspection method based on fuzzy support vector machine neural network and machine vision. Front. Elect. Electron. Eng. China, 5(4): 430-440.

Loncomilla, P. and J. Ruiz-del-Solar, 2005. Improving sift-based object recognition for robot applications. Proceeding of International Conference on Image Analysis and Processing (ICIAP, 2005). Italy, LNCS 3617, pp: 1084-1092.

Lowe, D., 2004. Distinctive image features from scale invariant key points. Int. J. Comput. Vision, 60: 91-110.

Mahajan, P.M., S.R. Kolhe and P.M. Patil, 2009. A review of automatic fabric defect detection techniques. Adv. Comput. Res., 1(2): 1-29.

Oshima, M., T. Hayashi, S. Fujioka, T. Inaji, H. Mitani, J. Kajino, K. Ikeda and K. Komoda, 1989. VHS camcorder with electronic image stabilizer. IEEE T. Consum. Electr., 35(4): 749-758.

Patel, K.K., A. Kar, S.N. Jha and M.A. Khan, 2012. Machine vision system: A tool for quality inspection of food and agricultural products. J. Food Sci. Technol., 49(2): 123-141.

Stojanovic, R., P. Mitropulos, C. Koulamas, Y. Karayiannis, S. Koubias and G. Papadopoulos, 2001. Real-time vision-based system for textile fabric inspection. Real-Time Imaging, 7(6): 507-518.

Thomas, A.D.H., M.G. Rodd, J.D. Holt and C.J. Neill, 1995. Real-time Industrial Visual Inspection: A Review. Real-Time Imaging, 1(2): 139-158.

Tokyo, J., 1993. Control techniques for optical image stabilization system. IEEE T. Consum. Electr., 39(3): 461-466.