

eX-Ray: A Mobile Application using Pattern Recognition Algorithm

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Abstract

“The project developed a mobile application that will help users to detect the abnormalities in their x-rays by using an algorithm in a mobile application. The researchers devised a tool in detecting the abnormalities using a built-in camera. The method used in detection was image segmentation using pattern recognition algorithm. It converted the image to grayscale to detect two kinds of edges in an image: Vertical Direction Edges and Horizontal Direction Edges. After the image was converted, it counts the number of white pixels which had been the basis if the x-ray is normal or not. This mobile application is available for android operating systems only. The programming language

that the researchers used is Java. The application resulted from 70% - 80% accuracy in detecting the abnormalities in the x-rays because it uses phone camera for detection instead of putting it on a light wall. It is recommended that the design be enhanced by adding more functionality such as sending a message to a radiologic center if the x-ray was detected with abnormalities. It is also recommended to add some features such as detecting the cause of the health problem.”

Keyword: Image Processing, Mobile Application, Pattern Recognition Algorithm

1.0 INTRODUCTION

“Roentgen’s discovery of X rays in 1895 occurred because a florescent screen (barium platinocyananide) emitted light when excited by radiation emerging from a Crookes tube and causes this radiation to be able to produce an image on a photographic dry plate. In the 95 years since Roentgen’s discovery, the extent to which x rays have been applied to

medical imaging and to the advancement of science and industry has been beyond all speculation of early pioneers and investigators. (Arthur G. Haus, et al, 1989).”

“According to King-Sun Fu, 1976, during the past twenty years, there has been a considerable growth of interest in problems of pattern recognition and image processing. This interest has created an increasing need for theoretical methods and experimental software and hardware for use in the design of pattern recognition and image processing systems. Over twenty books have been published in the area of pattern recognition. In addition, a number of edited books, conference proceedings, and journal special issues have also been published. Application of pattern recognition and image processing include character recognition, target detection, medical diagnosis, analysis of biomedical signals and images, remote sensing, identification of human faces and fingerprints, reliability, speech recognition and understanding, and machine part recognition.”

“Although pattern recognition and image processing have developed as two separate disciplines, they are very closely related. The area of image processing consists not only of coding, filtering, enhancement, and restoration, but also analysis and recognition of images. On the other hand, the area of pattern recognition includes not only feature extraction and classification, but also pre-processing and description of patterns. (King-Sun Fu., et al, 1976)”

In order to ensure the performance of an automatic x-ray scanner will be accurate with respect to the quality of input x-ray images, it is crucial to incorporate a pattern recognition algorithm in the detailed extraction module. It involves finding the similarities or patterns among small problems that can help us solve problems that are more complex efficiently.

This mobile application aimed to use pattern recognition algorithm in order to convert x-ray film into digital form. “According to Meyer-Base (2014), pattern recognition techniques play a critical role when applied to medical imaging by fully automating the process of abnormality detection and thus supporting the development of computer-aided diagnosis (CAD) systems. Pattern recognition tasks require the conversion of pattern in features describing the collected sensor data in a compact form. Ideally, this should pertain only to relevant information. The pattern recognition format has been used successfully by both national and international radiographic societies to educate and train radiographers working in regions where radiology advice or services are unavailable.”

2.0 THE RESEARCH

2.1 OBJECTIVES:

This study aimed to determine the following objectives:

1. To develop a mobile application that will capture x-ray film and convert to digital form.
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2. To use pattern recognition algorithm in the conversion of the diagnostic x-ray examination.
3. To use Java programming language in the development of the application.

2.2 REVIEW OF RELATED LITERATURE

X-rays

“You have probably seen a chest x-ray (chest radiograph), or might even have had one taken. Have you ever wondered how to read a chest x-ray? When looking at a radiograph, remember that it is a 2-dimensional representation of a 3-dimensional object. Height and width are maintained, but depth is lost. The left side of the film represents the right side of the individual, and vice versa. Air appears black, fat appears gray, soft tissues and water appear as lighter shades of gray, and bone and metal appear white. The denser the tissue, the whiter it will appear on x-ray. Denser tissues appear radiopaque, bright on the film; less dense tissues appear radiolucent, dark on the film.”

