Investigating the Role of Image Processing to Identify Pattern for Industrial Automation

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***Abstract*— When both the input and the output are images, image processing is used. It was given its name because of its focus on image processing. Imaging and signal processing, as well as image enhancement and voice signal processing, can all be done on this platform. In order for an image or video to be identified, a specific object or feature must be found. In this study, CBIR is used to discover patterns. Research work also focused on industrial automation and the function of image processing in it. Even at high speeds, industrial image processing ensures a precise recording. Industrial image processing is a typical feature in automated inspection systems. Industrial image processing accessories include things like sensors that trigger cameras and camera rails that allow cameras to be moved.**

Keywords*— *Image Processing, Pattern Recognition, CBIR, Industrial Automation

I. INTRODUCTION

Image processing is utilized when both the input and the output are images. Its name derives from the fact that it mostly deals with image processing. On this platform, imaging and signal processing may be done, as well as image enhancement and speech signal processing. An item or feature must be located in order to identify a picture or video. CBIR is employed in this research to identify patterns. Industrial automation and the role of image processing are also important to us. High-speed industrial image processing provides a perfect recording. Automated inspection systems often include image processing as a standard function. Sensors that activate cameras and camera rails that enable cameras to be moved are examples of industrial image processing accessories.

A. Introduction of Image Processing

Two-dimensional signals are all that images are. If x and y is horizontal and vertical co-ordinates, then it is defined as follows: f(x, y). The value of f(x, y) at any given place provides the pixel value of a picture. There are several aspects to signal processing, including signal analysis, signal processing, signal storage, signal filtering, signal coding, and signal decoding. The taxonomy of image processing is: analogue and digital. Software for digital image processing, such as computer graphics, signals, photography, camera mechanisms and pixels, is called digital image processing. Various activities, such as image enhancement, signal processing of analogue and digital data, picture signals, and speech signals, can be carried out on this platform. It makes photographs available in a variety of formats. Algorithms in Digital Image Processing (DIP) are used to alter images [15].

B. Characterstics of Digital Image Processing

- Some of the software it employs is free of charge.
- It's easy to see what's going on.
- Digital Image Processing enhances photographs in order to re-create the info that was previously lost.
- It is widely employed in a variety of industries.
- There is a reduction in the complexity of digital picture processing.
- Use it to enhance the quality of life for yourself and others.

C. Image Recognition and Pattern Recognition

When an object or feature in an image or video is recognized using image recognition, the process has been successful. Defect detection, diagnostic imaging, and security surveillance are just some of the uses for this technology. This digital world is awash in patterns. Algorithms can be used to mathematically examine patterns or to see patterns in actual space. As an example: the color of their attire, their talking style, or anything else they wear. Computer science uses vector feature values to represent a pattern. A machine learning method is used to identify patterns in a dataset [5]. The categorization of data implanted on previous evidences or statistical information collected from patterns and/or representations of patterns can be referred to as "pattern recognition." Pattern recognition's ability to be put to use is a crucial consideration. There are many examples of this: voice recognition, orator identification, multimedia document recognition, and automated medical treatment. In a general pattern recognition application, the unprocessed data is

processed and turned into a form which is usable by a machine [11].

D. Feature of Pattern Recognition

Pattern recognition possesses the following features:

- In order for a pattern-recognition system to be effective, it should be able to quickly and accurately identify familiar patterns.
- Recognize and categorize new and unusual items.
- Be able to correctly identify items and forms from various perspectives.
- Be able to discern patterns and things, no matter how masked they appear to be.
- Recognize patterns fast and easily, and do it on autopilot [8].

E. Content Based Image Reterival

Image retrieval systems are used to find photos that match the user's query in the database. Images can be searched, browsed, and retrieved from a huge database using an image retrieval system. Several web-based image annotation tools have also been developed as a result of the rise of social web apps and the semantic web [4]. CBIR is the application of computer optics techniques to solve the issue of locating for digital images in huge datasets. As a result, a "content-based" search is one that analyses the actual content of an image rather than the metadata connected with it. Colors, forms, textures, or various data that can be deduced from the image itself is referred to as "content" in this context [1].

There are various difficulties that can be solved by using content-based image retrieval (CBIR) because it is based on a visual examination of content that is in question. It is also known as query by image content (QBIC). From the Image database, features are extracted. Then, features of image are from database are matched with query. As per the query features are extracted and then matched. After feature matching, we get the required image. Finally, image is retrieved [3].

