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# Crack Defect Detection For MEMS Device

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ABSTRACT :

Micro electro mechanical Systems (MEMS) are essential to many different applications, hence reliable techniques for identifying flaws like fractures are required. Conventional examination methods frequently show to be time-consuming, costly, and subjective. This study presents an automated technique for crack defect detection specifically designed for MEMS devices, utilizing the latest developments in image processing technology. First, the algorithm takes high-resolution pictures of the MEMS device that is being examined. Preprocessing techniques are used to these photos in order to improve contrast, minimize noise, and maximize quality. Feature extraction approaches then locate pertinent crack-related features, such as textures and edges, which are essential for differentiating cracks from background noise. An method for categorization, like machine learning or deep learning, divides the retrieved information into regions that are cracked or not. This automated method reduces subjectivity, improves precision, and speeds up the examination procedure as contrast to manual techniques. Experimentation on a variety of MEMS devices validates the algorithm's effectiveness in precisely identifying and characterizing cracks. To sum up, the suggested algorithm for detecting crack defects provides a dependable, effective, and impartial way to guarantee the dependability of MEMS devices. This technique simplifies defect identification procedures by utilizing image processing technology, which helps to create more reliable MEMS devices for a range of applications.

Keywords: MEMS (Micro electro mechanical Systems),Crack detection, Image Processing.

**Main text**

The introduction of this method marks a significant advancement in the field of MEMS defect detection. Manufacturers may improve the quality control of MEMS devices, expedite the inspection process, and ultimately boost the performance and dependability of these devices by utilizing image processing technologies.

## Introduction :

Conventional techniques for identifying cracks in MEMS devices typically entail labor-intensive, time-consuming human inspection or destructive testing, which is not appropriate for settings where mass production is taking place. The development of image processing technology in recent years has offered a viable substitute for MEMS device fracture detection. Image processing methods provide an effective and non-destructive way to check for cracks in MEMS systems. With the use of sophisticated image processing methods and optical or electron microscopy to acquire pictures of MEMS devices, cracks can be quickly and accurately spotted, measured, and categorized..

### *1.1. Image Processing*

The multidisciplinary topic of image processing deals with the study and editing of digital images in order to improve their visual quality or extract relevant information. It includes a number of methods, including segmentation, compression, recognition, and image restoration. Algorithms are applied to images in image processing to carry out functions like object tracking, edge detection, noise reduction, and pattern recognition. As technology progresses, image processing finds use in a variety of industries, such as robots, medical imaging, satellite photography, surveillance, and entertainment. Its importance stems from its capacity to streamline operations, extract insightful data, and enhance decision-making in a variety of industries.

Technologies:

- Analysis of surface defects of MEMS devices
- MEMS devices image processing detail sharpening
- Image gray processing
- Image Enhancement Crack Defect boundary extraction
- Pseudo Crack Defect removal

### *1.2. Analysis of surface defects of MEMS devices*

The crucial issue of material fatigue resulting from cyclic mechanical movements inherent in MEMS (Micro-Electro-Mechanical Systems) devices' operation—such as stretching, compression, bending, vibration, and thermal expansion and contraction—is brought to light by the examination of surface defects in these devices. The buildup of fatigue damage brought on by this recurrent stress can eventually result in structural fractures, which would make the MEMS device unusable. In the meantime, cracks may appear.

### *1.3. MEMS devices image processing detail sharpening*

In order to improve the sharpness and detail of MEMS (Micro-Electro Mechanical Systems) device images—which are often captured with blur—bilateral filtering is utilized. By taking into account both the variations in pixel intensity levels and the spatial proximity, this approach sharpens the images. The filter efficiently lowers noise and enhances image quality without sacrificing the edge details necessary to detect surface fractures on MEMS devices by weighing these variables.

### *1.4. Image gray processing*

All of the original MEMS device photos gathered for this paper are in color. Red, green, and blue hues combine to create color images, commonly known as RGB images. Due to the lack of rich color features in the crack of the MEMS devices image, the image is grayed, or transformed from RGB to grayscale, which preserves the image's primary features while also lowering the computer's processing overhead.

### *1.5. Image Enhancement Crack Defect boundary extraction.*

Increasing the contrast of MEMS device images is required to enhance the subtle fault features in such images. It is evident that the crack defect contour is more distinct following the image enhancement processing of the gathered MEMS device images. This effectively improves the contrast of the image and gives more helpful information for the boundary extraction of the subsequent crack defect, including curved and penetrating cracks.

### *1.6. Pseudo Crack Defect removal*

The approach of image processing that is being presented aims to differentiate real cracks from fake fractures, or pseudo-cracks, in MEMS device images. False cracks are artifacts of imaging equipment, either vertically or horizontally aligned with the device's longitudinal axis, and frequently resemble true cracks. The approach uses the least squares method for calculation to remove spurious cracks based on their morphological characteristics and pixel distribution variance, improving the accuracy of crack detection and segmentation in these pictures. Pseudo cracks are defined as curves with variance less than a certain threshold, which are eliminated; real cracks, on the other hand, are defined as curves with greater variance and are kept in place.