“In the book Health Wellness and Longevity by Steve Dimon, diagnostic x-rays are useful in detecting abnormalities within the body. They are a painless, non-invasive way to help diagnose problems such as broken bones, tumors, dental decay, and the presence of foreign bodies.”

“According to Cameron, (2003), x-rays pass easily through air and soft tissue of the body. When they encounter denser material, such as a tumour, bone, or a metal fragment, they are stopped. Diagnostic x rays are performed by positioning the part of the body to be examined between a focused beam of x rays and a plate containing film. This process is painless. The greater the density of the material that the x rays pass through, the more rays are absorbed. Thus bone absorbs more x rays than muscle or fat, and tumours may absorb more x rays than surrounding tissue. The x rays that pass through the body strike the photographic plate and interact with silver molecules on the surface of the film.”

Once the film plates have been processed, dense material such as bone shows up as white, while softer tissue shows up as shades of grey, and airspaces look black. “A radiologist, who is a physician trained to interpret diagnostic x rays, examines the pictures and reports to the doctor who ordered the tests. Plain film x rays normally take only a few minutes to perform and can be done in a hospital, radiological centre, clinic, doctor's or dentist's office, or at bedside with a portable x-ray machine.”

“According to the studies, most applications of X-rays are based on their ability to pass through matter. This ability varies with different substances; e.g., wood and flesh are easily penetrated, but denser substances such as lead and bone are more opaque. The penetrating power of x rays also depends on their energy. The more penetrating x rays, known as hard

x rays, are of higher frequency and are thus more energetic, while the less penetrating X rays, called soft X rays, have lower energies. X rays that have passed through a body provide a visual image of its interior structure when they strike a photographic plate or a fluorescent screen; the darkness of the shadows produced on the plate or screen depends on the relative opacity of different parts of the body. (Graham and edit, 1985 and Kelves, 1997)”

Edge Detection

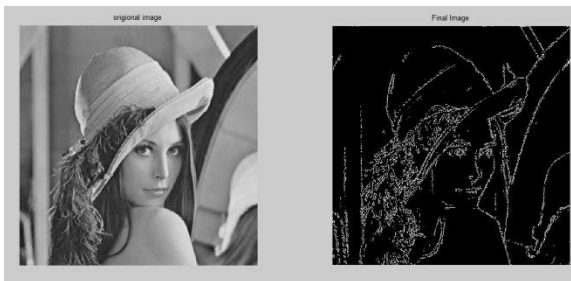


Figure 1
Edge Detection

“Maini, R. & Aggarwal, H. (2009) explains that edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel

intensity which characterize boundaries of objects in a scene. There are an extremely large number of edge detection operators available, each designed to be sensitive to certain types of edges. The geometry of the operator determines a characteristic direction in which it is most sensitive to edges.” Edge detection is difficult in noisy images, since both the noise and the edges contain high frequency content.

“In addition, SHIATS-Allahabad, U. P. (2013), introduces that edge detection is a well-developed field on its own within image processing. Edge detection is basically image segmentation technique, divides spatial domain, on which the image is defined, into meaningful parts or regions. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges typically occur on the boundary between two different regions in an image.” Sobel operator is a discrete differentiation operator used to compute an approximation of the gradient of image intensity function for edge detection. At each pixel of an image, Sobel operator gives either the corresponding gradient vector or normal to the vector. It convolves the input image with kernel and computes the gradient magnitude and direction.

According to Senthilkumaran, N., & Rajesh, R. (2009), edge detection is one of the most frequent used techniques in digital image processing. The boundaries of object in a scene often lead to oriented localized changes in intensity of an image, called edges. “This observation combined with a commonly held belief that edge detection is the first step in image segmentation, has fuelled a long search for a good edge detection algorithm to use in image processing.” “Edge detection techniques transform images to edge images benefiting from the changes of grey tones in the images.”

“Another source, Juneja, M, & Sandhu, P. S. (2009), showed the method of locating an edge as a characteristic of the “gradient filter” family of edge detection filters. The pattern recognition method finds edges using the approximation to the derivative. It returns edges at those points where the gradient of the image is maximum.”