F. Industrial Automation

Because of the use of control systems like computers or robots and information technology, human operators are no longer required to operate various machines or processes in an industrial setting. Improved product quality and production can be achieved through the use of cutting-edge technologies that are seamlessly incorporated into the manufacturing process. Industrial automation can be classified as either fixed or programmable or flexible or soft.

In automated inspection systems, industrial image processing is commonly employed. Various image processing processes are performed to improve the image quality, enhance the required features, and so on. Patterns can be spotted by analyzing the enlarged photos. In the majority of industrial image processing, specific cameras or imaging systems are installed on the production line. In order for industrial image processing to be successful, the second necessary component is a powerful image processing computer. Through a variety of computer interfaces, each camera can be tailored to its specific application [2]. Sensors that activate the camera, for example, or camera rails on which cameras can be moved, are examples of industrial image processing accessories. Industrial image processing is able to guarantee an accurate recording even at high speeds. This includes places where people cannot enter, such as areas with high or low temperatures or poisonous surroundings, where cameras can be put [14].

- *The Automobile Trade:* Manufacturing advanced self-driving cars is quickly becoming a reality.
- *Gaming:* In the gaming industry, the use of picture detection and recognition technology revolutionized everything. Gamers may now use their real-world environment as a battleground for adventure thanks to the latest in technological advancements.
- *Healthcare:* The healthcare industry benefits greatly from object detection technologies. It has made a significant impact on the entire patient experience.
- *Retail Grocery:* AI-based computer vision is used to automate goods delivery services in high-volume supermarkets. A real-time check of product availability and an instant request for out-of-stock products are both requested by the system when it identifies gaps in the shelves [14].

II. LITERATURE REVIEW

Researchers in the field of image processing, pattern recognition, and CBIR all contributed ideas and knowledge to our investigation of the function of image processing in identifying patterns for industrial automation. As a prelude, here is a brief overview of the papers that serve as a foundation and guide us toward our study goal.

Performance and comparison studies were presented by Saroj A. Shambharkar et al [1] for the two different CBIR systems. When it comes to applying deep learning in the sector of industrial automation, Benjamin Maschler et al. [2] found that there were two major roadblocks: a lack of sufficient training data and the requirement to preschool for the use case evolves with time.

In both cases, industrial deep transfer learning could provide a solution because it allows for efficient, continual and possibly distributed training on tiny, dispersed datasets. There is a strong correlation between large-scale pertaining and enhanced retrieval ability, according to the findings of Konstantin Schall et al. [3].

Using these encouraging results, the researchers want to pique interest in CBIR research[4], gave an overview of the CBIR architecture as well as recent low-level feature extraction approaches as well as machine learning algorithms, similarity metrics, and a performance evaluation in order to stimulate additional studies. CBIR stages and the most recent strategies for reducing semantic gaps were discussed.

Finally, their research highlighted some of the most critical difficulties that affect the performance of CBIR and focused on many directions that could lead to the development of a novel CBIR model. It was, however, a difficult undertaking to build an algorithm that delivered great accuracy while minimizing processing costs. As a new and fast information recovery procedure, CBIR was proposed by Senthil Kumar Sundararajan and his colleagues [5].

Search engines such as Google, Yahoo, and Bingo relied on textual descriptions of photos in order to systematically explore a large database. There was a considerable

discrepancy between the representation of image features and human visual comprehension, according to Afshan Latif et al. [6].

Thus, research reported here aimed to narrow the semantic gap between picture feature representation and visual comprehension. "It was their goal to provide a complete analysis of current developments in CBIR and picture representation in their paper, which was published this week. According to Jaya vardhana Gubbi et al. [7], machine vision has done an excellent job of utilizing deep learning. Innovations in the fields of digital twins and augmented reality have been on the market as well as driverless vehicles and industrial inspection (AR). However, in the past, data acquisition in computer vision was hindered by the need to manually evaluate collected picture data.

Binary object features (Area, Center of Area, Axis of Least Second Moment, Perimeter), Histogram Features (Mean, Standard Deviation, Skew, Energy, Entropy), Color Features, and Spectral Features were studied by Nilu Singh et al. [8]. For example –Distance and Similarity Measures in Feature Analysis for Vectors and Feature Spaces (Euclidean distance, Range-normalized Euclidean distance, City block or absolute value metric, maximum value).

There was a discussion regarding the importance of CBIR systems and retrieval of images using feature extraction methods by K. Srinivasa Reddy et al. [9], as well as a general overview of CBIR systems.

