Lung Cancer Detection by Image Segmentation using MATLAB

A PROJECT REPORT

Submitted by

PRIYANSH JAIN (14BCE0087)

in partial fulfilment for the award of the degree of

B. Tech

in

Computer Science and Engineering

VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

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School of Computer Science and Engineering
APRIL, 2018

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School of Computer Science and Engineering

DECLARATION

I hereby declare that the project entitled **"Lung Cancer Detection by Image Segmentation using MATLAB"** submitted by me to the School of Computer Science and Engineering, Vellore Institute of Technology, Vellore-14 towards the partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** is a record of bonafide work carried out by me under the supervision of **Akila Victor, Sr. Assistant Professor.** I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma of this institute or of any other institute or university.

Signature

Name : Priyansh Jain

Reg.No:14BCE0087

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School of Computer Science and Engineering

CERTIFICATE

The project report entitled "**Lung Cancer Detection by Image Segmentation using MATLAB**" is prepared and submitted by **Priyansh Jain (Register No: 14BCE0087), has** been found satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** in Vellore Institute of Technology, Vellore-14, India.

Guide
(Name & Signature)

Internal Examiner
(Name & Signature)

External Examiner
(Name & Signature)

ACKNOWLEDGEMENT

We take this opportunity to express our heartfelt gratitude to our guide Akila Victor, Sr. Assistant Professor, School of Computer Science and Engineering (SCOPE), whose able guidance helped us in the development of the proposed system for our problem statement. We shall ever remain indebted for her meticulous guidance, constructive criticism, clear thinking, keen interest, constant encouragement and forbearance right from the beginning of this research to its completion. We are also very thankful to our Head of the Department Prof. Santhi, whose constant support enabled us to pursue this project without any difficulties. We are extremely grateful to Dr. Saravanan R., the Dean, SCOPE for the various resources provided to us for making our final year project work easier and for lending the infrastructure we needed for the project and making sure that the quality of the project was not compromised. Last but not the least; we would like to extend our sincere gratitude towards Vellore Institute of Technology for incorporating Major project as a part of the curriculum.

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ABSTRACT

Lung Cancer is a sort of malignancy when cells of lung tissues develop wildly and shape tumours. Lung Cancer was first found in the eighteenth century by a British man named Dr. Thomas Bayes. He had a patient who said that he experienced difficulty breathing and he felt that his lungs were going to detonate.

Presently, in 2007 there are as of now 213,380 new cases and 160,390 passing. The fortunate thing about having lung disease today is that researchers have developed various systems to enable individuals to discover that they have lung malignancy at beginning periods, when they are determined to have lung growth, there are a wide range of alternatives accessible for disposing of the tumour. A standout amongst the frequently utilized technique is the Crystal Ball. The gem ball is a technique that shows on the off chance that somebody has lung malignancy by basically breathing on this machine which studies someone's DNA. On the off chance that it turns out constructive, that individual has lung growth, yet in the event that it doesn't, they don't.

The main source of lung malignancy is smoking. 90% of all lung growth passing are caused by smoking. Smoking causes lung malignancy in light of the fact that there is a disease causing substance in cigarettes called cancer-causing agents. Additionally, in light of the fact that cigarettes have nicotine, it is hard to quit smoking, so there is a higher possibility of getting lung tumour. Another way somebody can get lung disease is breathing in chemicals, gases, and strands, for example, radon gas, Asbestos filaments, and Silicate filaments. Second Hand smoking can likewise cause lung Cancer in light of the fact that the tobacco smoke is being breathed in. One of the last reasons that somebody can get lung tumour is smoking or biting tobacco. Tobacco additionally has a malignancy causing substance simply like cigarettes does.

1. Introduction

1.1. Theoretical Background

"Lung Cancer is a type of cancer when cells of lung tissues grow uncontrollably and form tumors. Lung Cancer was first found in the 18th century by a British man named Dr. Thomas Bayes. He had a patient who said that he had trouble breathing and he felt that his lungs were about to explode". Bayes thought that he should surgically open the man's chest area. When he did, he saw that the man's lungs were black. After that first case, Bayes thought that it was a type of cancer so he called it Lung Cancer.

In the 18th century lung cancer was very rare. Only five-tenths percent of people got the disease. By the 19th century, Lung Cancer became a lot more common because the cigarette was invented. Now instead of five-tenths percent of people having Lung Cancer, about ten percent had it! The worse part about having lung cancer in the 19th century is that they didn't have medicine. The only thing that could make them better was to have surgery.

1.2. Motivation

Now, in 2007 there are already 213,380 new cases and 160,390 deaths. The good thing about having lung cancer today is that scientists have invented many different procedures to help people find out that they have lung cancer at very early stages, when they are diagnosed with lung cancer, there are many different options available for getting rid of the cancer. One of the most often used procedure is the Crystal Ball. The crystal ball is a method that shows if someone has lung cancer by simply breathing on this machine which studys someones DNA. If it comes out positive, that person has lung cancer, but if it doesn't, they don't.

