A Hybrid Approach using ANN and ACO for Prostate Boundary detection from Ultrasound Images

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***Abstract*-Prostate cancer is a form of cancer that develops in the prostate, a gland in the male reproductive system. Most prostate cancers are slow growing. However, there are cases of aggressive prostate cancers. The cancer cells may metastasize (spread) from the prostate to other parts of the body, particularly the bones and lymph nodes. Prostate cancer may cause pain, difficulty in urinating, problems during sexual intercourse, or-erectile dysfunction [4]. Other symptoms can potentially develop during later stages of the disease. Rates of detection of prostate cancers vary widely across the world, with South and East Asia detecting less frequently than in Europe, and especially the United States. Prostate cancer tends to develop in men over the age of fifty [10]. Globally it is the sixth leading cause of cancer-related death in men (in the United States it is the second) [11]. The main barriers in the detection process of prostate Cancer are the judgment about the boundary or the prostate. As a misinterpretation in this case may cause bigger problems. Number of researchers are working on this field of detection of prostate boundary and proposes many new ideas [7]. The main reason of misinterpretations may be considered as individual human bias, the visibility of the ultrasound images in the presence of some kind of noise etc. In this paper we proposes a hybrid approach in combination of Artificial Neural Network and optimization technique Ant Colony Optimization (ACO) for the detection of boundary of prostate which will help us in the treatment process. Here Neural Network helps us in prediction or selection of pixels under consideration and ACO provides us the way to move throughout the Ultrasound image for the detection of Prostate boundary on the basis of certain assumptions or the requirements of prostate boundary.**

***Keywords:* Prostate Cancer, Artificial Neural Network, Ant Colony Optimization, Or-erectile Dysfunction.**

I. INTRODUCTION

Early prostate cancer usually causes no symptoms. Sometimes, however, prostate cancer does cause symptoms, often similar to those of diseases such as benign prostatic hyperplasia [6]. These include frequent urination, nocturia (increased urination at night), difficulty starting and maintaining a steady stream of urine, hematuria (blood in the urine), and dysuria (painful urination) [9]. About a third of patients diagnosed with prostate cancer have one or more such symptoms, while two thirds have no symptoms. Prostate cancer is associated with urinary dysfunction as the prostate gland surrounds the prostatic urethra. Changes within the gland, therefore, directly affect urinary function [7]. Because the *vas deferens* deposits seminal fluid into the prostatic urethra, and secretions from the prostate gland itself are included in semen content, prostate cancer may also cause problems with sexual function and performance, such as difficulty achieving erection or painful ejaculation. Advanced prostate cancer can spread to other parts of the body, possibly causing additional symptoms. The most common symptom is bone pain, often in the vertebrae (bones of the spine),pelvis, or ribs [20]. Spread of cancer into other bones such as the femur is usually to the proximal part of the bone. Prostate cancer in the spine can also compress the spinal cord, causing leg weakness and urinary and fecal incontinence. Ultrasound imaging is the most common imaging technology used in most urologic clinics because it is a fast, portable & cost-effective medical imaging technology offering interactive visualization of the underlying anatomic structure in real time & has the ability to show dynamic structure within the body [17]. For this reason, TRUS is commonly used for diagnosis of prostates, detection & staging of prostate cancer, and real time image guidance of therapeutic procedures. Achieving an accurate, robust & fast performance in automatic boundary identification still is a challenging task as the presence of noise and shadowing are the barriers in ultrasound images. Manual contouring is the only robust, reliable segmentation procedure available for the TRUS of the prostate.

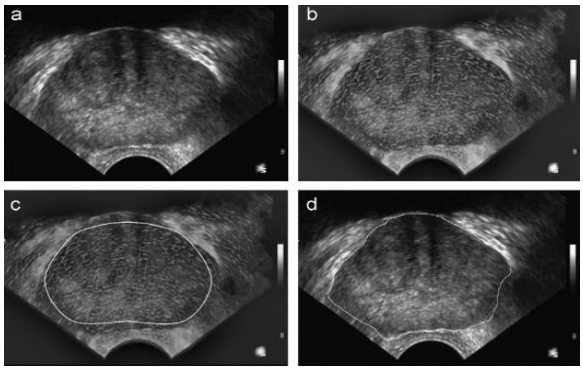

Fig1: Ultrasound Images with Prostate Boundary

But this process is too time-consuming & arduous because the results are very much dependent on the observer's experience