FR performance was examined by Shui-Guang Tong et al. [10] who attempted to mitigate the problem by considering face symmetry. On an image classification test, Vikram Voleti et al. [11] achieved 100% accuracy using simple methods.

The smart vision system suggested by Tushar Jain et al. [12] consistently beats other current systems in parts matching and detection.

III. Problem Statement

In the previous researches, there is lack of accuracy and efficiency. They are not up to the mark. They lack applicability in the real-life scenario. There is need to increase focus on image processing and understand its importance in industrial sector.

IV. Proposed Work

Proposed work is considering image processing to identify pattern for Industrial Automation. Image dataset has been used for training and suspicious events in industry are recognized using this system. Image processing mechanism allows resizing image and compression of graphical contents. Moreover graphical contents have been preprocessed using edge detection mechanism before training. CBIR allows feature extraction of image and proposed work is dealing with such features in order to detect the pattern.

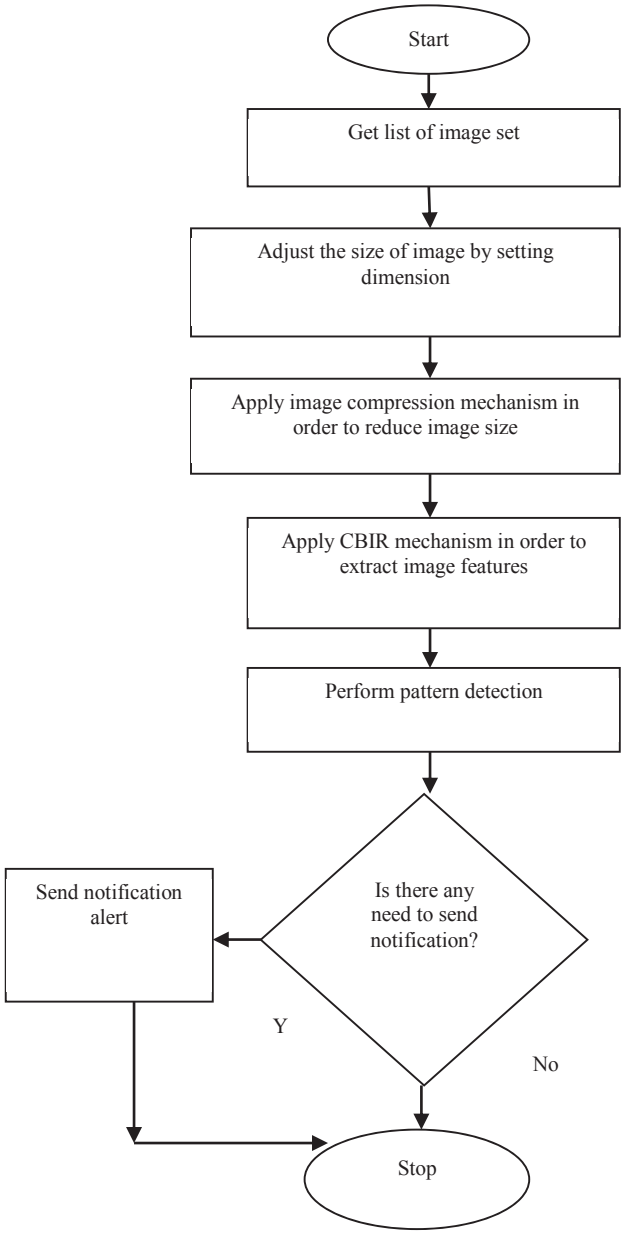

Fig. 1. Process Flow of Proposed Work

V. Results and Discussion

Get the images of different category for industrial automation for pattern detection. Their image may consist of fire image, authentic number plates, images of authentic person etc. These images would be preprocessed and stored. The time consumption during pattern detection has been considered during simulation. Moreover the size of image is also considered.

A. Simulation of Time Consumption during Pattern Recognition

The proposed work has reduced the time consumption as compared to previous researches. Result has been presented in table 1.

