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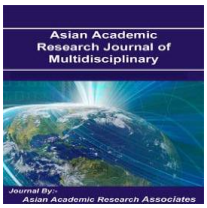

IMAGE PROCESSING A NEW ERA IN THE STUDY OF NATURAL POLYMER COMPOSITES

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Abstract

Image processing is one of the fundamentals of various intelligence systems based on data analysis. It is caused by that the significant part of information about outward things can be received on the basis of the video data analysis about images of the real world. As an example, we reviewed the methodology of image processing in the study of polymer composites. Such analysis uses various methods, approaches and theories where the special place is occupied by the procedures connected with recognition of scenes or separate objects, presented on incoming images. In general, this allows to us to improve the properties of fiber as a reinforcing agent in polymer composites.

Keywords: analysis of image objects, image processing, filtration, histogram equalization, polymer compositions, segmentation, structure.

1. Introduction

Over the past decade the natural fibres have found use as potential resources for making low cost composite materials. The most interesting thing about the natural fibres is their environmental friendly nature, since they come from a natural resource, which is completely biodegradable. The natural fibre reinforced composites are attractive due to their low cost, availability, low density, biodegradability, renewability and high degree of flexibility during processing [1-3 and references therein]. Various properties of the natural fibre composites are influenced by many factors such as fibre loading, dispersion and fibre to matrix adhesion [3, 4-9]. The Natural fibres has been used as reinforcing agent in polymer composites and becomes the point of attention and attraction among several researchers during last many years owing to their easy accessibility and biodegradable nature [10, 11].

Yet, till date, example, the performance of coir fibre as a replacement in polymer composites has not proved satisfactory and comparable to other fibres [2-9]. But natural fibres may possibly replace synthetic fibres in many dedicate purposes, like where high strength and rigidity are not expected. It is known that investigators have done chemical modification of natural fibres in order to improve them with a polymer composite [5, 6, 7]. It has been illustrated that there are many factors that can change the properties of natural fibre reinforced polymer composites [1, 12-16]. Due to this, it is essential to illustrate and record the properties of these fibres and investigate new source of applications of fibres in composites.

In the different studies, the main objective was to find effect of chemical treatment of natural fibre. It was also noted that the properties of fiber depends on its structure, changes in the morphology of fibre before and after treatment [2-4]. To consider these questions can detail by using the procedure of image processing fiber. Among possible variety of images of visual perception the special spot is occupied with the images received in systems of technical or computer vision therefore, in the present study, the main objective consideration of the possibility of applying of the methodology of image processing in the study of the properties of fiber as a reinforcing agent in polymer compositions.

2. Methodolgy of Image Processing in Polymer Composites

2.1. Analytical tools

The methodology image processing in general, represent the separate pictures of the individual perception of the reality, is one of the areas of data mining and method for extracting additional information about processes under experimental study. This is due to the fact that over 80% of information about the world around us, people tend to perceive by means of sight [13].

The standards of perception can be formed in systems similar to human sight, such as the video shooting, a photo or could be transformed in images of visual perception of the human by means of some technical device – for example, it can be roentgenograms, tomography pictures and other pictures which are received with different special devices in optical or not in optical range. These circumstances impose certain features and restrictions, both on the nature of considered standards of perception, and on possibilities of their analysis, additional data accessing about outward things.

One can also talk about the variety of methods that form the basis of functioning of different computer vision system. In particular, there are methods of preliminary image processing (noise suppression, contrast increase, localization of separate sites of the image) [14, 15], methods of the preliminary analysis (segmentation, contour allocation) [16, 17], cognitive processing recognition methods of the received information [18, 19] and methods of the formalized representation of the received visual patterns for their subsequent processing [20]. Nevertheless, despite the ability of using various methods processing and analysis of received visual image in different computer vision systems, one should consider both the specifics of how these images are displayed, as well as key tasks these computer vision systems fulfill.