Image Segmentation

“Based on the study of Kumar, S. and Prabat, P. (2013), “In digital image processing, image segmentation is essential step for image analysis.” “The image segmentation separates an image into its component parts and its objects. Segmentation algorithms for the discontinuity and similarity image intensity values. Discontinuity which is based on the abrupt changes in intensity and similarity is based on the partitioning of an image into regions. Edge detection is a part of the image segmentation. The effectiveness of many image processing depends upon the perfection of detecting meaning, full edges. It is one of the techniques for detecting intensity discontinuity in digital image.”

“According to Luccheseys, L. (2001), segmentation is the process of partitioning an image into disjoint and homogeneous regions. This task can be equivalently achieved by finding the boundaries between regions; these two strategies have been proven to be equivalent indeed. The desirable characteristics that a good image segmentation should exhibit have been clearly stated by Haralick and Shapiro (2013) with the reference to gray-level images. Regions of an image segmentation should be uniform and homogeneous with respect to some characteristics such as gray tone or texture. Segmentation is an extremely important operation in several applications of image processing and computer vision, since it represents the very first step of low-level processing of imagery.”

“From the article of Image and Vision Computing (2006), image segmentation is an important early vision task where pixels with similar features are grouped into homogeneous regions. A broadly used class of models is the so-called cartoon model, which has been extensively studied from both probabilistic and variational viewpoints. The model assumes that the real world scene consist of a set of regions whose observed low-level feature changes slowly, but across the boundary between them, these feature changes abruptly.”

Pattern Recognition

Detecting the presence of a specified pattern in an image requires matching the image with a “template”, or a standardized version of the pattern. Need for efficient archiving and retrieval of this data has fostered the development of pattern recognition algorithms in new application domains. The best pattern recognizers in most instances are humans, yet we do not understand how humans recognize patterns. The more relevant patterns at your disposal, the better your decisions will be. This is hopeful news to proponents of artificial intelligence, since computers can surely be taught to recognize patterns. Indeed, successful computer programs can help doctors diagnose disease.

“Srinivasan, et al, 2010, defined pattern recognition as “the act of taking in raw data and taking an action based on the category of the pattern”. Most research in pattern recognition is about methods for supervised learning and unsupervised learning. Pattern recognition aims to classify data (patterns) based either on a priori knowledge or on statistical information extracted from the patterns. The patterns to be classified are usually groups of measurements or observations, defining points in an appropriate multidimensional space. This is in contrast to pattern matching, where the pattern is rigidly specified. A complete pattern recognition system consists of a sensor that gathers the observations to be classified or described, a feature extraction mechanism that computes numeric or symbolic information from the observations, and a classification or description scheme that does the actual job of classifying or describing observations, relying on the extracted features.”

“Duda and Hart (1973) defined the pattern recognition is a field concerned with machine recognition of meaning regularities in noisy of complex environment.”

“Pavlidis (1977) defined pattern recognition in his book: the word pattern recognition is derived from the same root as the word patron and, in his original use, means something which is set up as a perfect example to be imitated. Thus pattern recognition means the identification of the ideal which a given object was made after.”

“Gonzales and Thomas (1978) defined pattern recognition as a classification of input data via extraction important features from a lot of noisy data.”

“Watanabe (1985) said that pattern recognition can be looked as categorization problem, as inductive process, as structure analysis, as discrimination method and so on.”

“Fukunaga (1990) defined pattern recognition as A problem of estimating density functions in a high-dimensional space and dividing the space into the region of categories of classes.”

“Schalkoff (1992) defined PR as The science that concerns the description or classification (recognition) of measurements.”

“Srihari and Govindaraju (1993) defined pattern recognition as a discipline which learn some theories and methods to design machines that can recognize patterns in noisy data or complex environment.”

“Ripley (1996) defined pattern recognition in his book: Given some examples of complex signals and the correct decisions for them, make decisions automatically for a stream of future examples.”

“Robert P.W. Duin (2002) described the nature of pattern recognition is engineering; the final aim of pattern recognition is to design machines to solve the gap between application and theory.”

“Sergios Theodoridis (2003) Pattern recognition is a scientific discipline whose aim is the classification of the objects into a lot of categories or classes. Pattern recognition is also an integral part in most machine intelligence system built for decision making.”

It is true that application was one of the most important elements for PR theory. Pattern Recognition has been developed for many years, and the technology of PR has been applied in many fields such as artificial intelligence , computer engineering , nerve biology, medicine image analysisarchaeology, geologic reconnoitring, space navigation, armament technology and so on.”

