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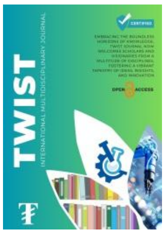

Enhancing Lung Cancer Diagnosis with MATLAB and GLCM: A Robust Image Processing Approach

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Abstract
This study presents a novel approach to the diagnosis of lung cancer by utilizing MATLAB to integrate modern image processing. Our method simplifies recognizing malignant phases by focusing on the examination of minute micro structural differences and utilizing MATLAB's Grey Degree Co-occurrence Matrix (GLCM) properties for accurate texture pattern extraction. The study investigates several wavelengths in conjunction with multispectral imaging to capture subtle differences across various cancer stages. Through the integration of advanced computational techniques with spectral insights, our methodology presents a comprehensive plan for enhancing photo sensitizer responses to enhance distinction. The main objective is to greatly increase the precision of tumour cell identification, encouraging early diagnosis and transforming therapeutic approaches for improved patient outcomes. This study advances the area of lung cancer identification and presents a viable path forward for enhancing clinical practice efficacy and diagnostic capacities.

Keywords
Lung Cancer, Image Processing, MATLAB, GLCM, KNN

INTRODUCTION

Lung cancer continues to be a major global health concern, requiring early and precise detection approaches due to its high rates of death and disability. Although useful, conventional diagnostic methods are frequently constrained by their inability to detect minute microstructural alterations that may be signs of lung cancer in its early stages. This paper suggests a sophisticated methodology that makes use of MATLAB-based image processing tools as a solution to these problems [1]. The incorporation of MATLAB's robust Grey Degree Co-occurrence Matrix (GLCM) functionalities facilitates a refined examination of pulmonary pictures, augmenting the detection of complex texture patterns linked to malignant cells.

Many of the current diagnostic methods are not precise enough to differentiate between different stages of cancer in the lungs. In order to tackle this, we investigate the incorporation of multispectral imaging, which enables the analysis of lung tissues at several wavelengths. This multimodal strategy intends to maximize the photo sensitizer response, which will increase the precision of tumor cell detection, while also facilitating a more thorough knowledge of malignant changes [2]. This discovery has the potential to change clinical interventions and improve the treatment of patients in the field of lung cancer identification by strengthening the capacity for early diagnosis.

Because cancer-related problems are complex and widespread, this study discusses the urgent need for continuous advancements in diagnostic methods to increase comprehension and promote early detection. The novel multimodal method combines MATLAB-based image processing with the unique data that a multidimensional photo sensor operating at 900 nm, 700 nm, and 380 nm wavelengths provides [3]. This novel approach reveals minor differences in the composition and organization of cancer cells, surpassing the limitations of conventional diagnostic techniques. In addition to addressing the shortcomings of existing methods, the combination of multispectral photo-sensors and MATLAB-based image analysis highlights the critical need of deciphering intricate cellular characteristics for improved cancer detection and tailored treatment strategies.

PHYSIOLOGICAL BACKGROUND

The unchecked proliferation of aberrant cells inside the lung tissues is the cause of lung cancer, a complicated and multidimensional illness. As an essential part of the respiratory system, the lungs exchange carbon dioxide and oxygen, which makes breathing possible [4]. The lungs' complex architecture includes alveoli, bronchi, and bronchioles, all of which are necessary for effective gas exchange.

Exposure to carcinogens, including tobacco smoke, environmental contaminants, and occupational risks, is frequently linked to an increased risk of lung cancer. These carcinogens cause lung cells to undergo genetic alterations, which interfere with the regular processes that control growth and apoptosis [5]. Consequently, malignant cells multiply unchecked, giving rise to tumors that have the potential to spread to adjacent tissues and, in more advanced phases, distant organs.

Comprehending the physiological complexities of lung cancer is crucial in order to create focused diagnostic instruments and therapies [6]. Through the use of MATLAB-based image processing, this research seeks to close gaps in existing diagnostic tools, providing a possible path towards better early detection and more successful treatment interventions in the ever-changing field of lung cancer.