1.3. Aim of the proposed Work

Determine the lung cancer through MATLAB Analysis

1.4. Objective(s) of the proposed work

The number one cause of lung cancer is smoking. Ninety percent of all lung cancer deaths are caused by smoking. Smoking causes lung cancer because there is a cancer-causing substance in cigarettes called carcinogens. Also, because cigarettes have nicotine, it is difficult to stop smoking, so there is a higher chance of getting lung cancer. Another way someone can get lung cancer is inhaling chemicals, gases, and fibers such as radon gas, Asbestos fibers, and Silicate fibers. Second Hand smoking can also cause lung Cancer because the cigarette smoke is being inhaled. One of the last reasons that someone can get lung cancer is smoking or chewing tobacco. Tobacco also has a cancer-causing substance just like cigarettes does.

2. Literature Survey

2.1. Survey of the Existing Models/Work

Cryosurgery appeared in 1961 for the first time is characterized by the use of freeze / thaw cycles and had for the purpose of destroys the tissue. The procedure of cryosurgery found several areas Application related to treatment of the growth of cancerous tumors: the liver cancer, breast cancer, skin cancer, Parkinson's disease, kidney cancer, abnormal brain, and cervical growth and cancer lung. Cryosurgery is desirable because of its health benefits including economic and down bleeding, good cosmetic results, minimal use of anesthetics, the short period of recovery, and low procedural costs. Cryosurgery is based on the use of cryo-surgical probes inserted into the patient's body at selected points where the location tumor. The cryo-probes are small hollow cylindrical devices (2-10 mm diameter) where a cryogenic fluid (liquid nitrogen) flows with a controlled rate. The objective of cryosurgery to freeze and is completely destroyed tumor tissue with minimal destruction of healthy tissue area. [17] The degree of success of a cryo-surgical process depends on a number of factors such as the lowest achieved temperature, the cooling rate during freezing, thawing rate after the freezing process, the placement of the probe, the number of repeated cycles of freeze / thaw, and cooling rate in the freezing front. As such, it is observed that the

shape and size of the frozen balls is significantly affected by the placement of the cryo-probe [15]. An analytical study and Digital cryosurgery applied to lung cancer was made by Bischof, Bastacky and Rubinsky in 1992. They said the front freezing accelerates it from between the tumor and in healthy tissue surrounding low density. Therefore, monitoring, control and linearization parameters involved are essential. In this situation, the numerical simulation of freeze / thaw cycles may play a role important.

2.2. Summary/Gaps identified in the Survey

The objective of this paper is to develop a finite element model based the enthalpy model and using Nedjar algorithm [14]. The model enthalpy proved relevant to study the case of phase change (Isothermal and non-isothermal). The programming is done in a MATLAB environment. This work has allowed us to study the solidification in the cases, linear and nonlinear, stationary convection-diffusion and conduction unsteady, in 2D and ax symmetric. This work was a set of test cases.

3. Overview of the Proposed System

3.1. Introduction and Related Concepts

Both solid and liquid phases are characterized by the presence of forces cohesion which holds the atoms in close proximity. In a solid, molecules vibrate around the fixed positions of equilibrium, whereas in a liquid, the molecules are free and can move between these positions. The macroscopic manifestation of this vibration energy is called “thermal energy ". The atoms in the liquid phase are more energy in the solid phase. The solid fusion phenomenon requires certain amount of energy to overcome the cohesive forces maintain the solid structure. This energy is known as the "latent heat of fusion "Of the material and which represents the difference in the levels of enthalpy between the solid and liquid state. The solidification of a liquid requires the removal of the latent heat and the structure of atoms in the more stable networks [12].

3.2. Framework, Architecture or Module for the Proposed System

The phase transition region where both solid and liquid phases coexist is called the interface. The thickness of this region may vary from few angstroms to a few centimeters and its microstructure is very complex. For most pure materials, with ordinary conditions solidification at a fixed temperature, the interface appears locally as a planar shape with a negligible thickness and can be considered like a sharp interface (surface area) separating the solid phase of the phase liquid at a temperature. In other cases, the transition region phase may have an apparent thickness known as " the narrow area "; This region typically results from a super cooling of the presence multiple components (alloys), and its microstructure can appear as being dendrites' (see Figure 2). Several mechanisms exist in phase change liquid / solid. This type of phase change involves the mass transfer and heat, super-cooling, absorption or release of latent heat, the change in physical properties and surface effects, etc. [12].