“J. Liu, et al (June 2006) PR is a subject researching object description and classification method, it is also a collection of mathematical, statistical, heuristic and inductive techniques of fundamental role in executing the tasks like human being on computers. In a sense, PR is figuring out actual problems via mathematical methods.”

With this in mind, we proposed pattern recognition as a simple, direct, and speedy alternative to detailed x-ray analysis.

It is said that pattern recognition technique applied to the raw x-ray photograph can provide the same description among samples as knowledge of their actual diagnosis.

To end this, we suggest the use of pattern recognition as a viable alternative to quantitative or semi quantitative analysis of x-ray data. This will show that pattern recognition can be readily applied.

2.3 METHODS

“Mobile apps are designed with consideration for the demands and constraints of the devices and also to take advantage of any specialized capabilities they have. This program runs on a handheld device, has a “smart” operating system, supports standalone software and can connect to the internet via Wi-Fi or a wireless carrier network.”

The method used in x-ray was image segmentation using Pattern Recognition Algorithm. It is one of the most popular algorithms used in image processing to represent a computer aided diagnosis such as medical imaging which is designed to assist physicians in x-ray analysis. It converted the image to grayscale and detected two kinds of edges in an image:

Vertical direction edges and Horizontal direction edges. This mobile application is available for android operating system only. The programming language that the researchers used is Java.

As the main objective of this paper is to capture x-ray film and convert to digital form, the application was built in Eclipse where Pattern Recognition Algorithm will help to compare the xrays through image segmentation. This algorithm helps the user to classify the structural description of the image through image classification which involves feature detection of property measurement and image description.

In this case, the role was played by the camera phone which captures the xray film at once. With the aid of a high definition camera, the application will implement Pattern Recognition on the image, and count the white pixels. This application has the ability to determine if there is an abnormalities in your bone. Though there are different smart machines that are available to detect the abnormalities, this mobile application is more portable and accessible to use.

Flowchart

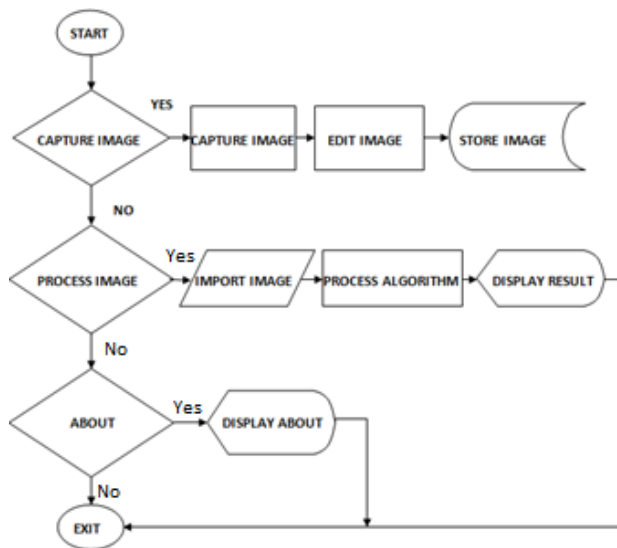


Figure 2
Flowchart

2.4 Results and Findings

eX-ray is a mobile application that helped determine if x-ray is normal or not. It used the device's camera and memory to perform its action by implementing the Pattern Recognition Algorithm on the image, and count the white pixels of the x-ray to determine whether it

is normal or not.



