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EFFECTIVENESS OF MACHINE VISION TECHNIQUES IN TRAFFIC MONITORING AND DIMENSION METROLOGY

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ABSTRACT

Machine vision, or the employment of computer-based image resolution and apprehension, is an automation that has manifested it can establish moderately to elaborate the abundance and ambience of manufacturing operations in basically every industry. In some industries many products cannot be generated without machine vision as an elemental mechanization on production lines. Acknowledged technologies in manufacturing impel to be very specific and often capitalize on clever "tricks" associated with manipulating the manufacturing environment. Nonetheless, many useful applications are possible with existing technology. These include finding flaws, identifying parts, gauging, determining X, Y, and Z coordinates to locate parts in three-dimensional space for robot guidance, and collecting statistical data for process control and record keeping and high speed sorting of rejects. Machine vision is a term associated with the merger of one or more sensing techniques and computer technologies. Fundamentally, a sensor (typically a television-type camera) acquires electromagnetic energy (typically in the visible spectrum; i.e., light) from a scene and converts the energy to an image the computer can use. The

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computer fetches information from the image (often first enhancing or otherwise processing the data), compares that information with earlier developed standards, and outputs the results usually in the form of a response.

INTRODUCTION

There are enormous refreshing approaches to automatic traffic monitoring using Machine Vision technology. A TV camera is hopped above the highway to monitor the traffic through two slice windows for each traffic lane. One slice window is a “detection line” perpendicular to the lane and the other is a “tracking line” along the lane.

(1) *Real-time and robust performance*: Traffic monitoring is a real-time visual system working robustly under various light conditions including shadows and vehicle lighting. It can automatically cope with both slow and sudden illumination changes. The system can automatically recover from false sensing or abrupt changes in environment.

(2) *Enhanced functions:* Our system can not only count vehicles and estimate their speed, but also classify the passing vehicles using 3D measurements (length, width and height). Moreover, robust speed and height estimation are obtained from the loci of a vehicle’s front and rear edges instead of using only the vehicle’s locations at two different instants as in. The detection results are visually superimposed on the live video screen.

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(3) *Low cost and efficient computation:* Traffic arguments are incurred by 2D spatiotemporal image techniques implemented using an inexpensive image processing system: a PC486 and a cheap frame grabber. Only a few scan lines are processed in each frame. ST images are more generic and simpler than frame-by-frame images in this special application. Narrow spatial viewing windows are compensated for by dense temporal sequences, and vehicles that are partially viewed in a single frame can be reconstructed using ST images.

(4) *Easy installation and calibration*. The camera system can be installed without disturbing the traffic flow. Once the hardware is installed, a detection line and tracking lines can be easily re-defined or re-positioned on a video screen to adapt for changing traffic control and/or data collection requirements. Camera parameters for the 2D ST image geometry can be easily decided without actually measuring any 3D coordinates of the road environment. Instead, camera calibration is realized using only the known size of a passing vehicle.

(5) *Compact visual representation*. PVIs are a compressed and panoramic representation of a traffic flow and they can be saved on hard disk for further examination and study. ST images are also suitable for performance analysis of a traffic monitoring system when the ground truth information is not available.

HOW DOES A VISION SYSTEM WORK

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The working of the machine vision system is shown in the figure below. Machine vision is one of the technologies of computer vision to factory mechanization. Human attorney work on the assembly lines visibly inspect different parts to rate the ambience of workmanship. Likewise machine vision system use digital cameras and image digitizing and processing software to perform analogous inventory. The system is basically a computer that makes judgements based on the analysis of digital images. The ingredients of machine vision ideology are enigmatic, and summing up everything together is the role of integrator which results in elevated ambience, amalgamating of production processes, low costs and the most efficacious of self-regulating operations possible.