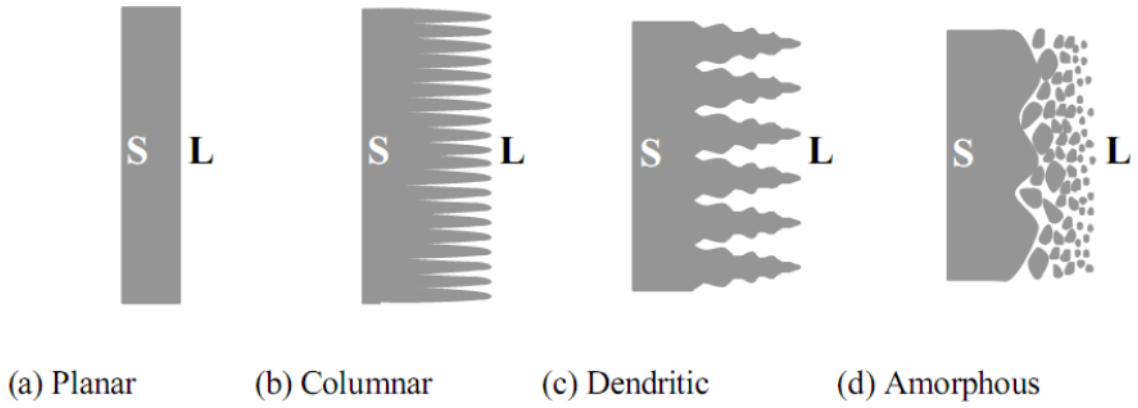


Fig 1. Different Microstructures of Liquid and Solid Interface

4. Proposed System Analysis and Design

4.1. Introduction

The tissue damage mechanism during cryosurgery must be included to connect the freezing process to the degree of destruction of cells in the tumor. The destructive effects of tissue freezing can be classified in two important mechanisms: immediate and delayed. The causes immediate cell destruction due to direct damage cells of the effect of temperature, cooling and methods of freezing, while the cause of delaying damage freezing, which can last for several

hours during the fulfillment of cryosurgery with the most dominant form of cell destruction, is vascular stasis. There are several distinct mechanisms where freezing can cause cell surgery within ice balls caused by the application cryo-probes. The fundamental change during freezing is the conversion to a fluid ice inside the cells and its space intercellular [13]. Some of the changes that occur in a cell subjected to freezing are: (1) the development of ice formation extracellular; (2) the development of intracellular ice formation; (3) optionally crystallization of the electrolyte; (4) dehydration cells; (5) heat shock; and (6) the denaturation of complexes lipoprotein. The tissue response varies with the intensity of the cryogenic surgery. Gage Baust [16] presented a review that discussed the mechanisms that lead to destruction of cells in tissues. The lowest temperature causing the death. This value has been recommended as a Reference to the cell death. For a clearer description of destruction tissue cells by intracellular and extracellular crystallization, Figure 2.1 shows the curve of the characteristic shape of the signing of survival cells undergoing freezing and indicates two areas of surgery associated with slow and rapid cooling, which are combined to ensure an intermediate range of the cooling rate wherein the survival of cells is optimal.

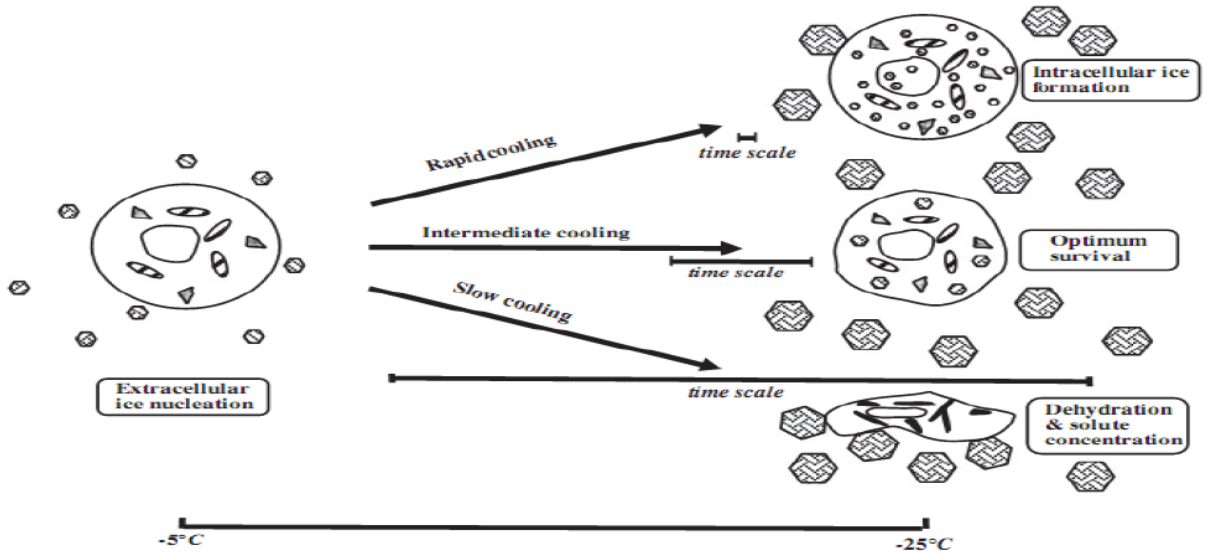


Fig 2. Shows the curve of the characteristic shape of the signing of survival cells undergoing freezing

4.2. Requirement Analysis

Generally, there are several assumptions considered to simulate phase change during cryosurgery:

1. The latent heat is constant.
2. The thermal properties vary in the points that are completely the frozen solid to liquid.
3. At the interface, heat conduction is involved only in the Thermal transfer.