AIMS AND OBJECTIVES

The objective of this study is to transform the field of lung cancer diagnosis by the incorporation of sophisticated image processing methods into the MATLAB environment. The principal aims of this study are to improve the sensitivity and precision of identification by means of a thorough analysis of lung pictures, utilizing the Grey Level Co-occurrence Matrix (GLCM) parameters in MATLAB to extract subtle texture patterns. Furthermore, the research aims to investigate the use of multispectral imaging to obtain a full understanding of the diverse features of lung cancer at different phases. Through computational approaches, sensor responses are optimized to promote differentiation and increase tumor cell detection accuracy. The principal aims of this study are to improve the sensitivity and precision of identification by means of a thorough analysis of lung pictures, utilizing the Grey Level Co-occurrence Matrix (GLCM) parameters in MATLAB to extract subtle texture patterns. Furthermore, the research aims to investigate the use of multispectral imaging to obtain a full understanding of the diverse features of lung cancer at different phases.

LITERATURE SURVEY

Recent years have seen tremendous progress in the field of lung cancer detection, as researchers have been looking into novel ways to deal with the difficulties involved in making an early diagnosis. Even though they are useful, traditional diagnostic techniques frequently fail to identify the minute micro structural alterations that are indicative of lung cancer in its early stages [7]. As a result, there is increasing interest in using methods for image processing to improve the sensitivity and precision of detection methodologies, according to recent literature.

Promising results have been shown in studies examining the application of MATLAB-based algorithms for image processing in cancer detection. For example, Grey Level Co-occurrence Matrix (GLCM) elements in MATLAB have been effectively used for texture pattern extraction in study on breast cancer diagnosis, demonstrating its potential utility in lung cancer diagnostics [8]. By using GLCM features, radiological pictures can be analysed more deeply and nuanced, making it easier to spot small differences that could be signs of cancer.

Multispectral imaging has become a significant field of study in the literature, providing a thorough understanding of tissue properties through the acquisition of data at many wavelengths. This method's promise for lung cancer diagnosis is growing, since it has been proven in a number of medical imaging applications [9]. By combining multispectral information with computational techniques, it may be possible to increase the accuracy of tumour cell detection by improving the distinction of malignant tissues and photosensitize responses.

The literature also emphasises the necessity for accurate and customised diagnostic instruments that take into account the variability of lung cancer at different stages [10]. Advances in computation are becoming more and more important to researchers, and MATLAB is a flexible platform that may be used to develop complex algorithms. Sophisticated computational tools support both the continuous advancement of precision medicine and the improvement of diagnostic accuracy.

Notwithstanding these advancements, gaps in the literature suggest that image processing methods for lung cancer diagnosis still require investigation and improvement [11]. This research is multifaceted, covering areas of clinical application, computer analysis, and medical imaging [12]. Through expanding upon the current body of knowledge and filling in these gaps, this investigation hopes to add to the continuing conversation about improving early detection techniques for the diagnosis of lung cancer.

