

Design and Development of Medical Image Processing Techniques and to Study their Applications Using Graphical System Design

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Abstract: In this research, an automated system is developed with the help of ANN and image processing methods. MATLAB provides access to these toolboxes. The MATLAB environment is used to create the entire system. As a classifier, the ANN toolbox employs Feed Forward Back Propagation (FFBP). X-ray pictures are used as input for PTB detection. These X-ray images are used in the application of segmentation and enhancement techniques. Features such as shape and texture are retrieved from the resulting image. The neural network is trained using these features as input. These characteristics are taken into account alongside the outcome of a clinical examination (sputum). After the ANN has been trained, it is put through its paces with a test X-ray picture. Segmentation and enhancement, the first two processes that occurred during training the ANN, will likewise occur during testing. Comparisons are made between the test image's extracted form and texture features and the trained features. The ANN classifier determines whether or not a given case involves tuberculosis. In addition to the classification, a severity check is performed. Architecture (6-2) is used for form characteristics, while architecture (128-40-10-2) is used for gabour features, making this ANN multi-level. The system's output, intermediate steps, etc., are presented to the user via a graphical user interface (GUI).

Keywords: Artificial Neural Network (ANN), MATLAB, gabour features, Graphical User Interface (GUI)

Introduction

In the mid-1960s, digital imaging was created to better probe the planets and moon. The conventional cameras used in the robotic Ranger spacecraft sent skewed and distorted photos of the moon back to Earth. To address this issue, Dr. Robert Nathan of NASA's Jet Propulsion Laboratory (JPL) started building the first practical digital image processing software. Digital imaging, which converts analogue information into digital signals that can then be processed by a computer, he said, provided clear, precise pictures of the lunar surface. As more and more complex spacecraft started receiving massive amounts of picture data from farther and further away from Earth, a continual stream of advancements in digital image processing began. In the years that followed, Dr. Robert Nathan, Robert Selzer, and Kenneth Castleman of JPL were among the first to use digital processing methods to improve pictures captured by electron microscopes, X-ray microscopes, and light microscopes. As a result of this work, other institutions began experimenting with medical applications, and a new market for medical image processing systems emerged. Applications in medicine that make use of this technology include CAT scanning, diagnostic radiology, angiography of the brain or heart, sonar body imaging, surgical monitoring, and nuclear magnetic resonance. The development of digital photography technology has spawned a wide variety of profitable businesses and consumer goods. New and improved medical apps and diagnostic tools continue to benefit both medical professionals and the patients they serve. Digital picture data for land remote sensing applications did not become widely accessible until the launch of Landsat-1 in 1972. Both the theory and practise of digital image processing were in their infancy, and digital computers were expensive and inefficient compared to what they are now.

An image, such as a picture or video frame, serves as the input for image processing, a subset of signal processing; the output of image processing might be another image or a collection of parameters or characteristics of the original image. Processing an input picture such that it meets the needs of the application is, in a nutshell, what this term refers to. Images are signals generated by cameras and other image hardware.

Since the time of Galileo Galilei and Isaac Newton, one of the primary goals of contemporary science has been the development and improvement of imaging technologies. When comparing digital computers to analogue electrical and optical information processing equipment, the fact that no hardware changes are required when reprogramming digital computers to do new jobs is by far the most significant benefit of digital computers. Using the same components, one may construct a computer capable of solving any issue by writing custom software. Because of this quality, digital computers are also a great tool for handling picture signals. Integrating digital computers into imaging systems enables them to execute any operation, not only the element-wise and integral signal transformations typical of analogue optics, such as spatial and temporal Fourier analysis, signal convolution, and correlation. Because of this, optical information processing may now be seamlessly merged with digital signal processing, overcoming a key obstacle in the field. When data are handled digitally, it is most natural to acquire and analyse quantitative data included in pictures as signals, and to link imaging systems to other informative systems and networks. Digital signals are the equal of money in the field of information handling, just as money is a general equivalent in the field of economics. A computer-generated digital signal that conveys, in a sense, the "cleaned up" version of the data originally sent by uncoated picture signals. The digital signal, being universal in nature, is a great tool for connecting disparate data infrastructures. The capabilities of computers in terms of memory and processing speed are the only constraints for digital photography and image processing. The use of images to supplement or even replace traditional data archives is becoming more common in scientific and industrial applications. The employment of digital cameras to document the completion of a project, such as the excavation of a road pipe, and its subsequent upload to a mapping or GIS system are two such examples.