TABLE I. Simulation of Time Consumption during Pattern Recognition

Number of Images	Normal Image	Compression	Edge Detection	Hybrid Approach
10	6.7674	4.5116	5.4139	2.7069
20	19.1054	12.7369	15.2843	7.64218
30	25.3668	16.9112	20.2934	10.1467
40	30.9957	20.6638	24.7965	12.3982
50	36.4181	24.2787	29.1345	14.5672
60	39.2424	26.1616	31.3939	15.6969
70	26.2377	17.4918	20.9902	10.4951
80	70.9959	47.3306	56.7967	28.3983
90	21.7395	14.4930	17.3916	8.6958
100	24.2020	16.1347	19.3616	9.6808
110	70.5796	47.0530	56.4637	28.2318
120	101.2238	67.4825	80.9790	40.4895
130	58.0252	38.6835	46.4202	23.2101
140	51.7081	34.4720	41.3664	20.6832
150	47.3347	31.5565	37.8678	18.9339
160	72.5912	48.3941	58.0730	29.0365
170	40.71975	27.1465	32.5758	16.2879
180	173.7415	115.827	138.9932	69.4966
190	122.9632	81.9755	98.3706	49.1853
200	190.6816	127.121	152.5453	76.2726

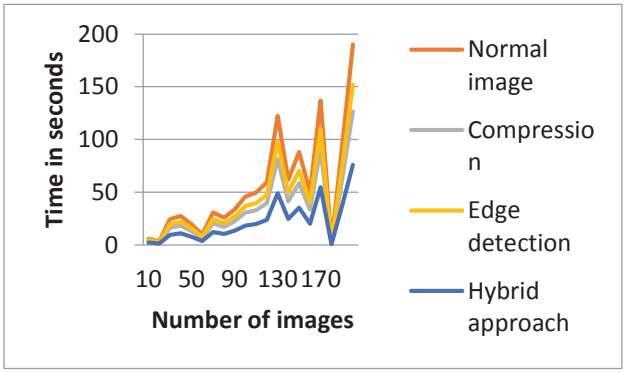

Fig. 2. Simulation of Time Consumption during Pattern Recognition

B. Simulation of Space Consumption when image is saved

The proposed work has reduced the space consumption as compared to previous researches. Result has been presented in table 2.

TABLE II. SIMULATION OF SPACE CONSUMPTION WHEN IMAGE IS SAVED

Number of Images	Normal Image	Compression	Edge Detection	Hybrid Approach
10	58.4300	38.9533	46.7440	23.3720
20	176.8808	117.920	141.5046	70.7523
30	269.6030	179.735	215.6824	107.8412
40	71.6463	47.7642	57.3171	28.6585
50	50.4433	33.6288	40.3546	20.1773
60	100.1911	66.7941	80.1529	40.0764
70	326.4872	217.658	261.1897	130.5948
80	664.3264	442.884	531.4611	265.7305
90	778.4097	518.939	622.7278	311.3639
100	592.5507	395.033	474.0406	237.0203
110	587.8011	391.867	470.2409	235.1204
120	515.5115	343.674	412.4092	206.2046
130	700.4041	466.936	560.3232	280.1616
140	107.9894	71.9929	86.39158	43.1957
150	1157.049	771.366	925.639	462.8197
160	1499.724	999.81	1199.779	599.8898
170	1373.151	915.434	1098.521	549.2605
180	1421.03	947.35	1136.825	568.4127
190	1231.128	820.75	984.9025	492.4512
200	1895.550	1263.7	1516.440	758.2202

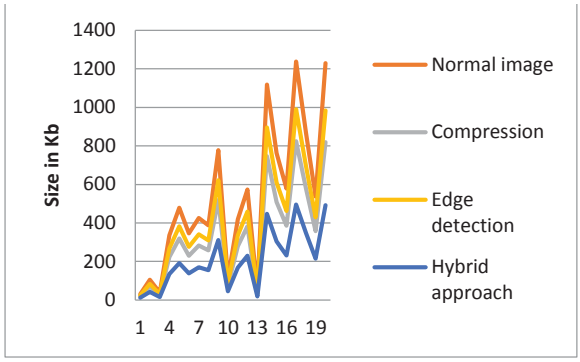

Fig. 3. Simulation of Space Consumption when image is saved

C. Simulation of Accuracy during Pattern Recognition

The proposed work has improved the accuracy as compared to previous researches. Result has been presented in table 3.

TABLE III. SIMULATION OF ACCURACY DURING PATTERN RECOGNITION

Number of Images	Normal Image	Compression	Edge Detection	Hybrid Approach
10	88.1	90.4	91.2	92.8
20	82.0	87.8	89.1	89.8
30	80.7	83.6	84.6	86.1
40	80.1	87.5	89.0	89.9
50	84.5	87.6	89.0	89.6
60	84.3	92.8	94.2	94.8
70	83.7	89.0	90.8	92.6
80	83.8	88.6	88.8	89.1
90	80.0	82.0	82.5	84.1
100	83.0	83.5	83.7	84.4
110	87.6	91.2	92.0	93.0
120	85.7	93.8	94.5	94.6
130	81.2	83.8	85.5	86.5
140	83.2	86.9	88.5	89.6
150	90.0	98.4	99.0	99.3
160	88.6	92.6	93.8	94.0
170	81.4	90.4	90.8	90.8
180	85.9	92.0	93.0	94.8
190	85.1	85.6	86.1	86.4
200	82.1	82.4	82.6	83.6