MATERIALS AND METHODS

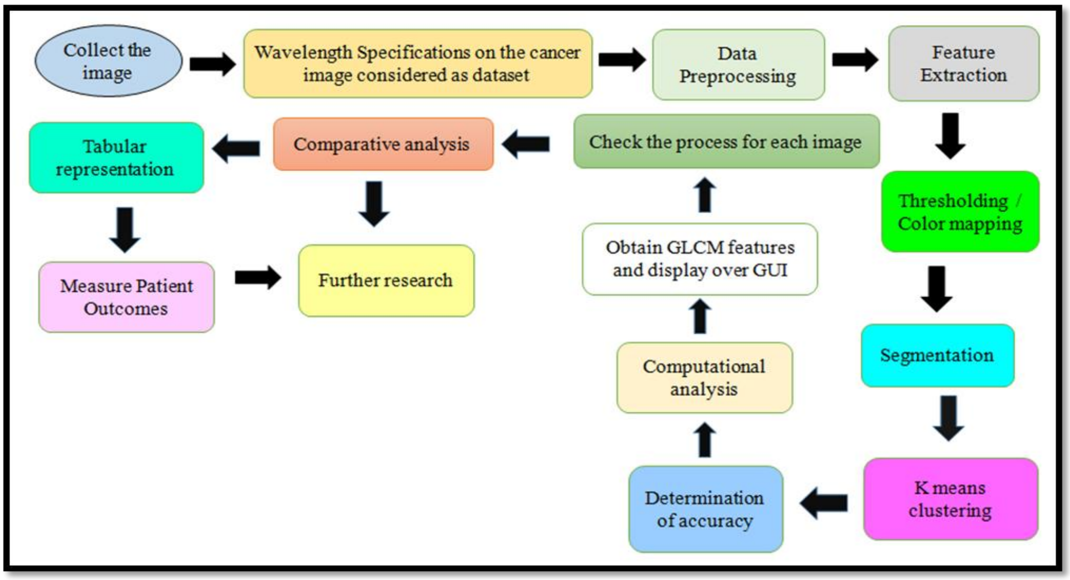


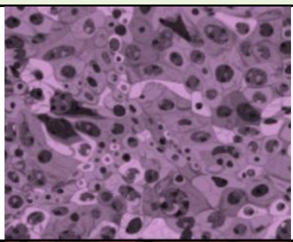
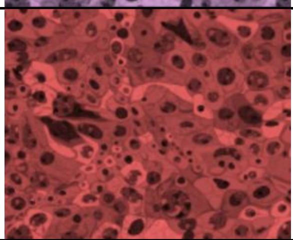
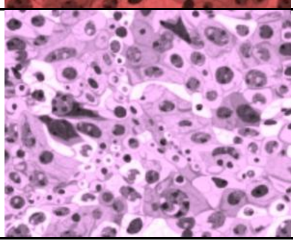
Fig. 1 Methodology

The technical approach used in this study applies multidimensional photo sensors operating at 900, 700, and 380 nm wavelengths to obtain cell pictures from publicly available information as per figure 1. The photos were then refined using MATLAB-based pre-processing methods like noise removal and contrast enhancement [13]. Grey Level Co-occurrence Matrix (GLCM) features, which include energy, contrast, and homogeneity, were extracted after thresholding, mapping, and segmentation procedures. These characteristics were crucial in identifying complex textural patterns suggestive of possibly malignant cells [14]. Additionally, K-Means clustering was used to group cells unsupervised based on retrieved data, which made it easier to identify shared properties. A double-blind comparison analysis was used to guarantee the impartiality of the methodology [15], which helped to create a strong and technically advanced framework for the identification of lung cancer.

RESULTS AND DISCUSSION

To demonstrate how the sensor functions or how to detect cancer cells at a certain wavelength, the corresponding dataset including a particular tag of a carcinogenic cancer is selected.

Table 1 Cancer cells of 3 different wavelengths

Cancer cell to be taken as input	Wavelength specified (nm)	Name of range	Title of the figure
	380	Violet / Ultraviolet	**Fig. (a)**
	700	Red	**Fig. (b)**
	900	Pink / IR	**Fig. (c)**

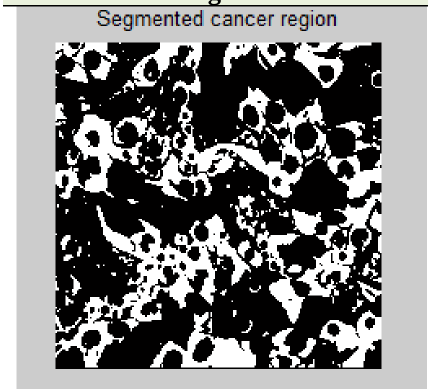
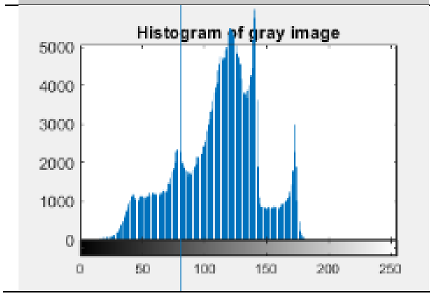
Alongside with the pictorial data numerical analysis with various GLCM features have also been done.