As a result, projects often use well-tested solutions, the success of which depends in part on the standard's widespread adoption and availability. Costs are projected to be reduced due to the widespread availability of digital cameras and PC software to see and print the findings. This is particularly crucial in industries where deployment must be directly linked to financial success. However, it is not unusual for there to be several alternate depictions of the same thing. Images of a vehicle engine, for instance, might be utilised by a car manufacturer for testing, training, servicing, and advertising. More emphasis will need to be placed on the reusability and re-purposability of digital assets like photographs as digital asset management becomes seen as an essential control that a corporation should adopt. In this regard, JPEG 2000's numerous advantages become apparent: accurate colour management, compression that allows for both glossy and glossless copies of a picture to exist in the same file, and a wealth of opportunities to annotate an image with both user-defined and industry-standard information. Many scientific and industrial applications also need further processing of digital images, such as feature enhancement or item counting. The information lost during lossy compression is invisible to the human eye and may not have the same characteristics as those detected by computerised image processing tools, which might lead to issues if applied to these photos. As a result, it's crucial to guarantee that archived content is kept in its greatest quality while still being easily accessible for quick searches and previews throughout the pre-processing phase. In the discipline of medical image processing, image processing methods are used to medical images such as MRI, CT, and X-Ray in order to extract information that aids in a more accurate diagnosis and subsequent therapy. A thorough literature review led us to the conclusion that, among all applications of image processing, medical image processing is among the most consequential. Disease detection utilising image processing methods is a fascinating area of study. Research into the diagnosis of pulmonary tuberculosis (PTB) use this method. This is because there are a plethora of diagnostic options for pulmonary tuberculosis (PTB), including sputum testing, skin tests, blood tests, and others. However, few diagnostic procedures make advantage of image processing. Even if the findings of a clinical examination are obtained, they are not always reliable. Simultaneously, X-ray pictures are used for diagnosis, but again, the findings are not very reliable. This is because there is a severe shortage of experienced practitioners and medical students. The system needs a high resolution picture of sputum, which is quite difficult to acquire, thus the solutions which employ image processing techniques also have a few limitations. The alternative method has a lower rate of correct diagnoses. Also, the produced system can't be handed over to physicians or laypeople. This has served as inspiration for the

creation of a system that improves detection accuracy and is simple enough for physicians to utilise. The current approach relies on three main phases for detecting PTB.

Image processing techniques

Neural network

Graphical User Interface (GUI)

Geometric Transformations and Image Registration

Images may be rotated, downsampled in quality, corrected for geometric distortions, and registered using geometric transformations. Simple operations like resizing, rotating, and cropping are all supported by Image Processing Toolbox, as are more complicated 2D geometric transformations like affine and projective. In addition to standard geometric transformations and interpolation techniques, the toolbox allows users to define their own transformations and procedures for N-dimensional arrays. Aligning pictures for quantitative analysis or qualitative comparison requires image registration, which has vital applications in remote sensing, medical imaging, and other fields. Intensity-based image registration is a feature included in Image Processing Toolbox that automatically aligns pictures by analysing their relative intensities. Control-point image registration, which needs the user to manually pick control points in each picture in order to align the images, is also supported by the toolkit. It might be challenging to analyse and show some photos using conventional techniques due to their massive file sizes. Workflows tailored to the processing of huge photos are included in Image Processing Toolbox. Avoiding the need to completely load a huge picture into memory, By segmenting a picture into spatial tiles and resampling it at various resolutions, we may create what's called a "reduced-resolution data set" (R-Set). The functionality of seeing and navigating images is enhanced by using this technique. To drastically cut down on the amount of memory a huge picture takes up, a block processing workflow may be utilised to apply a function to each individual block. In sum, the toolkit is a potent aid to analysis in the medical area. Identifying abnormalities like tumours, nodules, etc.

