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Industrial Monitoring Using Image Processing, IoT and Analyzing the Sensor Values Using Big Data

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Abstract

In this modern era, monitoring of industrial parameters like temperature reading of the respective machines, voltage supply to the equipment, inside environment of the industry, pressure level, inventory monitoring and management so on. Change in reading of the values can be a massive effect. Not only parameters like these but also the position of objects placed are also important to monitor. For an example, consider and oil or fuel drums that are placed one upon other in a room. Monitoring of these parameters has been changed day by day since past few years. Here we are using the software technologies like image processing, machine learning to monitor some of the industrial parameters. And also big data techniques to analyse the various sensor values for the prediction of future values or to know about the behaviour of the respective machine. This can also be extended to use machine learning techniques to automate the complete system. The hardware part here is controlled by Arduino mega which acts like a centralized processing unit for the whole part system. The system is stable and also it is an effective way to monitor. This technique can bring new safety measures for small scale industries too.

Keywords: IoT; Image Processing; SURF; SIFT;

1. Introduction

In industries we require manual power to monitor the parameters like voltage supply, different gases etc. If these are not monitored accurately it may lead to abnormal situation. This is one among the issues in industrial sector. But in harmful situations we can't use manual power to control them. It is too risky. So we can't depend only on manual power all the time. We need something that can do things automated.

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From the past few years the monitoring system is changing rapidly by decreasing the manual power and making the system automated by using the latest technologies like image processing by monitoring each and every second throughout the day. Here we are projecting our ideas by implementing some techniques.

In industry we have different type of sensors to get the accurate values or reading of the machine and also the parameters like temperature, voltage, gas etc. These values will be displayed on screen continuously and also uploaded to cloud using IoT which is a wireless module. All these uploaded values can be seen on computer system and can be monitored remotely from any place where you can access the site. Developing this type of system will reduce the risk taking chances in abnormal conditions. The main objective of the project is to use some of the present technologies like as mentioned image processing, big data, machine learning algorithm.

2. Related Work

Vinay. [4] Proposed function of facial recognition using SIFT and SURF algorithms from key point detection and Feature description.

Sakai. [5] Proposed a method for detection of the object and its tracking system using SIFT and SURF feature. From the results it is said that the accuracy of key point matching is high in SURF than SIFT.

Karami [7] Proposed a comparison between three different image matching techniques performance against different types of deformations and also transformations like scaling, rotation, noise, fish eye distortion, and shearing.

Abinayaa Balasundaram. [11] Proposed a real-time air pollution monitoring system at any time anywhere using Gas Sensor. The vehicle owner receives shared data and alert messages via text message, and also updated to the environment organizations.

Vaibhav Borkar. [12] Proposed and developed a system based on AVR microcontroller to monitor the voltage and current including the temperature of distribution transformer in a substation.

Ramesh Kumar. [13] Proposed a temperature monitoring and control system controlled by a PC using virtual instrumentation. The data is processed by microcontroller and the simulator acquires that data through Ethernet port and displays it LCD and PC monitor.

Sung. [14] This system uses the ZigBee protocol to improve industrial safety by enabling remote monitoring. The industrial parameters are also monitored like electricity monitoring, CO2 level, monitoring temperature levels so on.

Dan. [15] Proposed a SURF object tracking algorithm. It is a two stage matching method to improve the accuracy of matching points. To deal with the problem of object appearance change template update method is used. The Mean shift algorithm was used instead of SURF to track object for the frames which have less matching points.

3. Image Processing Algorithms

Feature detection helps us to examine an image and also in determining the features that are distinct from other objects of the image which in turn helps to detect an object based on its features in different images. The image should be detected even after scaling or transformation of the image. SIFT and SURF algorithms are used for this purpose. MATLAB ide is used for the execution of these algorithms.

3.1. SIFT Algorithm:

SIFT is both a key point detector and a key point descriptor .We can detect the features of the images by finding the key points which are mostly edges in an image. This specification helps us to detect the objects among many

other objects .There are many conditions when extracting these features. SIFT algorithm helps to detect the objects in an image irrespective of scaling and rotation of an image.

Algorithm works as follows:

Key point matching or the feature matching with various types of images is the problem in computer vision. When the images are similar the corners detectors can do the work easily. But if we have images of different rotation and scales we have to use SIFT algorithm.

Algorithm:

1. **Scale Space Construction**: Creating an internal representations of the image (original image) to make sure the scale invariance.
2. **Approximating Log:** To find the key points from an image the laplacian of gaussian is used.
3. **Search for Key points:** Using the approximation now let us find the keypoints by calculating the maxima and minima from the difference of image we got in second step.
4. **Elimination of Keypoints:** here we eliminate those keypoints which have edges and low contrast regions. These points are called as bad keypoints. This makes the algorithm efficient.
5. **Orientation assigning for keypoints:** For each and every keypoint the orientation is calculated making it rotation invariant.
6. **SIFT Feature Generation:** One more representation is generated by using scale and rotation invariance in place. This will help us to uniquely identify the features from the image. Assume that you have fifty thousand features. Now you can easily identify the feature you're looking for (say, a particular eye, or a sign board) by this representation.