Table 2 Comparative analysis of GLCM features and status of 3 different wavelengths

Fig name	Contrast	Correlation	Homogenity	Carcinogenic cell %	Energy	Kernel accuracy	Species status
a	0.1157	0.7337	0.9422	19.04%	0.4634	73%	Abnormal
b	0.2011	0.4516	0.8993	0.00	0.4722	83.33%	Normal
c	0.0709	0.7372	0.9646	15.23	0.6644	80%	Abnormal

Fig. (a) Results

Table 3 Computational images of **Fig. (a)**

Figure	Figure no	Figure name
	**Fig. 2**	Cancer cells segmentation
	**Fig. 3**	Ostu thresholding of the image
	**Fig. 4**	Histogram computed of the image

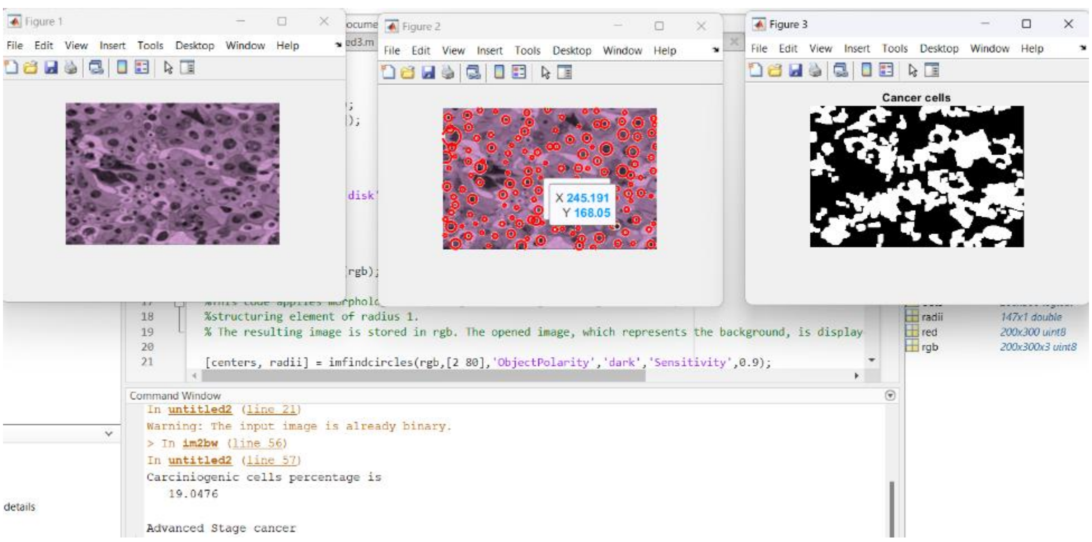


Fig. 5 Live GUI Results

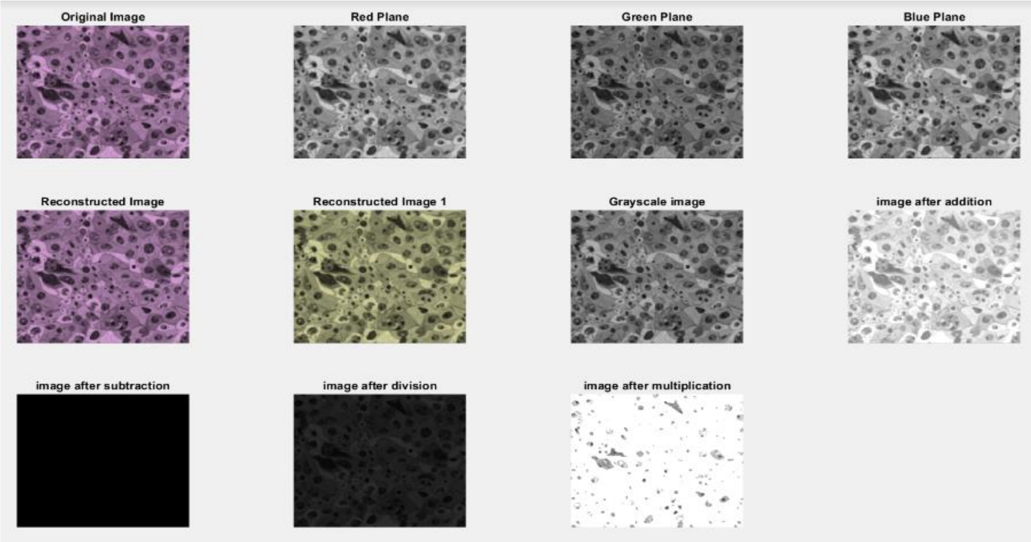


Fig. 6 Plane segmented of image

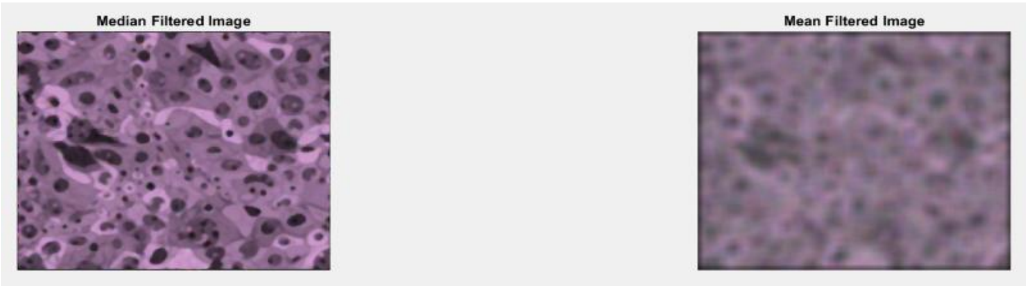
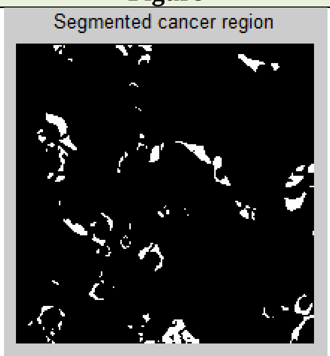
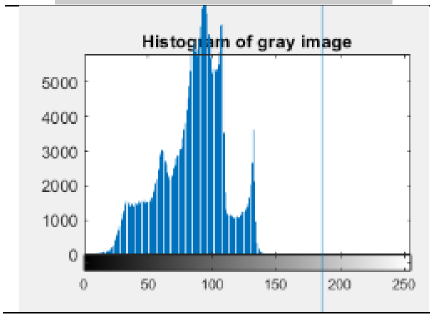


Fig. 7 Image filtering

Fig. (b) Results

Table 4 Computational images of **Fig. (b)**

Figure	Figure no	Figure name
	**Fig. 8**	Cancer cells segmentation
	**Fig. 9**	Ostu thresholding of the image
	**Fig. 10**	Histogram computed of the image

