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Design and Implementation of PCB Fault Analysis Using Sift Algorithm

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ABSTRACT: The ever-growing printed circuit board industry requires automation during the manufacturing process to produce flawless products. However, the selection of the algorithm set for the inspected PCB before the start of the process is still heavily dependent on user input. Printed circuit boards (PCBs) provide functional support for electronics such as laptops, biomedical devices, satellites, etc. by connecting electrical components, routes and vias on the board. Think of a printed circuit board mounted as a base with multiple electronic units. To illustrate the manufacturing process, the defects were separated from the PCB. The reflection of this separation process affects the efficiency of circuits. Furthermore, we proposed classification methods and DPS detection based on the SIFT algorithm. The necessary and relevant information was extracted from the input images using image processing methods with PCB detection based on the SIFT algorithm. PCB identification is achieved by using local SURF and ORB detectors and using the acquired orientation data to transform the PCB image into a reference image for defect inspection. It was used to detect defects compared to images of defective PCBs. This scheme helps to achieve the best image processing solution and modifies the algorithmic classification of DPS defects. If any fault in the PCB circuit is hardware monitored, it will be displayed on the LCD as Fault Detected. DC gear motors are connected to the L293D motor driver board, the PCB error detects that the gear motor stops. Combined with both and the hardware and software output of this application will have high accuracy and be a real-time application.

I.INTRODUCTION

The PCB industry is constantly growing and accordingly the need for a reliable and accurate vision system is needed as PCBs manufactured today have a much higher component density than before and it continues to grow. The study shows that the PCB industry is expected to reach USD 93.9 billion in 2020. Manufacturers want their products to be flawless in order to meet the needs of their customers and stay on par with the competition. Once a product is manufactured in a factory, it must go through a quality assurance process to ensure that the product that is sold to the customer has no defects. In this process, the inspected product is tested for defects and defects. Most manufacturers prefer the means of a non-destructive inspection system such as Computer Vision to ensure the quality of their products. Computer vision also known as machine vision in industrial applications is the process of extracting digital information from an image of a scene and then using that information to achieve various tasks. Computer vision has a wide range of applications in quality assurance. A survey conducted in describes the importance of computer vision in quality assurance in various industries such as component manufacturing, integrated circuits, printing, glass manufacturing, etc.

II.OBJECTIVE

The aim of this project is to provide an inspection system solution for rapid detection and classification of the type of board under inspection with resistance to different physical properties of the boards so that defect detection can take place for different PCBs in the same inspection cycle without human intervention.

- Develop a SIFT algorithm method for enhancing the quality of the PCB input image, which classifies the faulty PCB and enhances the quality of the input image, which leads to an improvement in the quality of the feature extraction process.

- Developing a suitable feature extraction helps identify all PCB defects and extracts useful information from the input image. Develop a SIFT algorithm for efficient PCB defect classification.

III. LITERATURE SURVEY

A new technique has been introduced, which consists in classifying defects using a neural network paradigm. The result showed the effectiveness of the neural network-based defect classification technology. Due to the intuitiveness, simplicity, and development of computer hardware and algorithms, the reference comparison method is used to check defects in our approach. In addition, the convolutional neural network highlights excellent performance in computer vision tasks such as classification, object detection, segmentation, etc. [1] It is not easy to directly compare two color images or grayscale images due to the fact that they are easily affected by lighting. However, when using a binary map, the outline and shape of the PCB is expressed only in black and white, which is more convenient for comparison. The next step is to convert the grayscale image to a binary image to obtain the location of the defects. There are many methods for image binarization, in our method it is an adaptive threshold segmentation algorithm. [2] In the Image Net Large Scale Visual Recognition Competition (ILSVRC) and Common Objects in Context (COCO), Faster R-CNN and Regional Design Network (RPN) were the core of several 1st place entries in Image Net detection tracks. Image network localization, COCO detection and COCO segmentation. RPNs can learn to design regions from data and therefore easily benefit from deeper and more expressive features. [3] Using transfer learning on a pre-trained model of the faster R-CNN initial V2, training is performed. After training, final testing is performed using the test data sets, while the mean average accuracy (mAP) is used to evaluate the performance of the system. To achieve effective training, several parameters need to be configured correctly. The first parameter, which is the class number, specifies how many types of objects to recognize. [4] The emergence of more new methodologies was introduced due to increased productivity. It saved a lot of space. More complex and precise. Although bare PCB inspection is the main thing during the actual PCB manufacturing process. Thanks to this check, they can find and categorize the defective board earlier and keep it for further management. [5]

IV. EXISTING SYSTEM

- Many methods have been proposed by other researchers to overcome the difficulties in the PCB control and classification process.
- However, few of them published their data set before, which hindered the introduction and comparison of new methods.
- In this existing system, synthesized PCB dataset containing images with 6 kinds of defects for use in detection, classification and registration tasks.
- In addition, an existing system method for inspecting and training an end-to-end convolutional neural network for defect classification.