It is connected with that the consideration of possibility of application of separate methods of analysis and image processing allows: to choose the most comprehensible methods of analysis and image processing for considered system of intellectual analysis of data; to optimize structure of considered system of intellectual analysis of data; to increase a productivity and an overall performance of concrete system of intellectual analysis of data [21-23].

2.2. Details of Image Analyzing Steps

The main task of application of the methodology of image processing in the study of the properties of fiber as a reinforcing agent in polymer compositions should be called clustering data (clustering of objects in the image). This will allow to realize various procedures of segmentation of images for their subsequent analysis and resulting of certain conceptual positions for acceptance of corresponding solutions on the basis of the analysis of incoming images.

This problem can be resolved on the basis of the following steps:
(i) The choice of markers for individual objects; (ii) the detection of objects from an image; and (iii) the calculating the proportion of an object in the image.

The choice of markers and detection of objects from an image are based on identification of the object by color.
In the present experimental work, the mathematical formula used for the calculation to determine the proportion of an object in the image such as: $v_i = \frac{s_i}{S} 100\%$,

where v_i – proportion i subjects in the image;
s_i – area of the i subjects in the image;
S – image area.

Nevertheless, the process of image analysis polymer compositions must also contain the steps of preprocessing the source images. It should be: (i) a filtration step of the original image; and (or); (ii) step of converting histogram for the original image.

It is necessary to improve the quality of the original image and obtain more accurate results clustering of objects in the image.

Then the methodology of image processing in the study polymer compositions includes the following steps:

Step 1: the improving the quality of the original image;

Step 2: the choice of markers for individual objects;
Step 3: the detection of objects from an image;
Step 4: the calculating the proportion of an object in the image.

Consider the application of methodology of image processing in the study polymer compositions for the specific images.

3. Data Analysis and Results

For analysis, we use images that are obtained by means of scanning electron microscopy. The scanning electron microscopy of the test samples were done by JSM 6390A (JEOL Japan). That is different portions of one sample, which is regarded (**Fig.** 1 and **Fig**. 2).

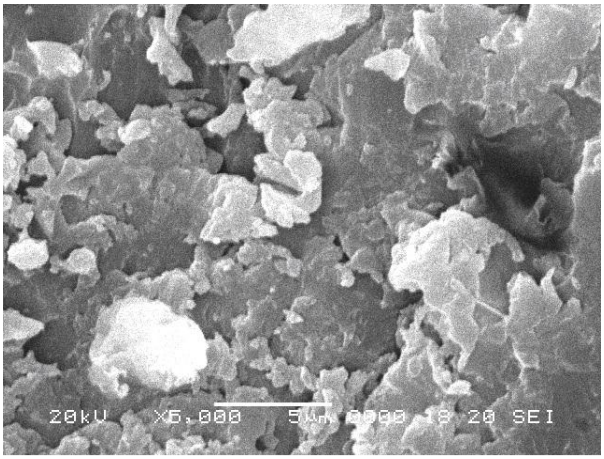


Fig. 1. The first part of the sample

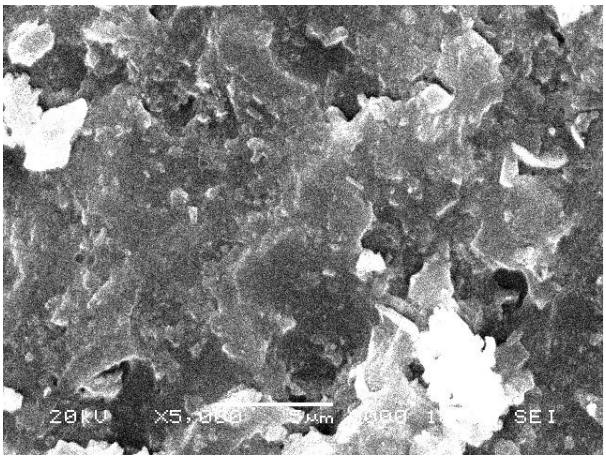


Fig. 2. The second part of the sample

Images of the prepared samples were taken at the plane polished surface. One can notice from the above figures that there is change in the morphology of fibre. From of these images you can see, that cluster of fibre have inhomogeneous and deformed at microscopic level and therefore can be, for example, the reason for resistive ac conduction. Uneven and cracked surface may be due to the presence of impurities in the fibre. We also see the crystalline nature of the fibre.