Equations supporting the algorithm[16][17]:

$L(x, y, \sigma D) = G(x, y, \sigma D) * I(x, y)$ -Finding laplacian of Gaussian

$(k-1)\,\sigma^2 \nabla^2 G \approx G(k\sigma) - G(\sigma)$ – Defining difference of Gaussian

$D(\sigma) \equiv (G(k\sigma) - G(\sigma)) * I$ – Difference of Gaussian.

3.2. SURF Algorithm

Object detection is done by using SURF (Speed-up Robust Features) algorithm. Speeded up Robust Features is a algorithm used mostly in computer vision tasks and tied to object detection purposes. SURF fall in the category of feature descriptors by extracting key points from different regions of a given image and thus is very useful in finding similarity between images:

The algorithm works as follow:

S.U.R.F or **Speeded Up Robust Features** is a **patented** algorithm used mostly in computer vision tasks and tied to object detection purposes. SURF fall in the category of **feature descriptors** by extracting **keypoints** from different regions of a given image and thus is very useful in finding similarity between images:

Algorithm steps:

1. For the keypoints of same object found in different images should be scale and rotation invariant. Corners, blobs so on are good and most often searched in multiple scales.
2. Now by rotating the image by finding the correct orientation of that point so that they (both images) are aligned in regard with that single point.
3. Descriptor having information about how neighbourhood keypoints looks like in right scale is computed.

Equations supporting the algorithm[16][17]:

1. $H(x, \sigma) = [Lxx(x,\sigma)\ Lxy(x,\sigma)]$

   $[Lxy(x, \sigma)\ Lyy(x,\sigma)]$

2. $Lxx(x,\sigma) = I(x) * \partial 2\ \partial x2\ g(\sigma)$
3. $Lxy(x,\sigma) = I(x) * \partial 2\ \partial xy\ g(\sigma)$
4. $I(x) = X\ i \leq x\ i=0\ j\ X \leq y\ j=0\ I(x, y)$ –Integral Image
5. $Det(Happrox) = DxxDxy - (wDxy)^2$

Now let us discuss an example. Assume an oil drum placed in a room. It can't be watched throughout the day by a human. But by using image processing we can detect if the oil drum has fallen down or not. Here the bottle is used as oil drum and the machine is being tested and trained by storing the images in the database. The correct position of the object is trained to machine. Now when the orientation has been changed then it gives a pop up of position of the object.

4. Demonstration

The important specification of the project is monitoring remotely from any place where you get internet. The initial part demonstration of the project is hardware. Once the power is supplied all the sensor gets active and values will be stored as well as displayed on LCD screen. For each sensor abnormal condition there is indication shown through either fan, motor with respective to sensor.

The secondary part of demonstration of project is the software part. The images of employees are stored in database initially. Now when we start monitoring, the system automatically detects the face within the image and compares with the database images and gives a pop up whether the person is authorized or not. The object detection is done in a similar manner but in different way. The object features are stored initially in the system. Now the change in orientation is done by training the system by its correct position and wrong positions. The output is given as pop up box as well as send to Arduino mega and displayed on LCD screen.

The last part of demonstration is the output of analysis of sensor values which we stored in excel sheet parallel while sending to IoT. The dataset is fed into Hadoop (HDFS) that will happen in this module. Sqoop is a command-line interface application for transferring data between relational databases and Hadoop. In this module we fetch the dataset into Hadoop (HDFS) using sqoop Tool. Using sqoop we have to fetch the dataset with specific condition that will be support by sqoop Tool and data will be stored in Hadoop (HDFS).

Hive is a data ware house system for Hadoop. It runs SQL like queries called HQL (Hive query language) which gets internally converted to map reduce jobs. In this module we have to analyse the dataset using HIVE tool which

will be stored in Hadoop (HDFS). Using hive we perform Tables creations, joins, Partition, Bucketing concept. Hive analyses only Structure Language.

5. Results and Conclusion

As we know that all the outputs will be sent to the central processing unit which is nothing but Arduino mega. It will send all the data to IoT module to upload the sensor values to the cloud. And the IoT module uploads all these values at regular intervals of time. Not only the sensor values but also the image processing output like in face recognition we say whether the person is authorized or not unauthorized or in object orientation we say the position of object if it has changed the correct position. The below figure shows the data that has been uploaded to cloud.

LogID	DATA	Logdate	LogTime
1	temp-21	03/04/2018	06:17:17
2	g-abnormal_579	03/04/2018	06:29:52
3	g-abnormal_577	03/04/2018	06:30:17
4	g-abnormal_579	03/04/2018	06:30:42
5	temp-21	03/04/2018	06:31:07
6	Unauthenticated	03/04/2018	06:31:33
7	temp-21	03/04/2018	06:31:58
8	g-abnormal_572	03/04/2018	06:32:24
9	g-abnormal_573	03/04/2018	06:32:49
10	g-abnormal_567	03/04/2018	06:33:15
11	g-abnormal_569	03/04/2018	06:33:40

Fig.1. Values Uploaded To Cloud Using Iot

Now in image processing we have three modules. First the face recognition. The following image shows the facial recognition output. If the face captured is matched with any database image that has been stored while setup then it shows the matched key points as shown below and also mentioned while describing about the image processing for facial recognition. We can also make a pop up to show the name of the person that has been authorized or else display unauthorized person if doesn’t match.