V. PROPOSED SYSTEM

- The proposed system is to detect and classify a defective printed circuit board using the SIFT invariant transform algorithm.
 - In this input image can be captured by the camera and the quality of the captured input image can be improved and resized in the pre-processing process.
 - Input image can be segmented based on ROI. Then SURF and ORB key points are detected from the segmented image. The key point is the location of the image in the spatial coordinates where the physical elements of the image, such as corner points, may lie.
 - These SURF or ORB points are then compared to a database of other similar points stored in the database using the SIFT algorithm. The data file basically contains a long list of these SURF points and ORB points for all the images to be compared.
 - The SIFT algorithm will then be used to classify the defective and undamaged PCB component by comparing the trained database.
 - Damaged and undamaged PCB images can be pre-trained and stored in a database system. This device is connected to a hardware device for real-time data collection in this application.
 - DC gear motors are used to connect the L293D motor driver board, the PCB error detects that the gear motor stops.

- The output will be displayed on the LCD if any fault is identified to detect that the fault has occurred on the PCB as a real-time output.

VI. ARCHITECTURE DESIGN

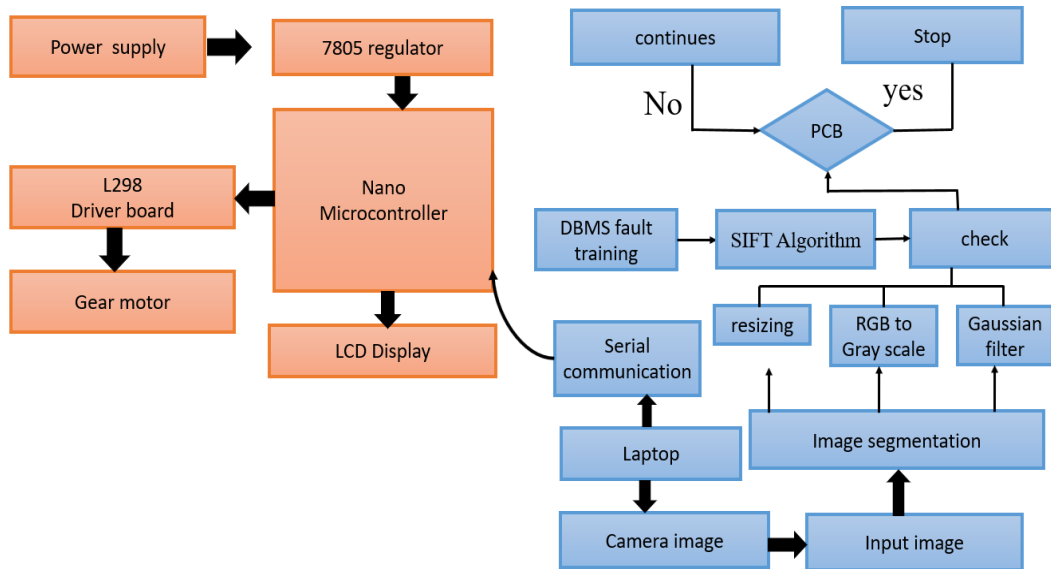


Fig no:1 Block diagram for proposed system

VII.BLOCK DIAGRAM EXPLANATION

In this project, PCB defect can be detected and defective and undamaged PCB component can be classified using SIFT algorithm. An input image can be captured using a camera, and the quality of the captured input image can be enhanced and resized in the pre-processing process. The input image can be segmented based on ROI. The next step is to convert the grayscale image to a binary image to obtain the location of the defects. There are many methods for image binarization, in our method we use SIFT algorithm. SURF and ORB key points are extracted from the segmented image. Once the features are extracted from the input image to be compared with the original image, a variation of the input image appears using the SIFT algorithm. The database system will consist of a pre-prepared PCB dataset. Finally, the SIFT algorithm predicts and classifies the defective and intact PCB component.