Artificial Neural network

Thanks to recent developments in computing power, there is renewed enthusiasm for applying so-called "Artificial Intelligence" (AI) to fields like biology and healthcare. Artificial neural networks (ANNs) are one of the most exciting and researched areas in artificial intelligence. In their most basic form, ANNs are just the computer-generated mathematical algorithms. Artificial neural networks (ANNs) are able to learn and retain information by using standard data. Trained ANNs have a lot in common with the basic functions of a tiny biological neural cluster. As a digital representation of the actual brain, they are able to spot interdependencies and other nonlinear patterns in data that a human analyst could miss. ANNs are now being utilised extensively in cardiology and other areas of medicine. Diagnostics, ESA, MED image analysis, and RAD are just few of the areas where ANNs have found widespread use [24]. Neural networks (NNs) are models of the neurons found in the brains of animals and humans implemented in software (and sometimes hardware) computers. The goal of this simulation is to learn their complex behaviours. We are only referring to a NN as a computer system when we use phrases like neuron, neural network, learning, and experience. ANNs may pick up new skills by observing others' actions. A NN may be taught to identify a vehicle from a photograph by exposing it to several instances of cars. There are various commercial and practical uses for NNs. When the business rules are unclear or difficult to catalogue, these systems' capacity to learn from example shines.

Graphical User Interface (GUI)

This set of tools allows you to create responsive graphical user interfaces in MATLAB, no matter the screen size. All sorts of different interface designs are possible using the given classes. Graphical user interfaces, or GUIs, allow users to interact with software using images. A well-designed graphical user interface (GUI) may

streamline the user experience by giving programmes a unified visual style and offering familiar interface elements like buttons, menus, and drop-down lists. The GUI's behaviour has to be intuitive and consistent so that the user always knows what to anticipate and when anything will happen. In response to a mouse click on a button, for instance, the GUI should carry out the task specified by the button's label.

Design And Development of the Artificial Neural Networks and Graphical User Interface(GUI) for Pulmonary Tuberculosis Detection

One kind of information management system, artificial neural networks (ANNs) are mathematical models that mimic the structure and operation of real neural networks in the brain. With its self-learning capabilities, associative memory, and highly parallel, fault-tolerant, and formidable nonlinearity handling capacity, ANN is able to use this information and experience to rationally judge hard queries. Signal processing, pattern identification, quality synthetic assessment, prediction analysis, etc. are just some of the areas where ANNs have been put to use. The purpose of this research is to investigate the viability of using an ANN-based TB diagnosis model.

At first, a large number of X-ray pictures are used to "train" a neural network on form attributes and symptoms. Data, in the form of pictures, is read and translated into a matrix format, as shown in Figure 1. Then, form characteristics are extracted from the photos. Feature collection describes this current process. The features are then used as input into the neural network. Once the symptoms have been input into the neural network, it will compare the characteristics of the testing photos to the extracted features from the training phase, displaying the outcome as TB or NON-TB on the computer screen. There is one more step here, from database to neural network, when the neural network is trained using symptom and form characteristics. One hundred and ten X-ray pictures, 59 of which were non-TB and 51 of which were PTB, were used to validate the system. The modelling sample was divided into two groups, one for training and one for testing, with a 4:1 ratio between the two. Of the total cases, 55 were found to be non-tuberculous and 49 were found to be tuberculous. In a research based on a sample of adopting advisors' training records,

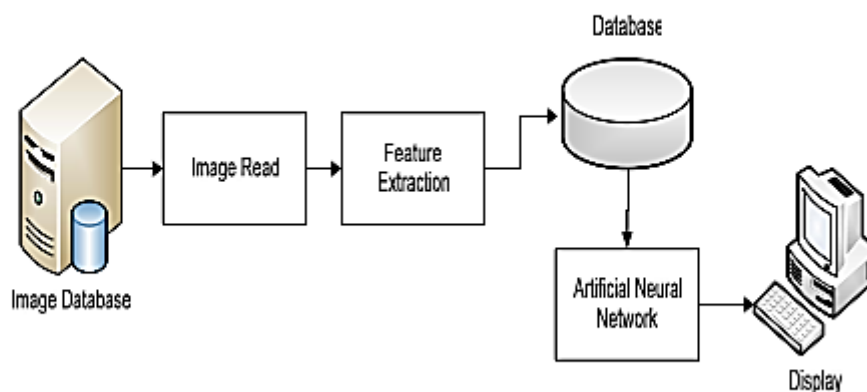


Figure 1. ANN Training Network

For the benefit of the user, a graphical user interface (GUI) has been developed to show the output. The resulting graphical user interface (GUI), seen in Figure 2, displays all relevant result data, including severity, intermediate outcomes, graphs, etc. A graphical user interface, or GUI, is a method of interacting with a computer programme that emphasises clarity and simplicity. An inexperienced user may navigate the interface

with the help of the clearly labelled push buttons, text boxes, radio buttons, pop-up menus, slider, etc. These parts make it simple for the user to figure out what to do or how to run the programme.