3.1. Results of Image Processing

Step 1:
The original images (**Fig.** 1 and **Fig.** 2) have a noise (see **Fig.** 3), which we remove by means of filtration.

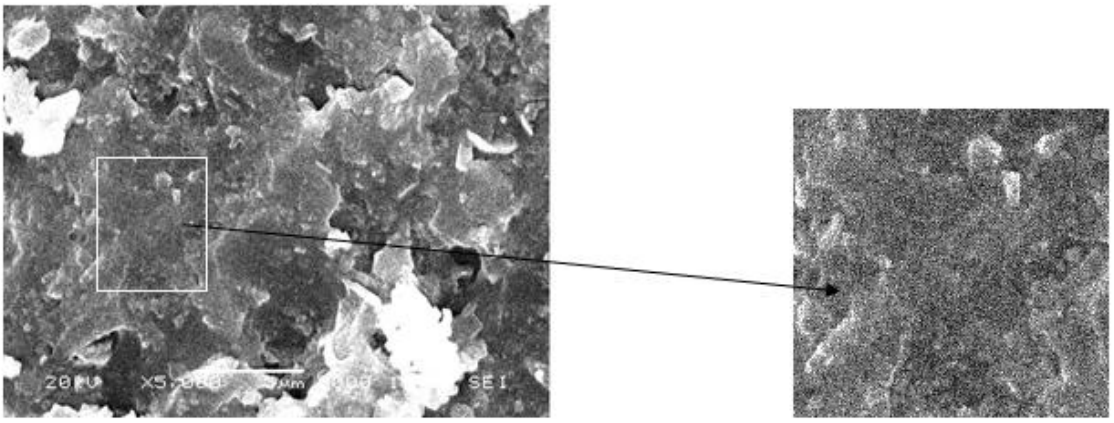
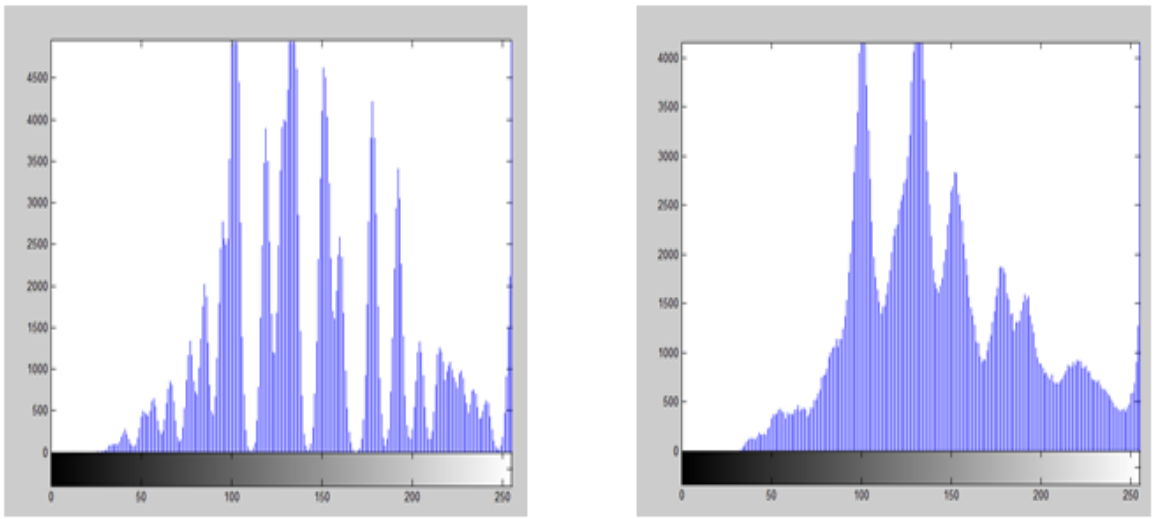