VIII.CIRCUIT DIAGRAM

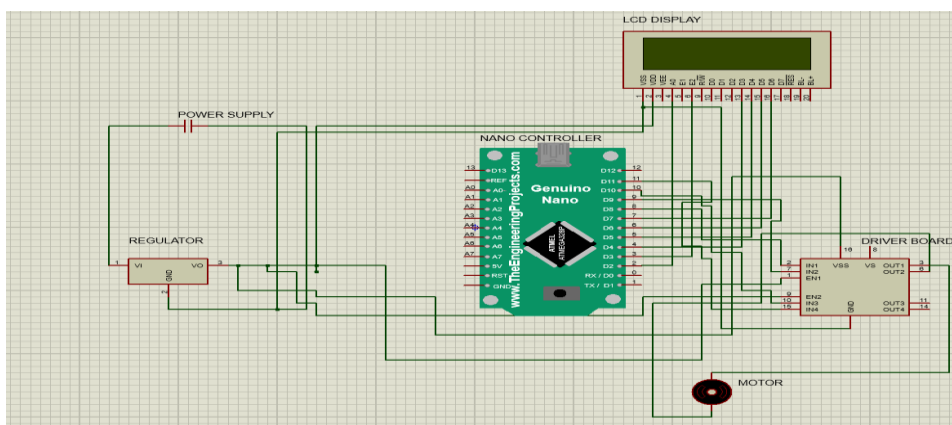


Fig no: 2 Circuit diagram

1. CIRCUIT DESCRIPTION

- The circuit diagram takes into account the components of the basic components such as LCD display, power supply, IC7805 controller, Nano controller, L293 controller board, gear motor.
- Power from the main 12V supply is passed to the voltage regulator, which converts the 12V to 5V. Then 5V is supplied to the control board.
- LCD display pin connection, VCC pin is connected to 5V power supply, VSS pin is connected to GND, and the remaining data pins are connected to controller digital pins d1, d2, d3, d4, d5, d6, d7.
- L293 controller board connection to VCC pin connected to 5V supply, GND pin connected to GROUND and IN pins connected to controller digital pin and EN pin connected to 5V regulator power supply. The DC gear motor interfaces to the L293 driver board.

IX. SYSTEM FUNCTIONS

1. IMAGE PRE-PROCESSING

Image segmentation is a method in a digital image is broken down into various subgroups called Image segments which helps in reducing the complexity of the image to make further processing and analysis of the image simpler. Segmentation in easy words is assigned labels to pixels. All picture elements pixels belonging to the same category have a common label assigned to them. Let's take a problem the picture has to be provided as input for object detection. Rather than processer the whole image, the detector can be inputted with a region selected by a segmentation algorithm. This will prevent the detector from processing the whole image thereby reducing inference time.

2. SIFT ALGORITHM

A small corner is fine. However, we need larger windows to detect larger corners. For this, scale-space filtering is used. It contains the Laplacian or Gaussian for an image with different σ values. LoG acts as a droplet detector that detects drops of different sizes due to the change of σ . Briefly, σ acts as a scaling parameter. For example, in the figure above, a low- σ Gaussian kernel gives a high value for a small corner, while a high- σ Gaussian kernel fits well for a larger corner. So we can find local maxima across scale and space, which gives us a list of (x, y, σ) values, meaning that there is a potential key point at (x,y) on the σ scale.

3. GAUSSIAN FILTER

A Gaussian filter will have the best combination of rejecting high frequencies while minimizing spatial dispersion, a critical point of the uncertainty principle. These properties are important in areas such as oscilloscopes and digital telecommunications systems. A Gaussian filter is a low-pass filter used to reduce noise (high-frequency components) and blur areas of an image. The core is not demanding on the drastic color change (edges), because the pixels towards the center of the core have more weight to the final value than the periphery. A Gaussian filter could be thought of as an approximation of a Gaussian function (mathematics). In this article, we will learn ways to use Gaussian filter to reduce noise in images using Python programming language.

X. HARDWARE COMPONENT

1. LCD Display

A liquid crystal display is a flat, electronic display film that utilizes the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly. An LCD can display any image (like a general computer) or a static image that can be shown or hidden, such as prefixes, numbers and 7-segment display on digital clocks. They use the same technology, except that one image consists of many small pixels and other images contain many large elements. They are found in consumer products such as video players, gaming devices, watches, wristwatches, calculators and telephones, and have replaced cathode ray tube (CRT) screens in most applications. They come in much larger screen sizes than CRTs and plasmas, and because they don't use phosphors, they don't suffer from image burn-in. However, LCDs are sensitive to image retention. LCD displays are more powerful and safer than CRTs. Low power consumption allows use in battery-powered devices.