## CRACK DEFECT DETECTION OF MEMS DEVICES IMAGE

The OTSU technique performs less well when it is difficult to distinguish distinct peaks in the histogram due to low contrast between the device and fractures in MEMS pictures. We use OTSU with the attribute weighted naive Bayes algorithm to improve detection. This increases accuracy by taking certain picture pixel properties into account. The only issue is knowing how to find it! This is the secret to raising the UWB's effective range. Naturally, detecting a single pulse is far more challenging than identifying a sequence of carrier frequency oscillations Therefore, in order for the UWB to be successful, we not only need to design keys (pulse oscillators) with a precisely defined form and switch time, but we also need to solve the far more difficult task of developing high-quality detectors of such pulses.

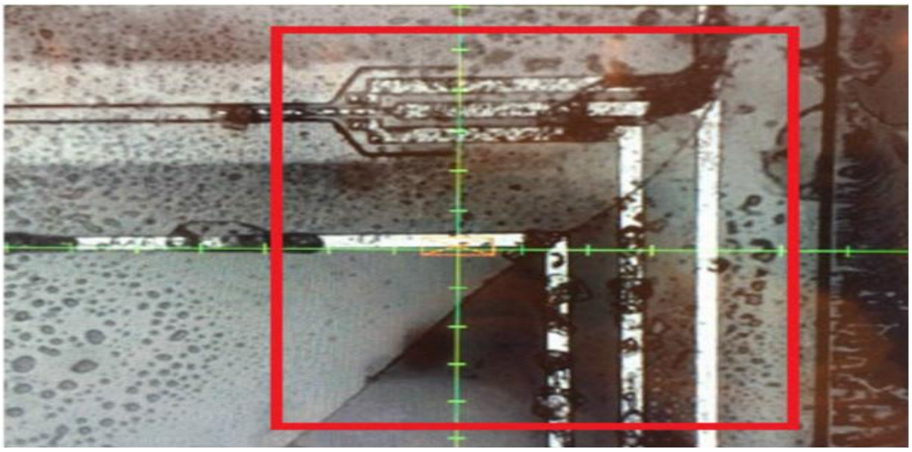

**Fig1: There is a crack image between the two metals on the surface of the MEMS device.**

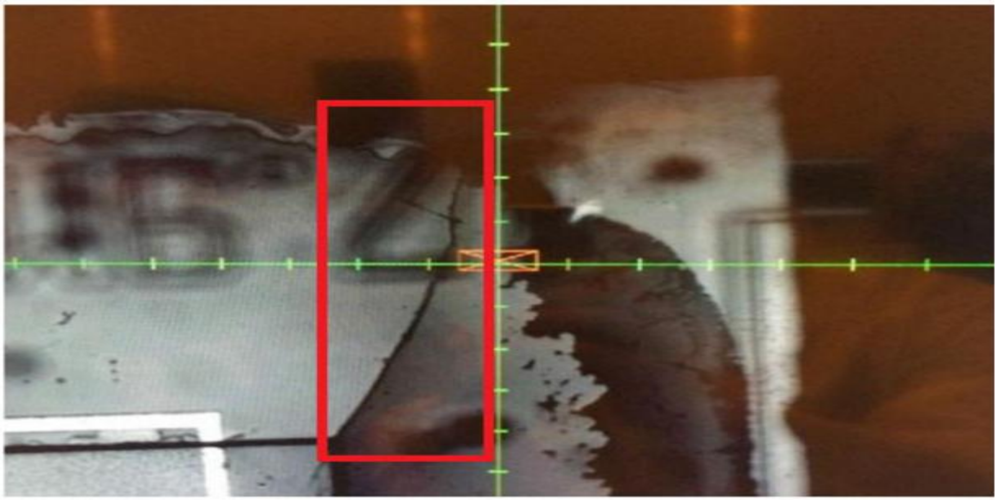

**Fig2: A curved crack image on the MEMS device**

## Visualization

Our approach and technique for detecting crack defects in MEMS devices with image processing technology presents a viable way forward for manufacturing quality control. We can precisely identify and locate flaws by utilizing image analysis, ensuring that only high-quality items are sent onto the market. This method benefits both manufacturers and customers in the long run by streamlining production procedures and improving the performance and dependability of MEMS devices. Our approach has the potential to significantly increase the overall efficacy and efficiency of MEMS device manufacture with more development and application.

## Future scope

Real-time crack detection systems that can continuously check components, equipment, and infrastructure for flaws and cracks are in greater demand. In order to enable proactive maintenance and real-time monitoring, future advances might concentrate on implementing image processing algorithms on edge devices and connecting them with sensors and IoT (Internet of Things) platforms.

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