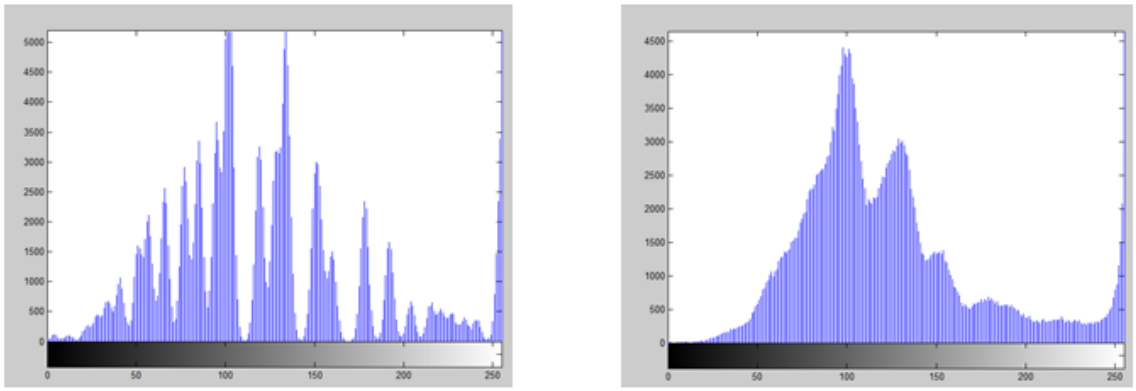
Fig. 3. The magnified portion of the original image in **Fig.** 2

We use median filtering. The results of the pretreatment can be clearly seen on **Fig.** 4 and **Fig.** 5.



(a) the histogram of the original image (b) the histogram of the image after filtering

Fig. 4. Histogram of the original image and the image after filtering (for image **Fig.** 1)



(a) the histogram of the original image (b) the histogram of the image after filtering

Fig. 5. Histogram of the original image and the image after filtering (for image **Fig.** 2)

As a result, we have two images, which used median filtering (**Fig.** 6 and **Fig**. 7.). The figures (**Fig.** 6 and **Fig.** 7), do not differ visually from that shown in **Fig.** 1 and **Fig.** 2. But it is important for subsequent processing of images (see **Fig.** 8).

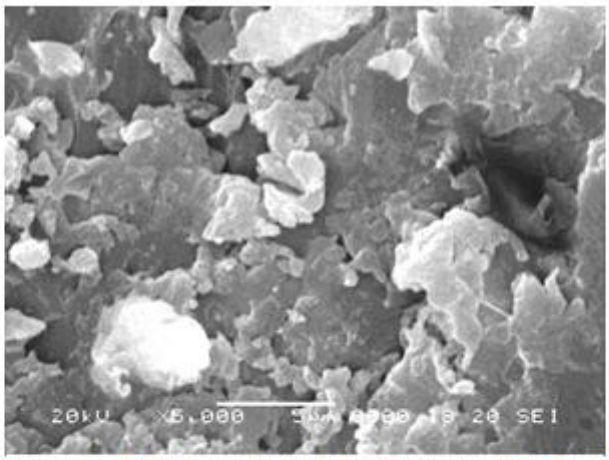


Fig. 6. The first part of the sample (after filtration of the original image)