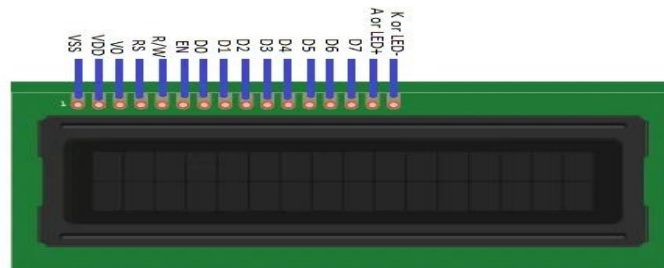


Fig no: 2 pin diagram LCD Display

3. NANO MICROCONTROLLER

Arduino Nano is a microcontroller board developed for Arduino. It can be created using microcontrollers like Atmega328. T. It is a small board that can be adapted to many applications. Other popular Arduino boards include Arduino Mega, Arduino Pro Mini, Arduino UNO, Arduino YUN, Arduino Lily pad, Arduino Leonardo, and Arduino Due. This board has many similar functions and features to the Arduino Demilune board. But the nanoplates are packaged differently. It can be used from a small USB port because it doesn't have a DC connector, but it can also be connected directly to a pin like VCC. The board can supply voltage from 6 to 20 volts from the mini USB port on the board.

4. 7805 IC VOLTAGE REGULATOR

Voltage regulators are important to many electronic devices because the electronics used in them regulate current and voltage. Deviation from the fixed price will damage the product. The battery is an important DC power source. However, it is not a good idea to use batteries in electronic devices because over time, batteries discharge and lose their capacity. Also, the voltage supplied by the battery is usually 1.2V, 3.7V, 9V and 12V. However, most TTL ICs run on 5V logic, so we need an idea to provide a compatible 5V supply.

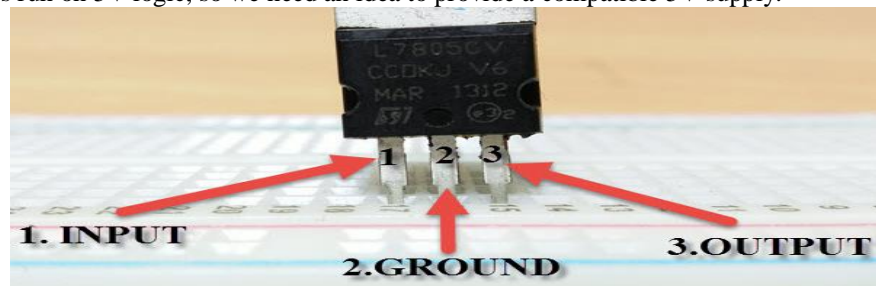


Fig no: 4 IC7805 voltage regulators

5. DRIVER BOARD

The bridge circuit uses transistors to drive the DC driver in both directions. The H-bridge in the IC reduces the complexity of the driver circuit. L293D is double H driver, so with one IC we can control two DC motors, they can be controlled clockwise and counterclockwise, and if you have a motor you can use all four I/Os. Up to four DC motors. The output current of the L293D is 600mA and the maximum output current of each channel is 1.2 A. In addition, output diodes are included in the IC to prevent reverse EMF looping. The output voltage (VCC2) ranges from 4.5 V to 36 V, making the L293D an ideal choice for DC drives.

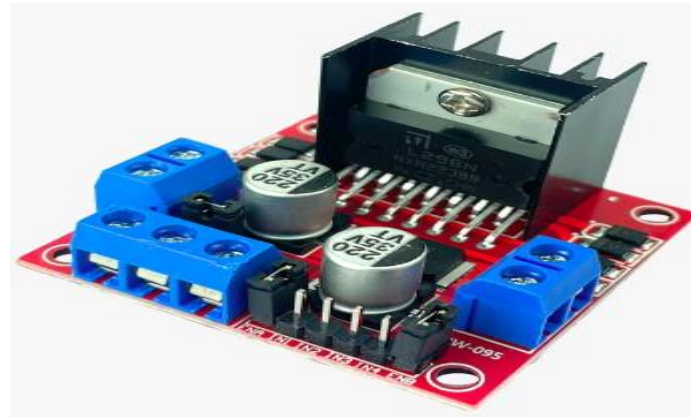
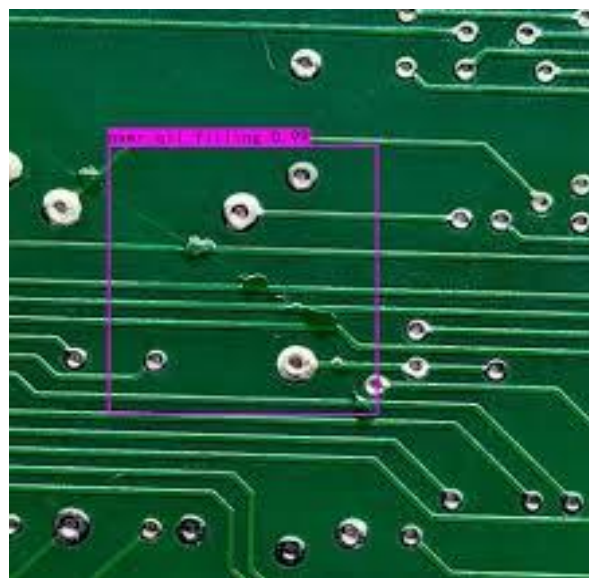