The blood flow rate is constant when the temperature is close to the lower limit temperature of phase change. Metabolism is zero during freezing. The liquid fraction varies only as a function of temperature. Mathematical formulation by the enthalpy method. The blood flow rate is constant

4.2.1. Functional Requirements

4.2.1.1. Product Perspective

Consider a domain divided into three parts, the liquid portion, the part solid , and the paste portion of phase change (See Figure 3).

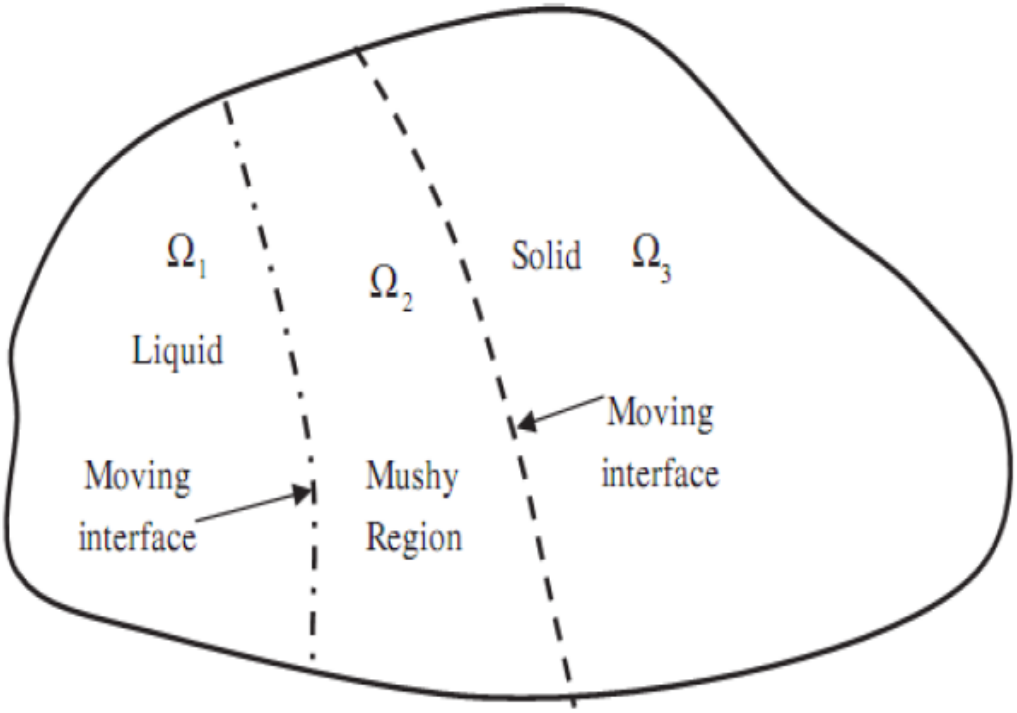


Fig 3. Phase Change Domain

To deduce the enthalpy model of bio-thermal multi-domain model phase change standard, the effect of the latent heat is incorporated with the capacity depending on the temperature. So, a new setting introduced. In the case of biological tissue, freezing is carried out in a manner non-isothermal where there is an existing mushy zone between the two phases. The form enthalpy is defined by Bischof [11] in the case of biological tissue as following:

$$H(T) = \int_{T_{ml}}^{T} c_s dT$$

$$T \leq T_{ms}) :$$

$$H(T) = \frac{T - T_{ml}}{T_{ms} - T_{ml}} Q$$

$$H(T) = Q + \int_{T_{ms}}^{T} c_l dT$$

$$Q = L + \int_{T_{ml}}^{T_{ms}} \left[c_s - \left(\frac{T - T_{ml}}{T_{ms} - T_{ml}} \right) (c_s - c_l) \right] dT$$

The phase change problem formulation in a biological tissue by the enthalpy method was made for use in simulation Cryogenic freezing problem of lung cancer

4.2.1.2. Product features

In this section, we give the discrete form of the model mathematically described. This discretization has been established in the case2D Cartesian and axially symmetrical, and in the case of convection-diffusion stationary and non-stationary conduction. Consider the field the four borders, and who

Where are complementary: the domain is considered two-dimensional and can be Cartesian or ax symmetric (Figure 4).