& vary between several observers. As a human result also may vary for the cases when the same observer is performing the same job at different times. To improve the efficiency, a possible solution is to automate the boundary detection process with minimal manual involvement especially for computer-assisted surgery. In this paper we propose a new method of making the prostate boundary detection process automatic. We proposed a hybrid technique, in which we combine the features of Artificial Neural Network as a searching and decision making technique and Ant colony optimization technique is used to detect prostate boundary from ultrasound images. For the verification of results we can compare this proposed system with the performance given by the use of Genetic Algorithm's (GA) operator. and results can be compared on the basis of parameters such as Mean Distance (MD), Mean Absolute Distance (MAD), pixels under consideration etc. Fig1 represents an example of Ultrasound image and the detected prostate boundary form the image.

II. ANT COLONY OPTIMIZATION

Ant colony optimization (ACO) is a heuristic method that imitates the behavior of real ants to solve discrete optimization problems. The created artificial ants behave like intelligent agents with memory and ability to see. These ants share their experiences in order to search optimal paths iteration by iteration. Ant colony optimization (ACO) is a multi-agent system that iteratively searches for optimal solutions. Elements of optimal solutions are extracted according to the shortest path of ant tours [18]. Ants deposit their searching reward, pheromone, on their passed paths. These feedbacks may attract other ants to follow partially with a probability called state transition rules. State transition rules imply that shorter and more ant-experienced paths attract more ants to pass through [5]. As with real ants, not all ants follow the most attractive paths, instead a few ants try to explore new paths. The process of taking the maximal probability path is called exploitation, and the process of selecting the next path by probability is called exploration. The characteristics of ACO algorithms are their explicit use of elements of previous solutions. The main underlying idea, loosely inspired by the behavior of real ants, is that of a parallel search over several constructive computational threads based on local problem data & on a dynamic memory structure containing information on the quality of previously obtained result. This collective behavior, emerging from the interaction of the different search threads has proved effective in solving combinatorial optimization (CO) problems [2].

Basic Algorithm of Ant Colony Optimization

1. **Initialization**
   Initialize T_{iu} (Trail Level), N_{iu} (Attractiveness) & other parameters of ACO
2. **Construction**
   For each ant K (currently in state i) do
   Repeat
   Choose in probability the state to move into
   Append the chosen move to the K^{th} Ant's Set $Tabu_k$
   Until ant k has completed its solution
   End For
3. **Trail Update**
   For each ant move (i-u) do
   Compute sum (T_{iu})
   Update the Trail Matrix
   End For
2. **Terminating Condition**
   If not (end test) go to step2

A set of computational concurrent asynchronous ants (a colony of agents) moves through states of the problem corresponding to partial solutions of the problem to solve. By moving, each ant incrementally constructs a solution to the problem. When an ant completes a solution or during the construction phases the ant evaluates the solution & modifies the trail value on the components used in its solution. This Pheromone information will direct the search of the future ants. Two underlying mechanisms play an important role in the performance of Ant Colony Optimization: *Trail Evaporation* which in order to avoid unlimited accumulation of trails over same component decreases all trail values over time and *Daemon Actions* which can be used to implement centralized actions which cannot be performed by single ants, such as the invocation of a local optimization procedure, or the update of global information to be used to decide whether to bias the search process from a non-local perspective [14].
Ants deposit a certain amount of pheromone while walking, & each ant probabilistically prefers to follow a direction rich in pheromone rather than a poorer one. Ants choosing the shorter path will more rapidly reconstitute the interrupted pheromone trail compared with those choosing the longer paths. Thus, the shorter path will receive a greater amount of pheromone per unit time, and in turn, a larger number of ants will choose the shorter path. Due to this positive feedback, all the ants will rapidly choose the shorter path. Ants prefer higher pheromone trail levels causing this accumulation to build up still faster on the shorter path [8].