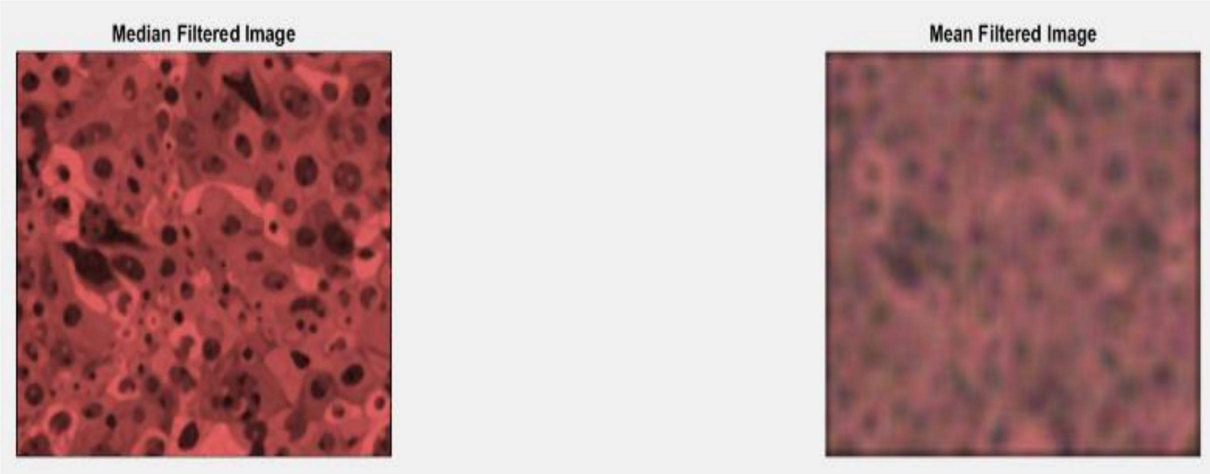


Fig. 11 Filtering

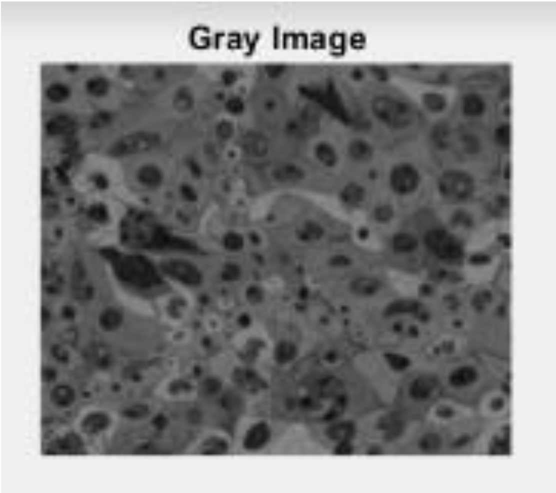


Fig. 12 Grayscale image