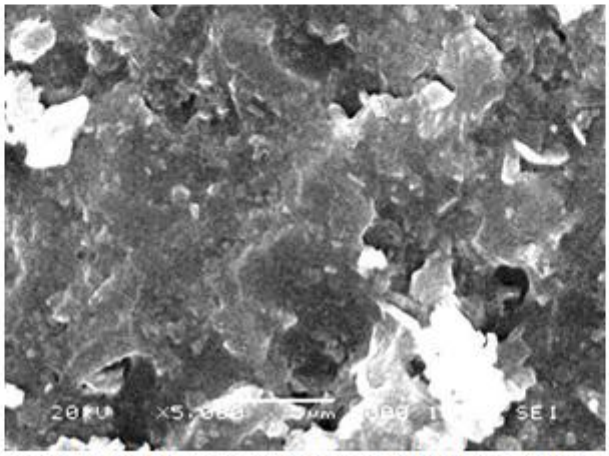


Fig. 7. The second part of the sample (after filtration of the original image)

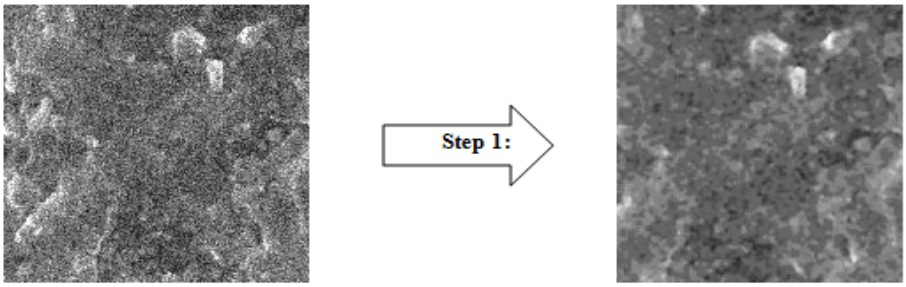


Fig. 8. Image area for filtration (a) and after filtration (b)

Step 2 - Step 3:

Then we will consider four types of objects - bright objects (white color), of less than bright objects (gray color), less dark objects (dark gray color) and dark objects (black color).

We mark the examples of objects in each image. Then, we identify all objects in each image. Such identification is based on the segmentation of each image. We use the color segmentation. On **Fig.** 9 example of color segmentation for image **Fig.** 6.

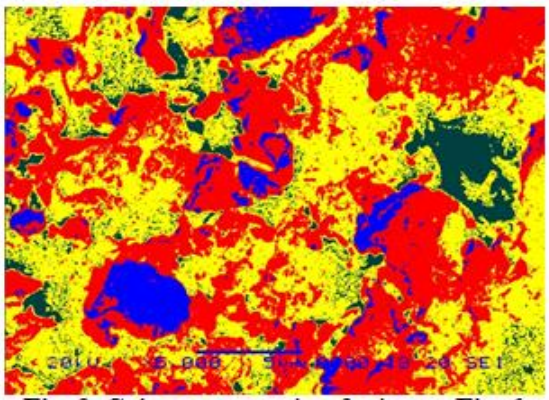


Fig. 9. Color segmentation for image **Fig.** 6

Step 2:

Blue color segmented bright objects (see **Fig.** 1). Red color segmented of less than bright objects (see **Fig.** 1). Yellow color segmented less dark objects (see **Fig.** 1). Black color segmented dark objects (see **Fig.** 1).

From **Fig.** 9 we can see all uneven and cracked surface of the sample, which is studied.

Step 3:

Then we share the the selected objects. It is necessary to calculating the proportion of an object in the image. On **Fig.** 10, **Fig.** 11, **Fig.** 12 shows the selected objects to **Fig.** 6.