III. ARTIFICIAL NEURAL NETWORK

An Artificial Neural Network (ANN) is an information-processing paradigm that is inspired by the way a biological nervous system in human brain works. Large number of neurons present in the human brain forms the key element of the neural network paradigm and act as elementary processing elements. These neurons are highly interconnected and work in unison to solve complex problems. Likewise, an Artificial Neural Network can be configured to solve a number of difficult and complex problems. ANNs find a wide variety of applications in diverse areas including functional approximation, nonlinear system identification and control, pattern recognition and pattern classification , optimization ,

English text pronunciation, protein secondary structure prediction and speech recognition [16]. Fundamentals of ANNs and its salient features are discussed in the following sections.

Salient Features of Artificial Neural Networks

The biological neurons have many useful and significant characteristics and properties. These are also emulated by neurons in artificial neural networks. Some of these features of artificial neural networks are outlined as under:

- Input-output Mapping
- Learning With Experience
- Nonlinearity
- Model Free Environment
- Hardware Implementation
- Parallel Distributed Processing
- Multivariable Systems
- Fault Tolerance
- Data Fusion

IV. PROPOSED METHODOLOGY

We proposed here a method to detect the prostate boundary form Ultrasound images. This detection process requires ultrasound images as input image to the system after that to deal with the issue of speckle noise in case of US images we have proposed Snakes filter. After the removal of speckle noise, the next step is to take the expert observations. We decided to take the observations of 4 different experts which who will tell us about the idea of 12 different points, which according to then will help to draw the boundary of prostate. So the basic idea is to get the initial estimate for the system to get the X and Y coordinates of points mentioned by the experts.

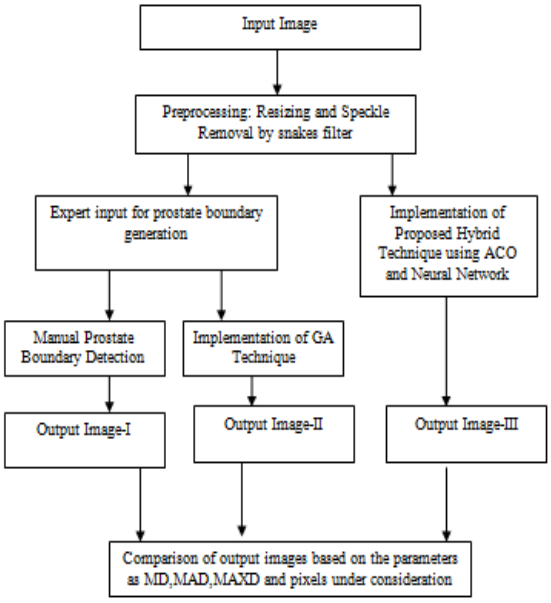

Fig: Proposed Methodology

After getting this coordinates input then we apply the concept of Genetic Algorithms to find the prostate boundary. This algorithm firstly tries to reach to the center of prostate then with the reference of the centre draw the boundary of the prostate and get an output image. Then on the same image which earlier was the output of preprocessing step we apply the concept of Ant Colony Optimization and Artificial Neural Network. With the concepts of Ants, we consider Ants as those pixels which are the part of prostate boundary. And the different trail values of different pixels serve as the weights of Neural Network, which will helps to make the selection decision about the prostate boundary pixel. At the end the prostate boundary detected from GA and ACO can be compared against the parameters as MD, MAD, MAXD and number of pixels under consideration.

V. CONCLUSIONS & FUTURE WORK

Prostate Cancer has a considerable impact on the quality of life of adult men and it is difficult to detect the Prostate Cancer at early stages [7]. Also the Poor image quality of ultrasound images causes difficulty in disease diagnosis. Further Manual Contouring is time-consuming & subject to inter-and intra-observer bias. The Inefficiency of Traditional Edge Detectors in Prostate Boundary detection so there is a need to automate boundary detection process to decrease clinician's workload & reduce segmentation time [9]. So to deal with all these issues we proposed a hybrid approach in this field. This contains Artificial Neural Network and Ant Colony Optimization. The ability of ACO to work with large solution domain and the ability of ANN to make decisions on the basis of weights assigned to different nodes will help to work good under this problem area where we have to perform under the large number

of pixels contained by the ultrasound image. Also preprocessing step improves the detection process by improving the visibility of the input image.

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