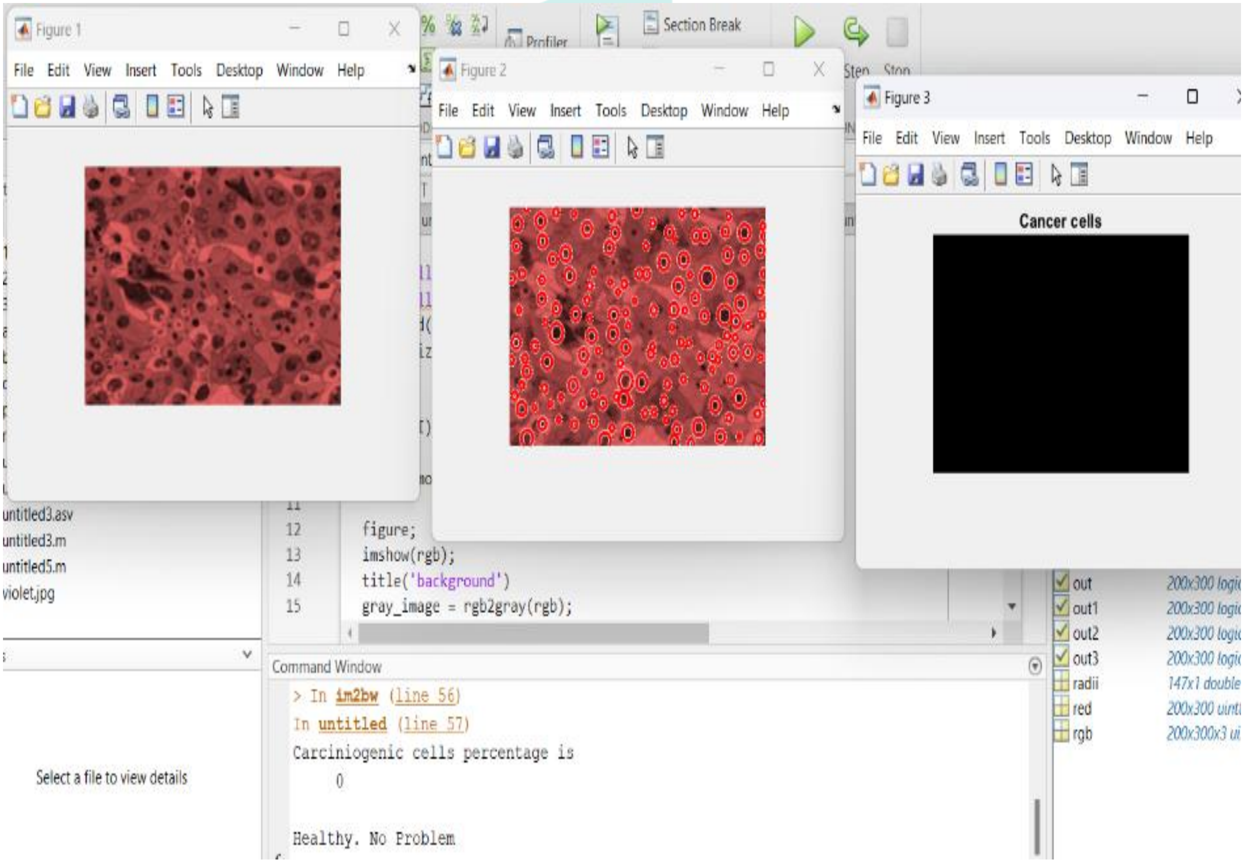
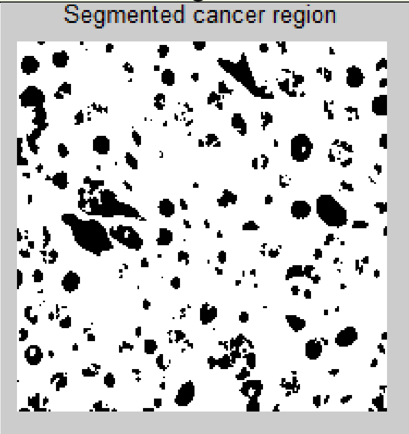
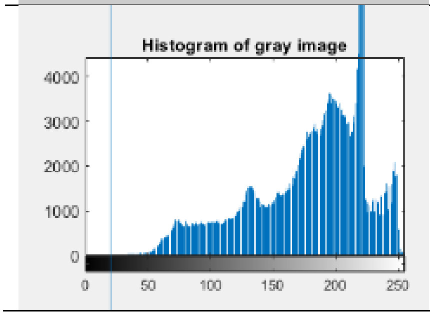