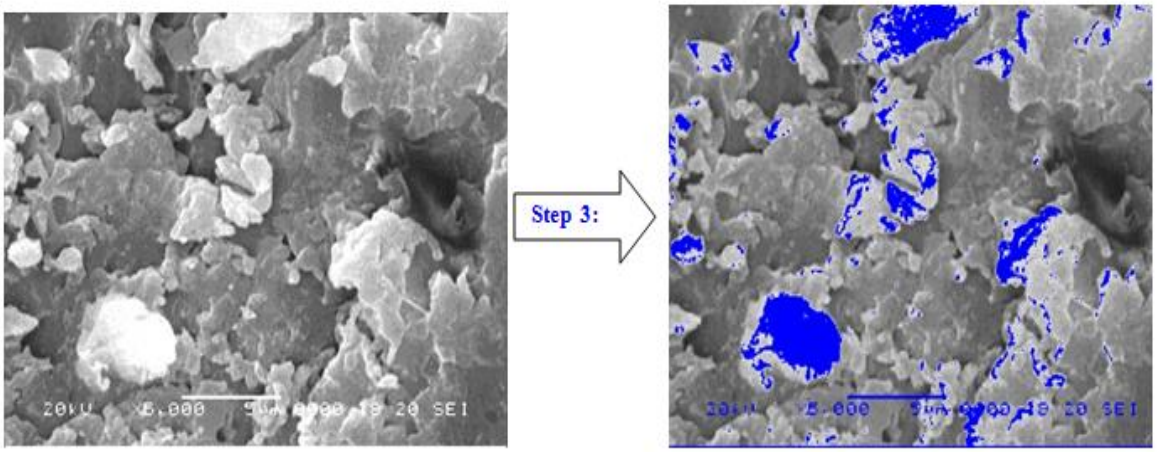


Fig. 10. Bright objects on **Fig.** 6

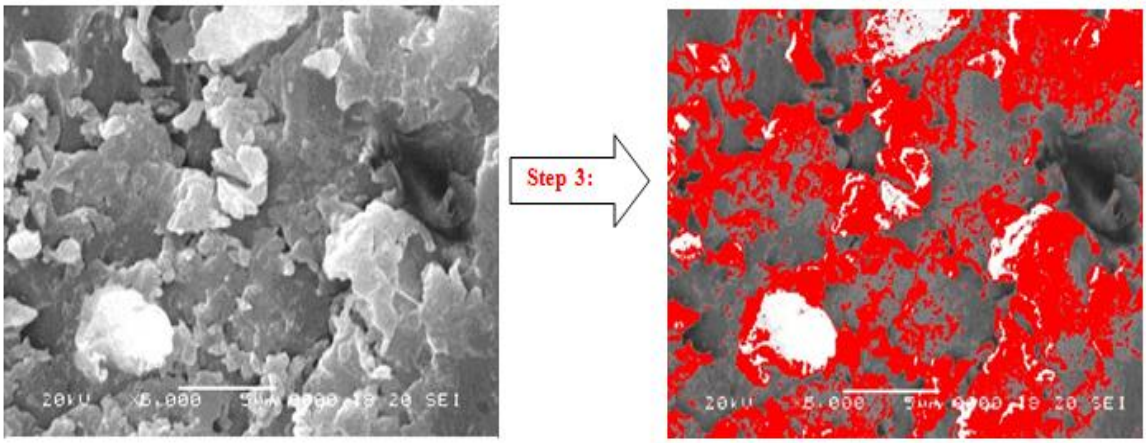


Fig. 11. Less than bright objects on **Fig.** 6

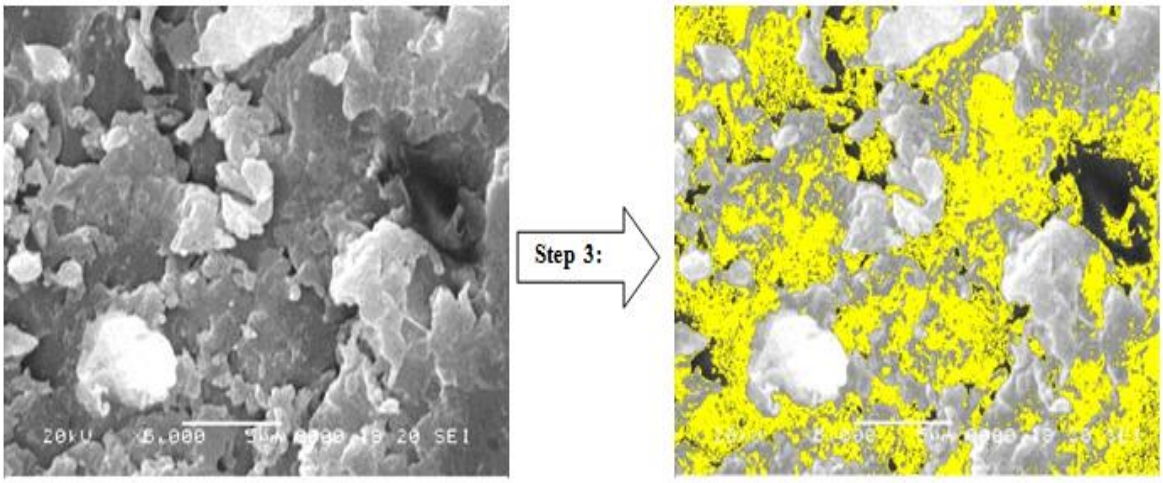


Fig. 12. Less dark objects and dark objects on **Fig.** 6

On **Fig.** 13, **Fig.** 14, **Fig.** 15 shows the selected objects to **Fig.** 7.