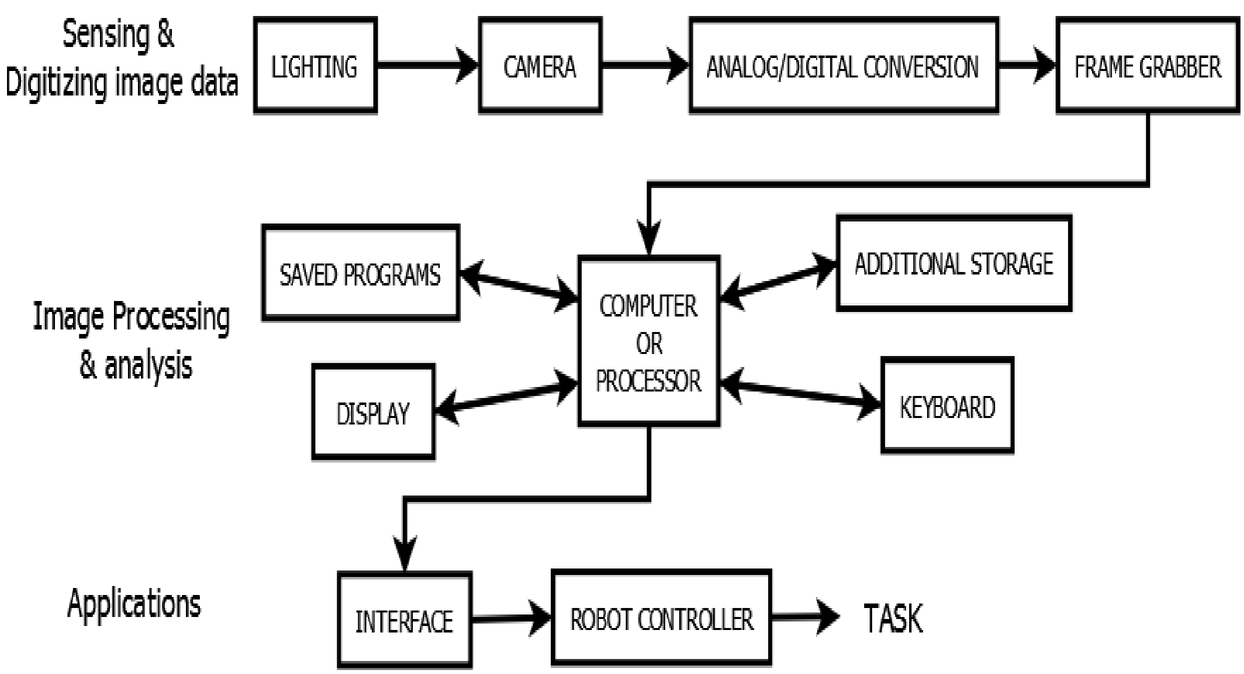

FIGURE 1.2 : FUNCTIONING OF MACHINE VISION SYSTEM

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A fundamental machine vision system will generally include the following functions:

- Lighting: Dedicated illumination.
- Optics: To couple the image to a sensor.
- Sensor: To convert optical image to analog electronic signal.
- Analog-to-Digital (AID) Converter: To sample and quantize the analog signal. (Note: some cameras have digital outputs so a separate A/D function is not required.)
- Image Processor/vision engine: Includes software or hardware to reduce noise and enhance, process, and analyze image.
- Computer: Decision-maker and controller.
- Operator Interface: Terminal, light pen, touch panel display and so on, used by operator to interface with system.
- Input-Output: Communication channels to system and to process.
- Display: Television or computer monitor to make visual observations.

Components of a machine vision system is basically fabricated of multitudinous ingredients that include lighting, cameras, frame grabbers, optics, lenses, software, processors and displays [14]. Simple machine vision systems can identify two dimensional or three dimensional barcodes, but more refined and artificial systems that can assure inspected parts meet peculiar benevolence, have been amassed correctly, and contain no defects.

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OUTLINES / DESCRIPTION OF SOME IMPORTANT TERMS THAT ARE USED IN THE MACHINE VISION IDEOLOGY

S.No	**Term**	**Description**
1.	Algorithm	A mathematical process designed to systematically solve a problem.
2.	Analog-to-Digital Converter	A device used by a vision system to convert real-world values into the binary numbers that a computer can understand.
3.	Back lighting	A lighting technique that places lighting behind the target object, usually glistening through a apparent surface.
4.	Collimator	A lighting device that creates a balanced light source that does not dismissimmediately.
5.	Condenser projector	A lighting device that begets a bright, narrowly concentrates light beam.
6.	Diffuse surface device	A lighting device that begets a soft, broad light.
7.	Digitized	Transformed from real-world values to binary numbers. Computers attempt only in some binary or digital numbers.
8.	Flood projector	A lighting device that begets a wash of light not just on the object, but all through the surrounding arena.
9.	Front lighting	A lighting technique that places lighting near the camera and directs light towards the target entity.