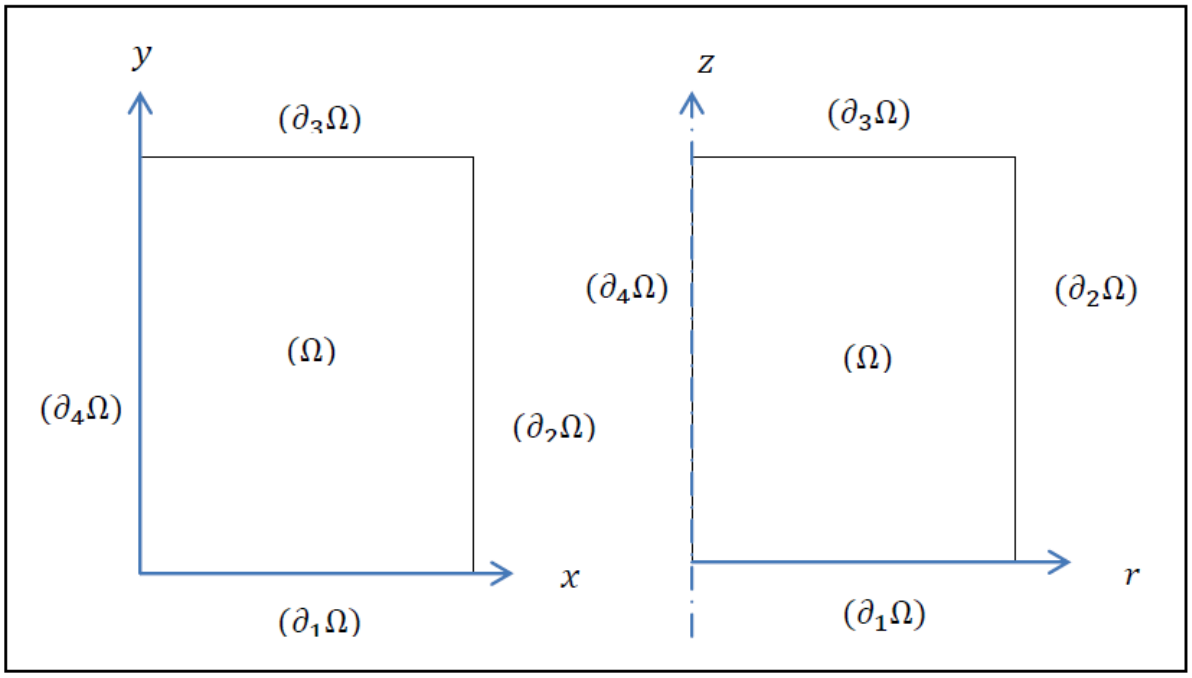


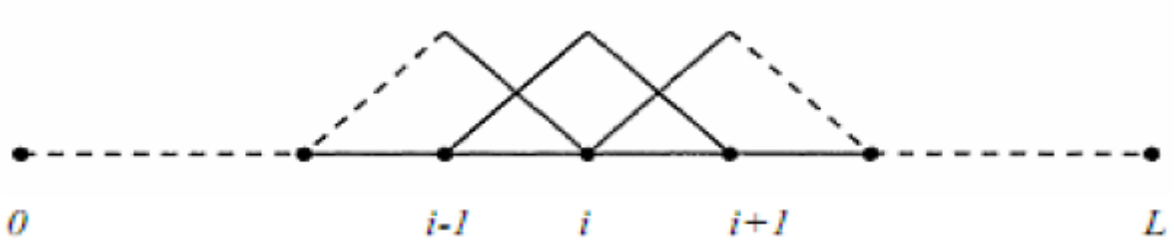
Figure 4: mapping of the two-coordinate reference: Cartesian ax symmetric to the field

4.2.1.3. User characteristics

To show the numerical oscillations obtained by the Galerkin method standard, we chose a case of stationary convection-diffusion dimensional described by the equation:

$$a\frac{du}{dx} - k\frac{d^2u}{dx^2} = 0 \quad dans \ \ \Omega$$

The domain is considered between [ ] and is discredited with a mesh with uniform length elements. The shape functions shown in Figure 1:



4.2.1.4. Assumption & Dependencies

Assumption:

Following are the assumptions in the project:

1. The image files must be clear and in the required "TIFF" format
2. The project must be installed clearly so that the installation will automatically set up everything
3. The ideal set-up for this system is Windows but the system can work on Mac and Linux as well provided that the required latest OS updates are installed.
4. MATLAB installation must be correct and tested and it is pre-requisite of correct functioning of the project

4.2.1.5. Domain Requirements

Following are the domain requirements for this project:

1. The knowledge of cancer and the lung functioning is must
2. The specialist must be able to clearly verify that the cancer has been correctly detected by the system or not
3. The working knowledge of computers and system is necessary so that the specialist can correctly run the system
4. The specialist must have clear understanding about the imagery so that he can inform as to what level of cancer the patient is by clearly evaluating the images.

4.2.1.6. User Requirements

Following are the user requirements of the project:

1. The software must be user friendly
2. The project must be installable with one click so that there are no hassles
3. It is assumed that the users are not computer specialists and the installation must be user-friendly so that no intervention is required
4. The project must be user friendly so that the project can automatically load the TIFF images without the intervention of the user
5. The project must provide the output in a simple manner and the operations must be simple and to the point
6. The object of the system is to detect the lung cancer and the user must be able to easily verify after running the system

4.2.2. Non-Functional Requirements

4.2.2.1. Product Requirements

4.2.2.1.1. Efficiency (in terms of Time and Space)

The Project is created so that it can run efficiently and with acceptable turnaround time. Usually the project should take less than 10 minutes to produce the output of all other things are correctly provided. If there are any errors from the input images, the software should be able to identify efficiency rather than running ideally.