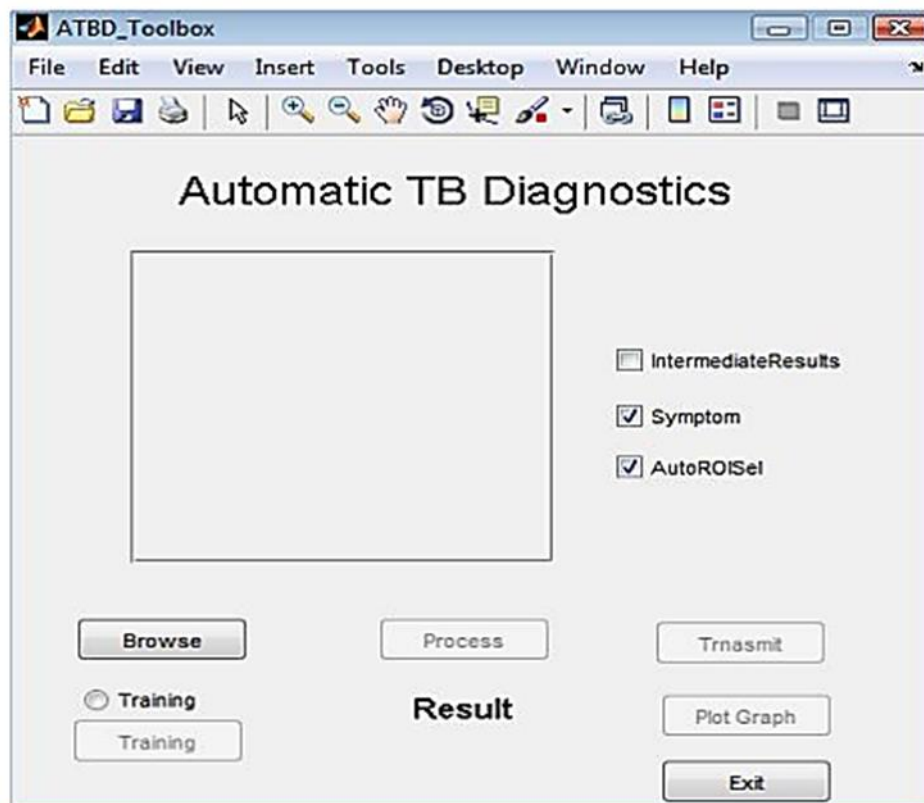


Figure 2. Front Panel GUI

When a user interacts with a GUI by pushing a button, selecting an option from a list, or typing text into a text box, the programme receives the data it needs to process the action. For creating graphical user interfaces (GUIs), MATLAB has a tool called GUIDE (GUI Development Environment). Many disciplines use GUI methods. Some systems include GUIs to make it easier for users to interact with the system and grasp its structure. By providing a graphical user interface (GUI), the created object detection system is able to communicate with its users. The MATLAB environment is used to create the whole system. Matrix Laboratory, or MATLAB, is a popular technical language used for programming in mathematics. It offers a large number of preconfigured programmes or features that may simplify and speed up the problem-solving process for engineers and scientists. MATLAB's abundance of useful add-ons, called "toolboxes," has simplified research in many fields. The primary contents of a toolbox for a given field are the procedures and applications used to address issues that arise within that field. Today's MATLAB professionals may take use of the program's graphical user interface (GUI). When compared to languages like FORTRAN, C, C++, and Java, MATLAB makes writing programmes a breeze. This is because MATLAB removes the need for the programmer to worry about common causes of error in other languages, such as the definition of variables, their types, sizes, and memory needs. The graphical user interface (GUI) developed for this work consists of a radio button, six push buttons, three tick boxes, and a place for the result and photos. Initial activation of the training's start radio button. The neural network is trained using PTB and Non TB photos when the training button is hit. After the training is complete, the unidentified X-ray picture may be selected with a click of the browse button. The boxes next to ROI and sputum will be checked (active) at all times. There is also a checkbox, with a corresponding button, for intermediate outcomes. If the checkbox for intermediate results is maintained selected, the outcomes of the enhancement, segmentation, and compression phases will be shown. Selecting the test picture activates

the procedure button. When you click this button, a chain of operations including segmentation, enhancement, compression, ROI selection, feature extraction, feature comparison with trained features, and presentation of the result begins in the background. Using the transmit button, the ROI picture may be sent from one location in the building to another.