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10.	Grayscale	A digital image in which the value of each pixel carries only the data of light intensity. Grayscale is diverse from black and white in that it identifies many more than two levels of intensity.
11.	Linear array	A basic, one-dimensional vision system that can actuate if objects are present and discover surface defects.
12.	Machine vision	The capability for a robot to "see." This sense of sight is assured by a vision system.
13.	Many-to-one mapping	A way that computers control relationships between unique information. For vision systems, this means there are "many" data pinpoints in the real-time three-dimensional world for each "one" data pinpoint in its two-dimensional presentation.
14.	Matrix arrays	Multiple cameras, two- or three-dimensional vision set ups that can evaluate and gauge parts.
15.	Optical inspection	A form of enquiry that can use a laser to rapidly scan and evaluate the surface area of parts to search for errors.
16.	Pixel	The smallest piece of data in an image. Pixels can be presented as black and white, or shades of gray that merely depends on light intensity.
17.	Pixel matrix	A two-dimensional grid with complementary number values onto which pixel information is set

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		up.
18.	Side lighting	A lighting process that places lighting perpendicular from the object and the camera.
19.	Solid state camera	A newer type of camera that converts images into a two-dimensional array of evenly spaced photosensitive elements.
20.	Vidicon camera	An older type of camera that forms images on a photoconductive surface and converts the light values into pixel data.
21.	Vision system	A device that gathers data and forms an image, which is judged by a computer to evaluate an appropriate position or to "see" an object.
22.	Work cell	The defined arena of space through which a robot can move.

IMAGE ACQUISITION

The appliance of machine vision automation includes dealing with many visual variables. In most cases one must be magnanimous of some variables and precise to others, the system must discover. Even simple applications have to confront with variables that a person doing the same task can easily banish. Label presence and/or absence discovery is often cited as a machine vision employment. One variable a system must be able to confront with is hue saturation. For instance, a label may be accurately acceptable as long as its "colour" is yellow, from pastel to perceptually orange. A person can accept this range and still discover a missing or skewed label.

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A machine vision system may be deceived into thinking the label is missing when normally the acceptable hue saturation change is what was accomplished.

Lighting and optics in many appliance can be optimized to increase the contrast linked with the variable for which a system is brought or, conversely, can aid in abating the significance of the variable on the information needed to make a reliable "vision/decision."

In a given machine vision accession, dedicated lighting is approved. However, secondary sources of illumination may derive from surroundings lighting and the reflection of the primitive source of light off of other accessories or even a floor after scouring. The net result is a complicated pattern of light in which consistency is a challenge. This can affect the characteristic feature of shadows and shading on the surface, which can alter the judgement of the object.

Gray Levels interpreted by a machine vision system are physical calculations are a function of radiance, viewpoint, surface reflectance, and assimilation. Generally, variations in radiance, surface reflectance, and surface acclimatization give rise to shaded images as seen from a viewpoint; surface reflectance, and surface assimilation give rise to shaded images as seen from a given viewpoint.

The reflectivity feature of an object is obstinate by such surface features as texture or colour. An entity of consistent colour and smoothness radiates light consistently from all points on its surface. Real time entities do not act this way, abiding different surface properties, and subsequently, diversifications in brightness are noticed in images.

Human visual of brightness or the colour of a part of an image is very strongly affected by the brightness or colour of the surrounding parts. The relative consistency of the anticipated

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lightness and colour of a surface under different radiance conditions also influence human perception. A gray piece of paper taken from an indisposed lit room into the bright outside sunshine still emerges gray, even though the quantity of light radiated is several orders of eminence bigger than from a white piece of paper indoors. Consequently, a surface of a certain colour generally grasps its observed hue even though the colour of radiance alters.