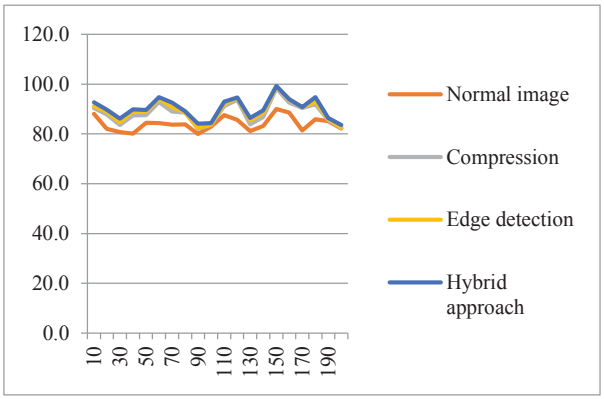

Fig. 4. Simulation of Accuracy during Pattern Detection

D. Simulation of Error rate during Pattern Recognition

The proposed work has improved the accuracy as compared to previous researches. Result has been presented in table 4.

TABLE IV. SIMULATION OF ERROR RATE DURING PATTERN DETECTION

Number of Images	Normal Image	Compression	Edge Detection	Hybrid Approach
10	11.9	9.6	8.8	7.2
20	18.0	12.2	10.9	10.2
30	19.3	16.4	15.4	13.9
40	19.9	12.5	11.0	10.1
50	15.5	12.4	11.0	10.4
60	15.7	7.2	5.8	5.2
70	16.3	11.0	9.2	7.4
80	16.2	11.4	11.2	10.9
90	20.0	18.0	17.5	15.9
100	17.0	16.5	16.3	15.6
110	12.4	8.8	8.0	7.0
120	14.3	6.2	5.5	5.4
130	18.8	16.2	14.5	13.5
140	16.8	13.1	11.5	10.4
150	10.0	1.6	1.0	0.7
160	11.4	7.4	6.2	6.0
170	18.6	9.6	9.2	9.2
180	14.1	8.0	7.0	5.2
190	14.9	14.4	13.9	13.6
200	17.9	17.6	17.4	16.4

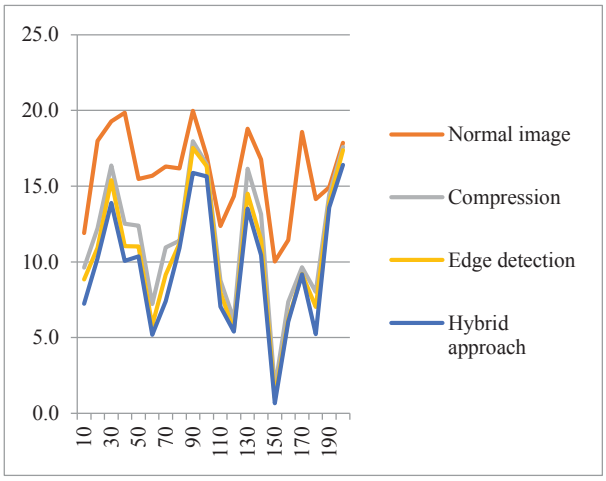

Fig. 5. Simulation of Error Rate during Pattern Detection

VI. CONCLUSION

In this research due importance is given to the potential of image processing and pattern recognition. Pattern recognition will help in minimizing the time of completing tasks in industrial sector by assisting in automation. This research is applicable in real life scenario. Proposed research has high accuracy and efficiency. For the automation in industrial sector, computer vision serves as revolutionary.

VII. FUTURE SCOPE

The scope of industrial automation is very high. Computer vision or machine vision is very crucial for enhancing capability of robotics and automation. Pattern recognition help machines to identify similar goods such as it will help to sort standardized goods and sub-standard goods like nut and bolts. It will also aid in quality check area. Image processing and industrial automation have wide scope for future. In other words, Industrial automation has a wide range of applications. Robotics and automation benefit greatly from the use of computer vision or machine vision. For example, pattern recognition can be used to sort standardized products from lower-quality ones like nuts and bolts. The quality control section will benefit as well. Industrial automation and image processing both offer bright prospects for the future.

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