4.2.2.1.2. Reliability

The project provides reliable results. Although the final says as to whether the cancer is present or not depends on the specialist, but it is expected that the project will provided sufficiently reliable results. It is assumed that the specialist will be having good domain knowledge about the cancer detection imagery so that he is able to verify that the system has provided the reliable results. In some cases, the project may not provide the correct results, if there is no sufficient clarity in the images

4.2.2.1.3. Portability

It is expected that the system will run on the major OS like Windows, Linux and Mac. If for example the correct updates or versions of OS are not used, like obsolete versions are being used then it is possible that the project may not run properly. Also, the MATLAB must be installed correctly and without errors.

4.2.2.1.4. Usability

The project is intended for the usage at the advanced medical centers and it is for the consultation purposes only. Though the specialist with no prior computer knowledge, can run this system, but the medical expertise is required to cross-check the results and this project is not intended to be used by non-medical personnel. The software can be used as tool in the diagnostics.

4.2.2.2. Organizational Requirements

4.2.2.2.1. Implementation Requirements

Following is the implementation requirements:

a. It is expected that the latest workstations or servers are available.
b. This system can be installed over the Windows/Linux/Mac based servers
c. The implementation as of now is the single user mode.
d. Usage in network can be done but in the single user mode only
e. If another specialist wants to use this system then another copy of the system can be installed and used as there is no restrictions
f. It is assumed that the printer and scanners are connected with the system.
g. Currently in this version of the project there is no direct way to capture the images and so some of the images in TIFF format are directly used for the testing purposes.

h. The images are directly uploaded in the installation as there is minimal interference of the user as highlighted

4.2.2.2.2. Engineering Standard Requirements

There are no specific standards with respect to the technology except that the image quality is of high pixel. It is expected that the image quality, as per the engineering standards must be as follows:

i) pixel size: 0.664 micrometers

ii) Distance between two subsequent frames in a z-stack: 0.686 micrometers

4.2.2.3. Operational Requirements (Explain the applicability for your work w.r.to the following operational requirement(s))

- Economic

  There are extra expenses for this system and its usage perhaps save lots of time and it acts as a tool. The project is economically feasible and provides net returns in terms of cost savings to the medical center.

- Environmental

  There are no particular environment impacts. The project consumes very low power and it can even be run on a laptop. There are no possible carbon footprints for the system and no impact on greenhouse effect or phenomena like Global warming.

- Social

  The project has a definite social value as it adds to the accuracy of the diagnosis. The project is used as a tool and it lends credibility to the diagnosis. The project is economical and therefore it is socially acceptable as it benefits the society. The project can be used in early detection of the cancer as it has capability of working on high definition. This leads to early cure and benefits to the society.

- Political

  There are no particular political impacts or influence of this project. There are no impacts of any political changes in the system or the region as this is for a particular medical community usage.

- Ethical

  The project should be used ethically. The verification must be done by the specialist and it is expected that the project will be used as a tool. There are no huge costs of development and the medical specialist will try to provide the service to the community with no extra costs.

- Health and Safety

  The project itself is a tool and has no impact on the health and safety of the user. It does not deal with any radio-active matter as it works on images. On the other hand, it can be used for the enhancement of health and safety measures as it has capability to detect cancers.

- Sustainability

  There are no environment effects of the project and it helps the society and community. In this way it helps the medical centers to lead towards sustainability. The medical centers can gain by using the tools as not only it can potentially lend accuracy but also saves time in diagnosis.

- Legality

  There are no particular legal implications as this is being used as a tool by the medical specialists. The ultimate say is of the doctor or the medical specialists. They have the right to reject the results provided by

the system. Thus, there are no legal impacts of using or operating this tool alone.

- Inspect ability

  It is recommended that the specialist would inspect the results. The system provides the working which can be inspected and they have the right to reject the results if for certain reasons like defects in the images, that the results are not appropriate. The system provides the inspection facility for the purposes.

4.2.3. System Requirements

4.2.3.1. H/W Requirements (details about Application Specific Hardware)

The system can run on the normal desktop or a laptop. However, it is recommended that the system must be installed on the medical center servers so as to maintain the efficiency of the system.

4.2.3.2. S/W Requirements (details about Application Specific Software)

It is recommended that the project can be installed on the latest MATLAB versions and the latest OS like Windows, Linux or Mac. The installation of MATLAB and OR must be error free.