Images of high PTB detection

Images 3(a), 3(b), 3(c), 3(d), 3(e), 3(f) show the important intermediate stage results of a high TB case.

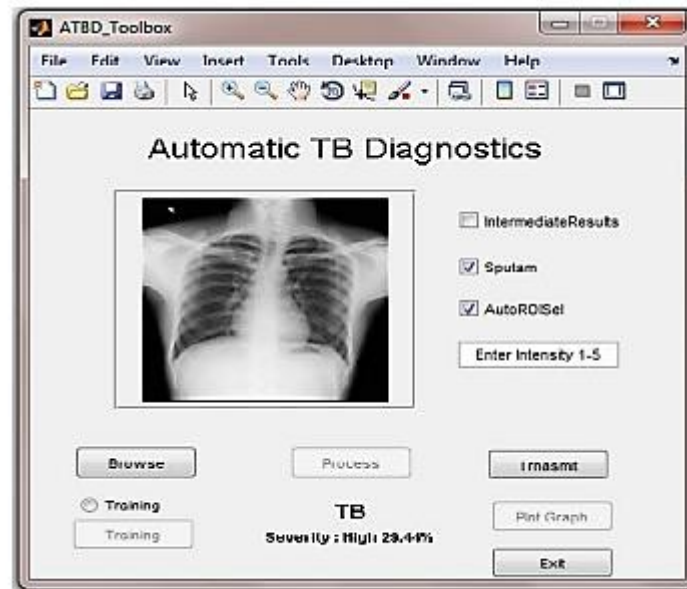


Figure.3 (a) GUI displaying the result

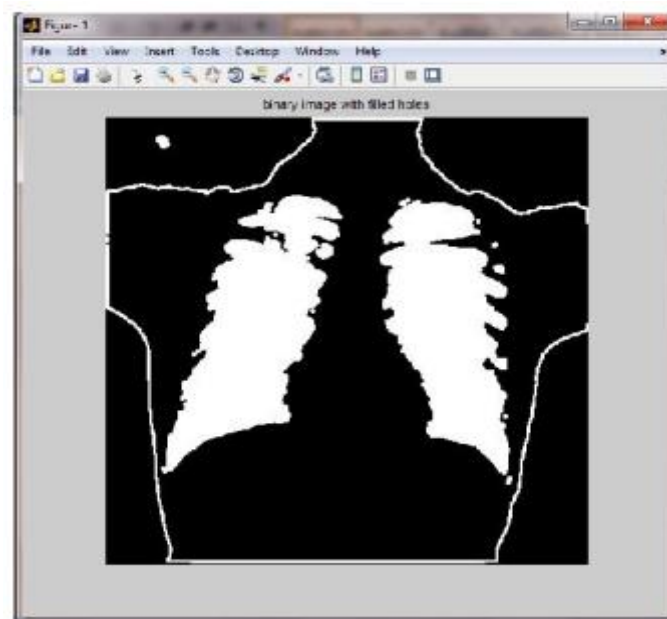


Figure.3 (b) Binary image with filled holes

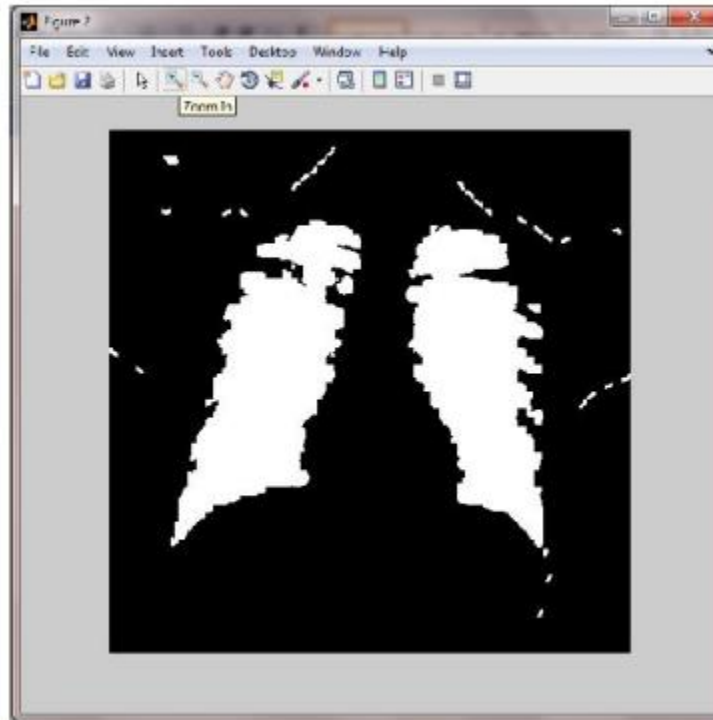


Figure. 3(d) Lung image with bounding box

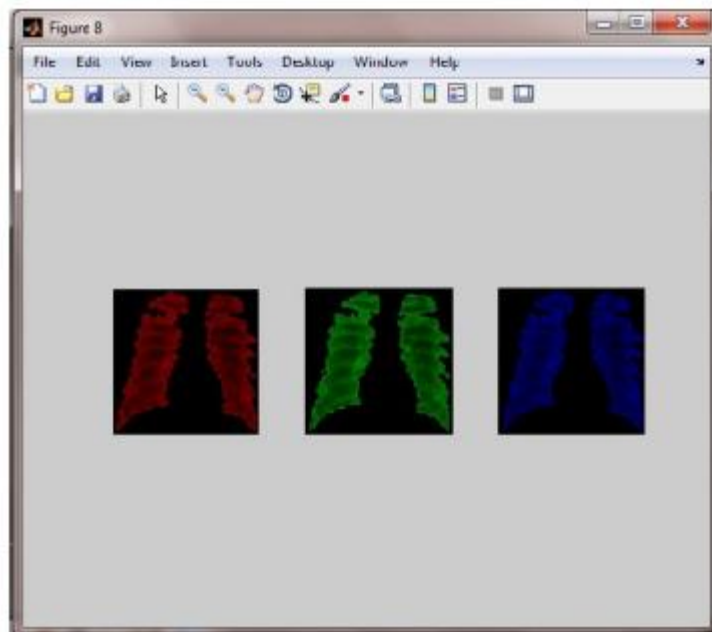


Figure. 3(e) Colour separated lung image

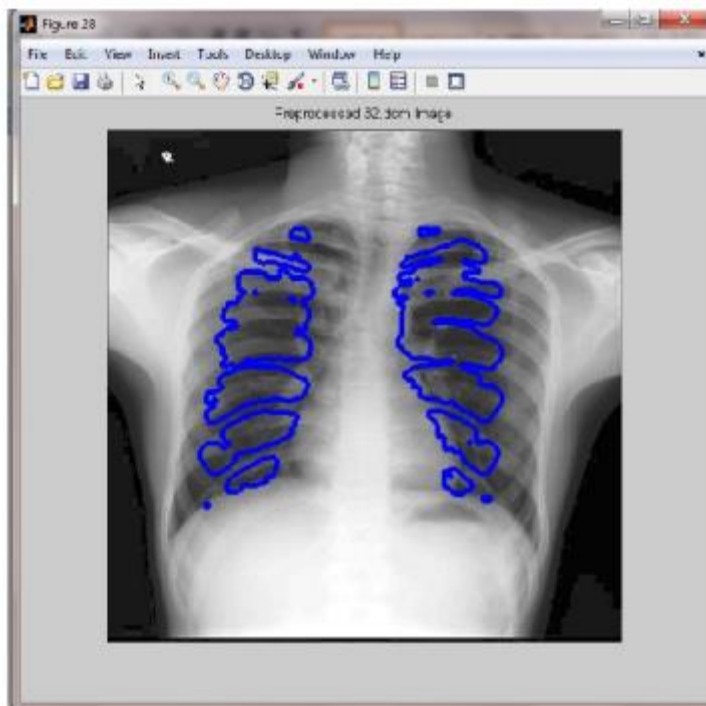


Figure. 3(f)ROI image

Conclusion

The article presents a simple, straightforward method. The MATLAB-built GUI makes it easy to process X-ray images with little input from the user. The test picture and the results of the test are shown in the same window. There is no need for the user to go looking for tools since everything is right there on the GUI panel. This makes the technique a potent diagnostic tool for tuberculosis. In this study, we use a combination of ANN and image processing methods for PTB detection. The ANN is developed in three phases; the first of these is a multi-level multi-layered method with six shape features and two hidden layers for optimal segmentation accuracy of 70%. This level of precision is insufficient. The accuracy was improved by using an improvement method that combines colour and discrete wavelet transform (DWT) augmentation.

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