Fig no: 5 Driver board

XI. RESULT

This test is a measurement of accuracy of the fault detection using sift algorithm employed to detect either missing components on PCB. The identification of defects in natural PCB images is processed and the defect is identified with respect to the reference image using sift algorithm tools. The PCB defect detection and sorting using image processing techniques. The connected to hardware device, if DC gear motors is to interface the L293D Motor Driver board, PCB fault detect the gear motor will be stop automatically. It Continues monitored the LCD display this will show as fault detected.



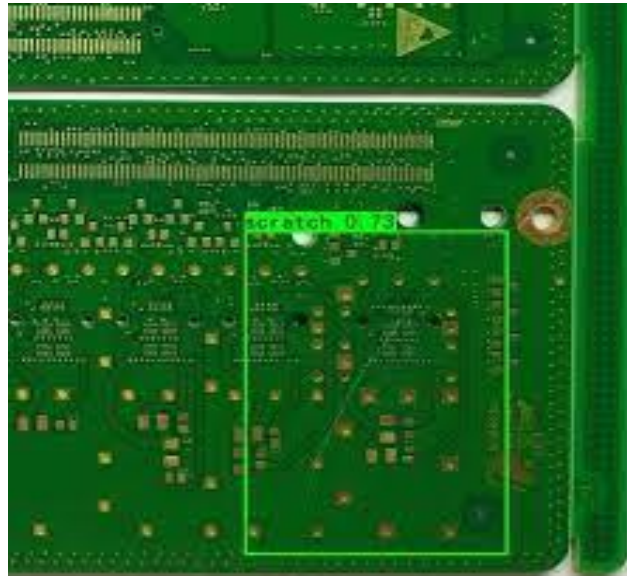


Fig no:6 PCB fault detected

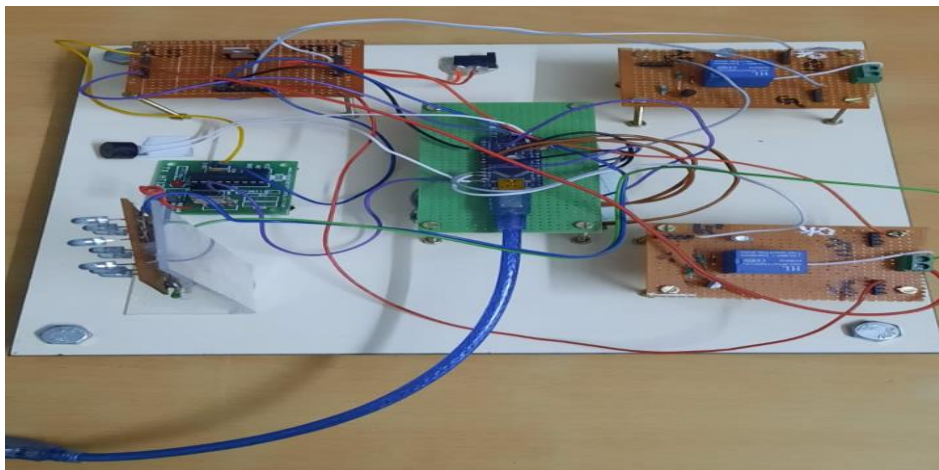


Fig no: 7 Kit overall setup

XII. CONCLUSION

So, our project is to develop a system that would allow the processing of different products with pattern recognition and image processing, which would help the manufacturer to ensure different product testing within a single inspection cycle. The ideology of the project was to enable machine vision PCB inspection equipment to identify the PCB model and make a decision based on the result of the identification, in this case PCB defect detection. Identification of DPS in this system prior to the inspection process was achieved using feature detectors and the SIFT algorithm, which is a pattern recognition method. The identification rate gives 98.66% for database images. The SIFT algorithm developed an accuracy of 92.3% for the best case and performs very well compared to other methods for a similar problem.

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