5. Results and Discussion

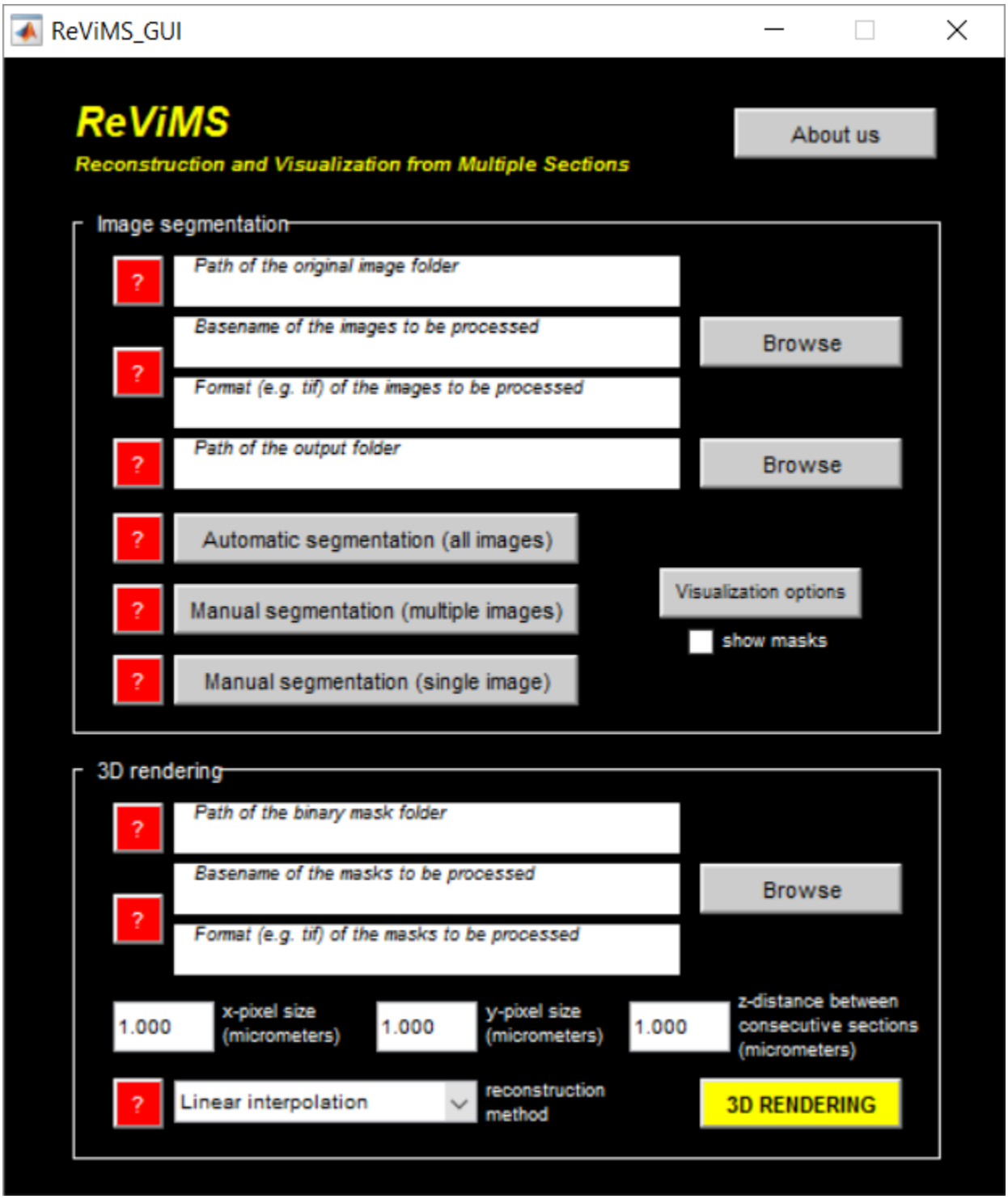


Fig 5. The software was run and this is the first screen which comes.

The paths and the images are set-up to be taken automatically by the system.

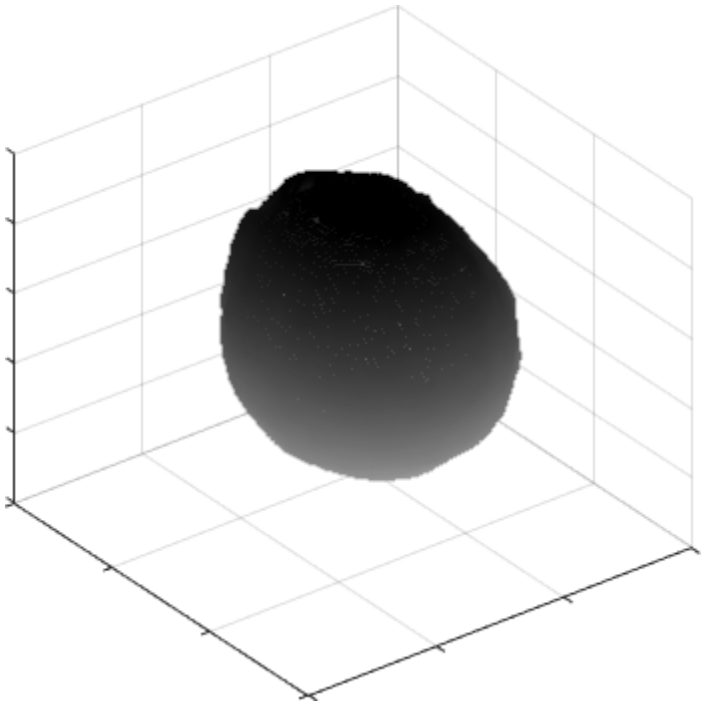


Fig 6. A typical image accepted by the system

The software has the capability to accept various images taken from different angles through the medical facility and the software can provide the 3D rendering of the image as shown above.