A sensor, whose reaction is proportional to the average light intensity in a small surrounding, makes local calculation of the brightness of a small arena of an image, while to the eye the observed brightness depends on the intensities of the neighbouring pixels. The human observation of colour includes differentiation based on three independent properties: intensity, hue, and saturation.

1-D MACHINE VISION TECHNIQUES

A scene is a three-dimensional setting that is made up of physical objects. Modelling a three-dimensional scene is an act of building a characterization for the surfaces of the entity of which the scene is constituted. The overall problem is to create algorithms and data structures that allow a program to locate, analyse, and/or operate on the physical entites in a scene from two-dimensional images that have a gray scale feature.

The following represent some "brute-force" methods:

(1) Two-dimensional plus auto focusing used in off-line dimensional machine vision systems

(2) 2D×2D×2D, i.e, multiple cameras each viewing a separate two-dimensional plane

(3) Laser pointer profile probes and triangulation methods

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(4) Acoustics.

Several approaches have evolved, and these are sometimes categorized based on triangulation measurements:

1) Stereoscopy
    a. Passive
        i. Binary
            1. Point
            2. Edge
            3. Area
        ii. Grayscale
            1. Point
            2. Edge
            3. Area
            4. Template
        iii. Colour
    b. Active, using projected bars and processing methods linked with a.i and a.ii
    c. Passive/active, based on laser scanner technologies, sometimes referred to as based on signal processing
2) Controlled illumination
    a. Structured light
        i. Sheet
        ii. Bar
        iii. Other
    b. Photometric stereo

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RELATIONSHIP TO OTHER FIELDS

Machine vision ideology is related to many other fields of computer engineering [13] discussed below:

a) Image processing
   - Image transformation
   - Filtering
   - Compression
   - Restoration
   - Enhancing particular data
   - Suppressing noise

b) Pattern recognition
   - Classifying numerical data and symbolic data
   - Classifying feature vectors in statistics
   - Representing the configuration of an entity
   - Parsing the description of entity
   - Classifying the different objects

c) Computer graphics
   - Decomposition of images
   - Generates images from geometric indigene
   - Visualization

d) Artificial intelligence
   - Computational aspects of intelligence

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- Analysing scenes
- Computing symbolic representations
- Perception: converts signals to symbols
- Cognition: manipulates symbols
- Action: translates symbols to signals

e) Neural network

- Procedures that are applied to pattern recognition analysis
- Image recognition
- Image classification
- Image segmentation

CHALLENGES

During the practicability study and fulfilment of a vision appliance there are some problems that are very common than others [15]. Typical bottlenecks and pitfalls in vision projects are listed as below:

- Defining Requirements

It can be a confrontation to specify the task so that all engaged parties have the same expectations of system consummation. The customer has the outlook and terminology of his or her industry, and so does the vision supplier. Inter-communication between both parties may need that each shares their knowledge. To designate clear assent test conditions is a good way of advertising the expectations of the system.

- Performance

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The cycle time can become an analytical factor in the elite of camera system and algorithms when entities are enquired at a high frequency. This scenario is typical for the packaging and pharmaceutical industries. Accuracy is the repeatability of calculations as comparable to a reference value or position (measure applications). Success rate is the system's authenticity in terms of false OKs and false rejects. A false OK is when a faulty object is wrongly diversified as OK, and a false reject is when an OK object is wrongly diversified as false. It is often important to make the distinction between the two aspects, since the emanation of each can be totally variant in the production line.

- System Flexibility

Creating a vision system that executes one task in a constant surrounding can be easy. However, the system's complications can increase rapidly when it shall enquire variable objects in a variable surrounding. It is common to expect that since the vision system enquires object A with such success, it must also be capable to enquire objects B and C with the same setup since they are "so similar".

- Object Presentation Repeatability

The object presentation is the object's outlook in the image, including position, rotation, and radiance. With great repeatability in the image, the appliance solving can be easy. On the other hand, the application solving may become more difficult or even impossible for the very same object if its presentation is erratic.

- Mechanics and Environment

Although a vision system can be a mechanized optimal solution, sometimes there is not enough mounting area. Then one must consider an alternative solution or reconstruct of the machine.

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