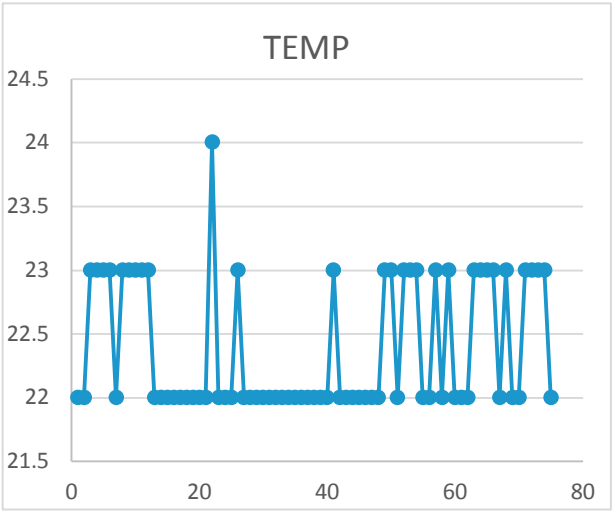

Fig.2. Graph Plotted Using Temperature Sensor Values

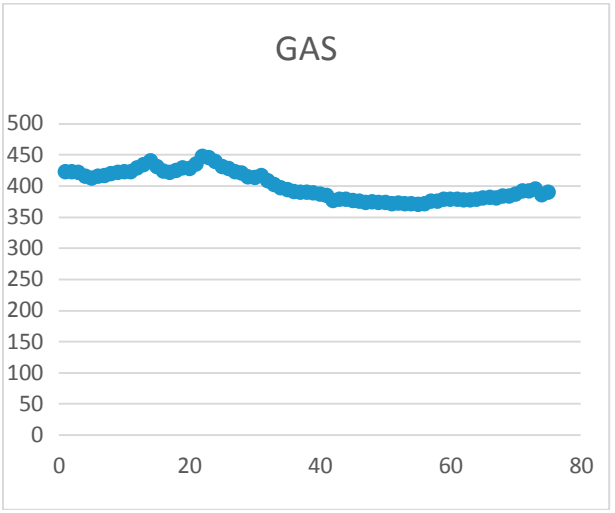

Fig.3. Graph Plotted Using Gas Sensor Values

The second and third are the object detection and object orientation output is as shown below. As the system has been trained that the position of the object should be in a particular orientation. Now if the object orientation has changed accidently the camera that is monitoring the object will recognize that and sends an alert message to the respective supervisor of that block. Here we are using GSM module for sending SMS but for real industry purpose we can develop an application that can be used within the industry. Along with the message the system will raise a pop up showing that orientation has been changed. Object detection is simple and done by storing the features of the object. Here we stored the features of a water bottle. As we have store the features now the detection is performed on cool drink bottle (Sprite) which show the output as bottle. Here the main point is that, once the features are stored it can detect any object related to that just by getting the feature and comparing them. All the sensor values will be updated in cloud as well as into the excel sheet. We can analyse the sensor values by processing it in Hadoop as mentioned above. As we are short in types of sensor values the analysing and predicting values may not be performed accurately. Finally we conclude that using the latest technologies in industrial monitoring can help humans to take control of risk taking situations. The extension of this project using few more present technologies are described in the next section.

6. Future Work

In this we have used object orientation and object detection. The main idea behind it is to make the complete system auto communicative by developing an application for communication of the system. Consider the example given in object orientation in software part above. The future work is that if the object has fallen, the screenshot has to be sent to respective supervisor as a notification to his/her mobile. Now the supervisor can assign that work to any other employee nearest to that location. As soon as the work gets completed a photo can be send to the super visor that the work is done. Else it can be used in other such a way that, if at a work place a tool is needed. Using object recognition a request can be made in the application for any tool that is needed for the ongoing work. For an example, consider a construction field network. If suppose a tool X is required at location A. Now using this application we can make a request of the tool by entering the tool name in the application. Then the system using the cameras check for the tool X that is not being used or idle. Once it finds the tool it gives the notification to the requested user. Then the user can send an message to the nearby user to get the tool for him or else he can go and get it. This improves the speed of working and reduces the time required to search for tool and communication purposes. Each module that has been developed is executed one after the other due to lack of hardware equipment that can run the whole system at once. By making the complete system auto communicative the time can be reduced

a lot in finding the tools or assign any urgency work to nearby employees. By using machine learning the predicted values from big data can be used to learn the machine or system behaviour and further it can also be automated. We can also get to know how many tools are being requested per day and from which department those are coming from. Also the deficiency of tools can also be known because the request will be high.

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