Figure 2.4.1

Home/Menu Screen



Figure 2.4.2

Office Lens Camera



Figure 2.4.3
Office Lens



Figure 2.4.4
Image of the X-ray

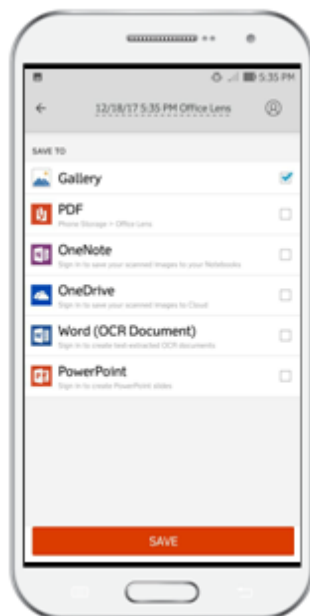


Figure 2.4.5

Saving of an Image



Figure 2.4.6
Importing Process

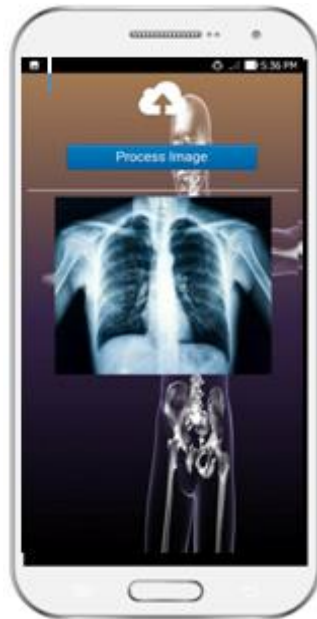


Figure 2.4.7
Image from the Gallery

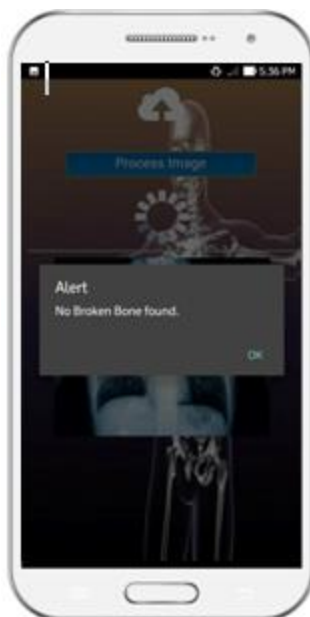


Figure 2.4.8

Message Detection Screen (Normal)

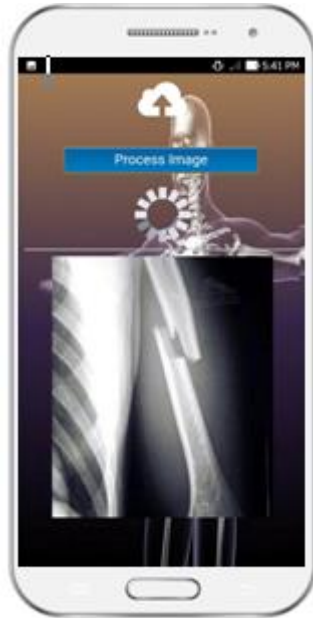


Figure 2.4.9

Another image selection



Figure 2.4.10

Message Detection Screen

(Abnormal)



Figure 2.4.11

About

The users can detect broken bones with the use of camera of their mobile phones, android as their Operating System (Kitkat version and above), also through the use of Pattern Recognition in image segmentation. This mobile application has 70% - 80% accuracy in detecting abnormalities in bone. The definite use of Pattern Recognition Algorithm is converting the captured image of the x-ray into a binary image consisting of black and white pixels showing that white pixels represent the edges of the image and the elements of the image. In this manner, the converted image through the use of pattern recognition might be processed to count the number of white pixels of the image which will be the basis of determining if the x-ray is broken or not.

Based on the test conducted, the researchers found out that each normal x-rays has greater white pixels than the broken ones. Through the help of another application, they implemented the use of Pattern recognition Algorithm and count the white pixels.

However, this applications has limitations. Darker x-rays and colored pictures are not advisable for the app. You should not take pictures on dark areas, proper lighting is required. The device's camera must be 8 megapixels and above, and has auto-focus. Also, never use a blurred image in detecting. The intended users of this application are those android users who have android operating system, Kitkat version and above.

2.5 Conclusion

This mobile application was created to provide patients an easy way to determine if their xrays are normal or not with the use of their android phones. This study differs from other xray detectors in which they used light walls to determine if there are fractures and abnormalities. Compared to our research which we used Pattern Recognition Algorithm in image segmentation to determine xray results. Users simply have to capture an image of an xray, and the application will automatically determine whether the xray is normal or not.

2.6 Recommendations

This study can be a reference to researchers who are into developing mobile application using eclipse as their IDE. Furthermore, it is recommended that the design be enhanced by adding more functionalities such as sending a message to a radiologist if the xray was detected with abnormalities. It is also recommended to add some features such as detecting the cause of the health problem.

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