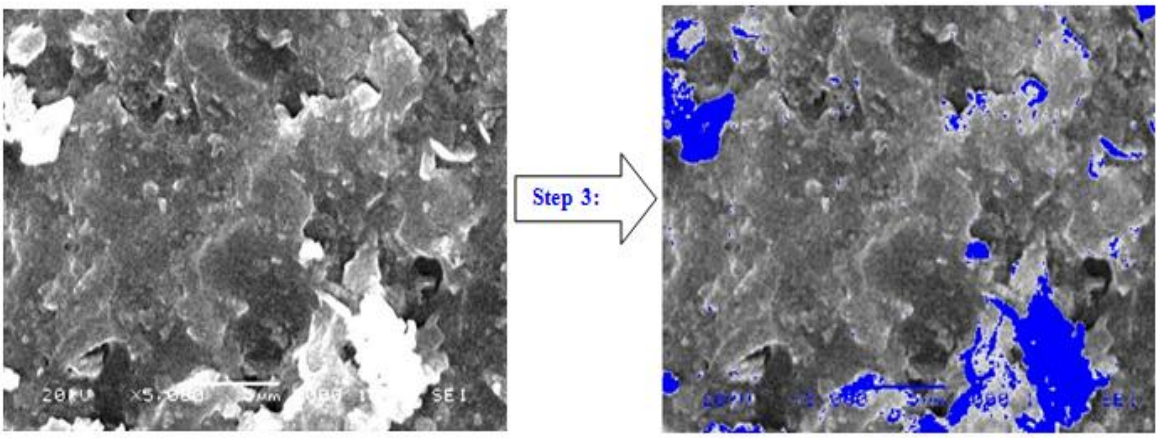


Fig. 13. Bright objects on **Fig.** 7

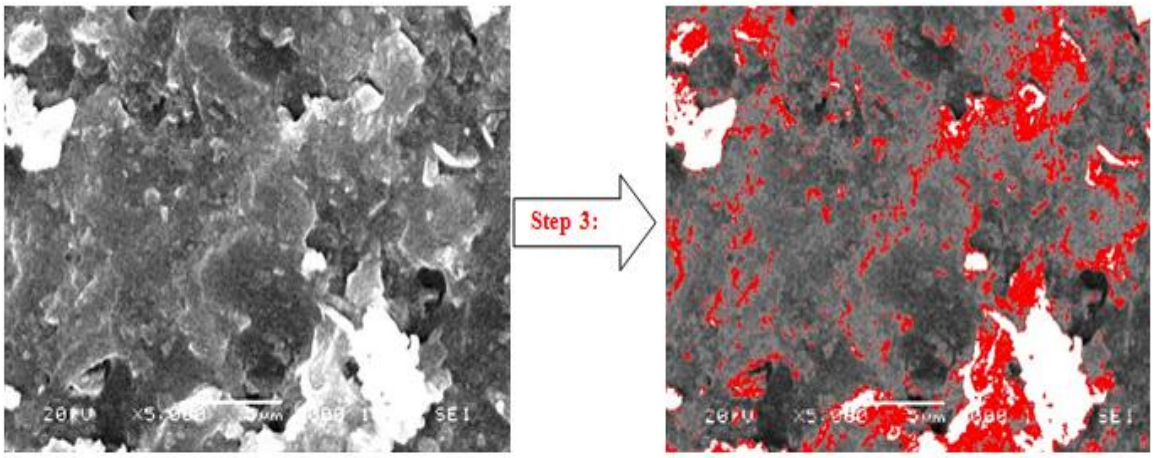


Fig. 14. Less than bright objects on **Fig.** 7

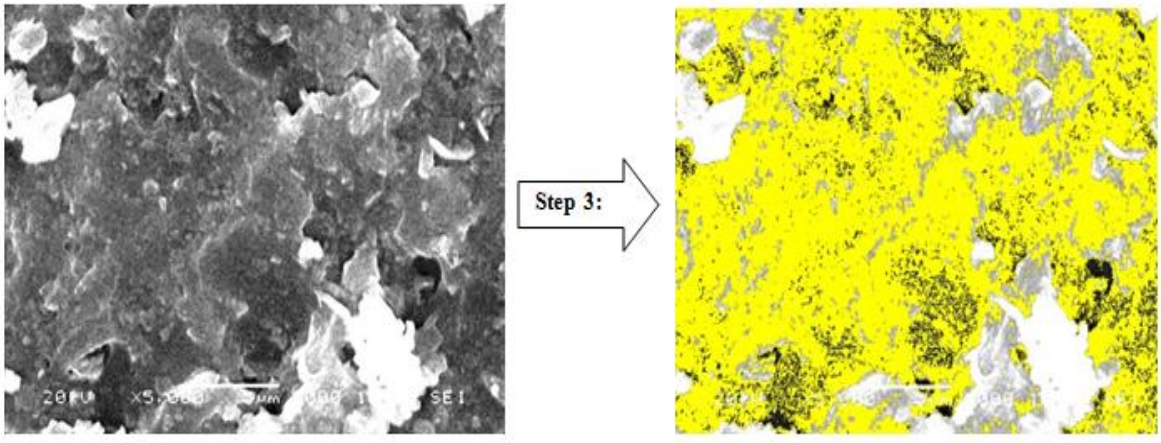


Fig. 15. Less dark objects and dark objects on **Fig.** 7

Step 4:

The proportion of objects in the image to **Fig.** 6 and to **Fig.** 7 has been depicted in Table. 1, such as following:

Table. 1: The proportion of an object in the image.

Object type	Fig. 6	Fig. 7
bright objects	8%	9%
less than bright objects	44%	15%
less dark objects	39%	68%
dark objects	9%	8%

We see that the share of different objects varies from image to image. This can be the basis for explaining the properties of fiber as a reinforcing agent in polymer compositions.

5. Conclusions

Based on the present research work on image processing effect of natural polymer composites, one can concluded that the applied methodology in the study of polymer compositions is very important tool. This work shows that successful fabrication of natural fiber / polymer composites by simple hand lay-up technique as well as image processing effect. This methodology is based on color segmentation of different types of objects in the image. This allows to someone for the better perceive the differences between uneven and cracked surface in polymer compositions. This approach not only needs engineering judgment but also requires a rigorous mathematical model to obtain optimal process settings.

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