Fig.13 Dynamic GUI representation

Since this is an image of a healthy cancer cell the segregated plane segmentation process is not undergone.

Fig. (c) Results

Table 5 Computational images of **Fig. (c)**

Figure	Figure no	Figure name
	**Fig. 14**	Cancer cells segmentation
	**Fig. 15**	Ostu thresholding of the image
	**Fig. 16**	Histogram computed of the image

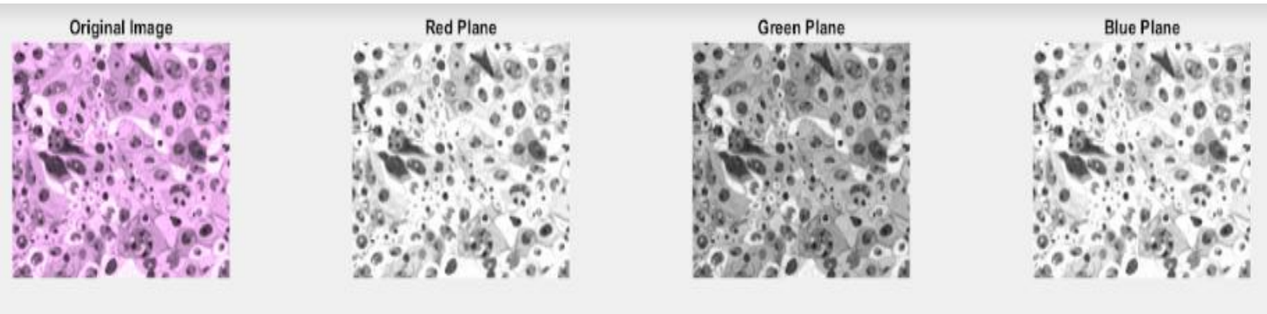


Fig. 17 Plane segmentation of image

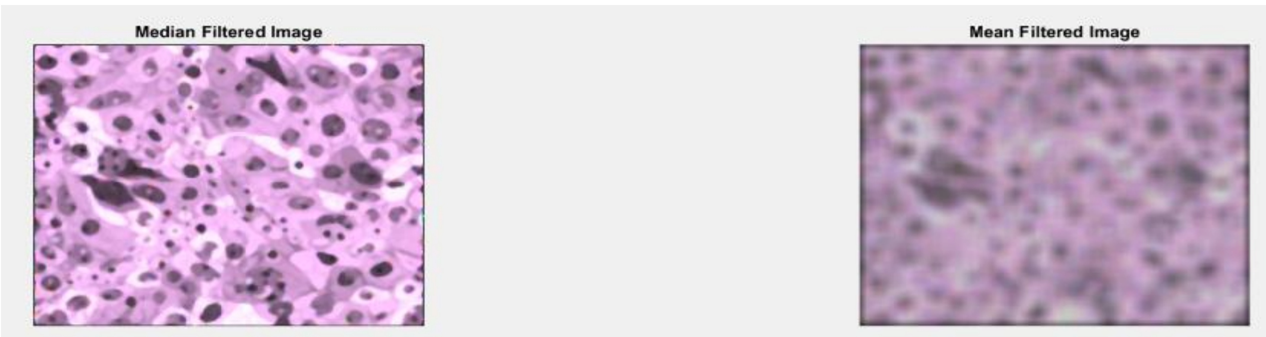


Fig. 18 Filtering of respective image

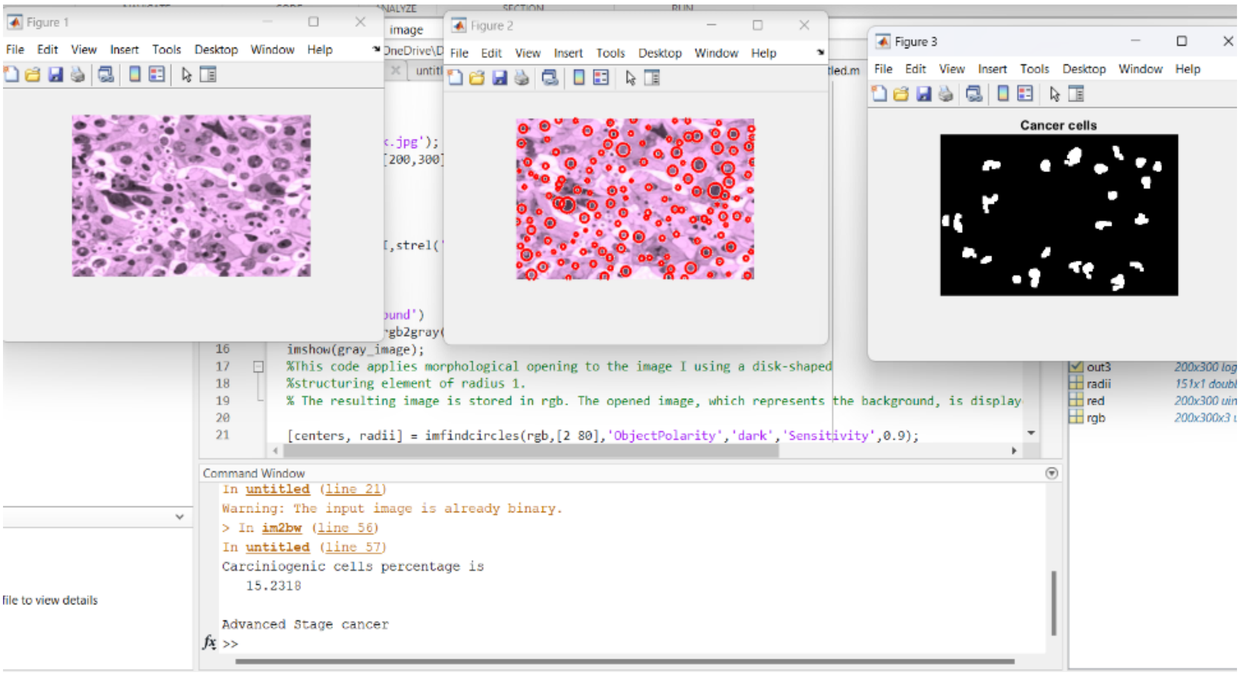


Fig. 19 Dynamic GUI representation

Thus, it is drawn from the results that the respective photosensor is quite sensitive and works efficiently for the wavelengths of pink (IR) and violet (UV) range.

CONCLUSION

This study has developed a comprehensive methodology that uses cutting-edge image processing techniques to detect lung cancer. A thorough examination of cellular pictures has been made possible by the combination of multifunctional photosensors, MATLAB-based processing, and feature extraction utilising the Grey Level Co-occurrence Matrix (GLCM). Through the use of thresholding, mapping, & K-Means clustering, complex textural patterns suggestive of malignant cells may now be more accurately identified. Adopting a double-blind comparative evaluation guarantees the findings' objectivity. The outcomes demonstrate how well the suggested methodology works to increase the degree of sensitivity in lung cancer diagnosis. This technical approach highlights the potential influence of algorithms in increasing the timely and precise identification of lung cancer and not only helps to improve diagnostic capabilities additionally offers promises for potential uses in clinical settings.

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DECLARATION OF CONFLICT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. On behalf of all authors, the corresponding author states that there is no conflict of interest.

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LIST OF ABBREVIATIONS

MATLAB: Matrix Laboratory
GLCM: Gray Level Co – Occurrence Matrix.
IR: Infrared.
KNN: K-Nearest Neighbors

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