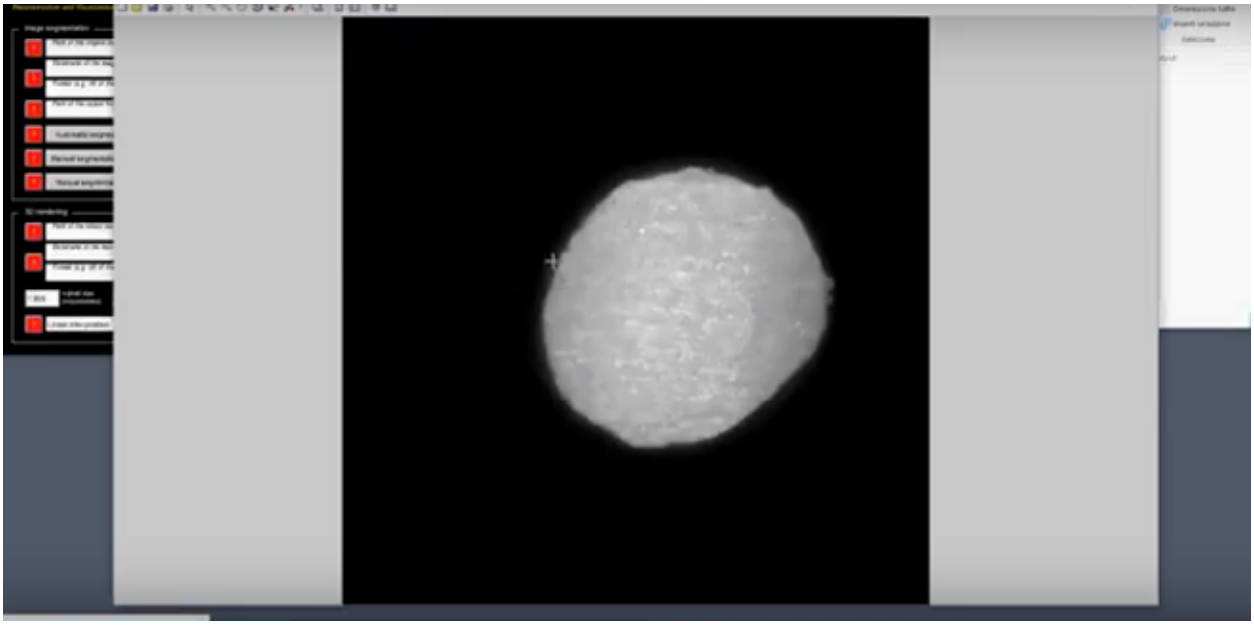


Fig 7. After selecting the image stack, it will display the intermediate processing

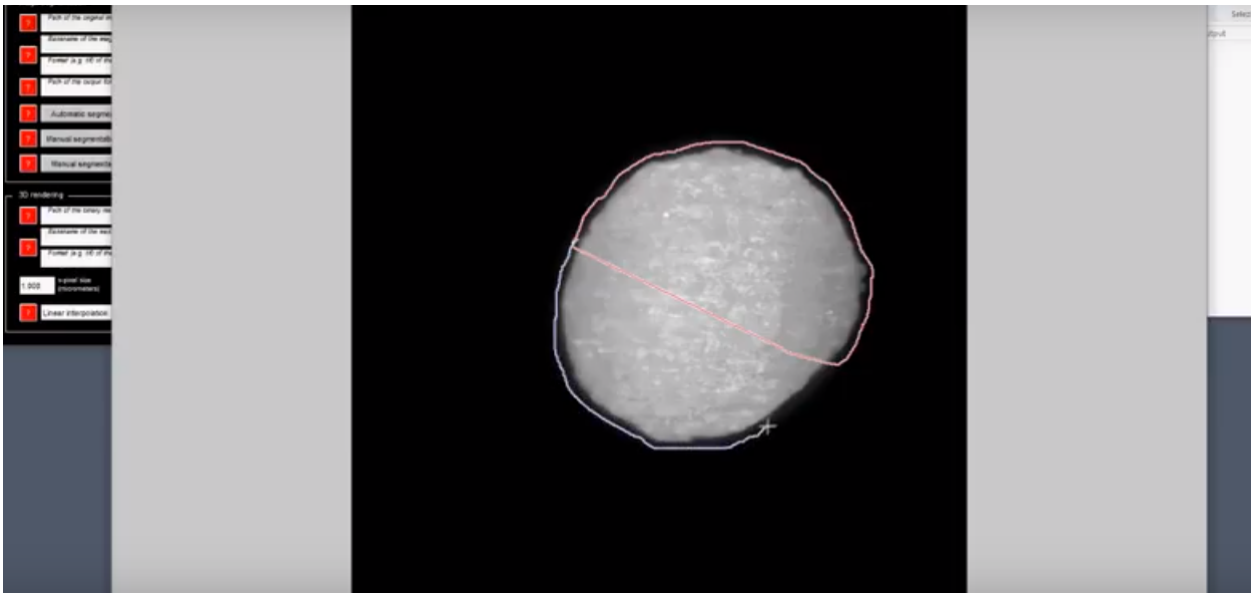


Fig 7.1. Next Stage

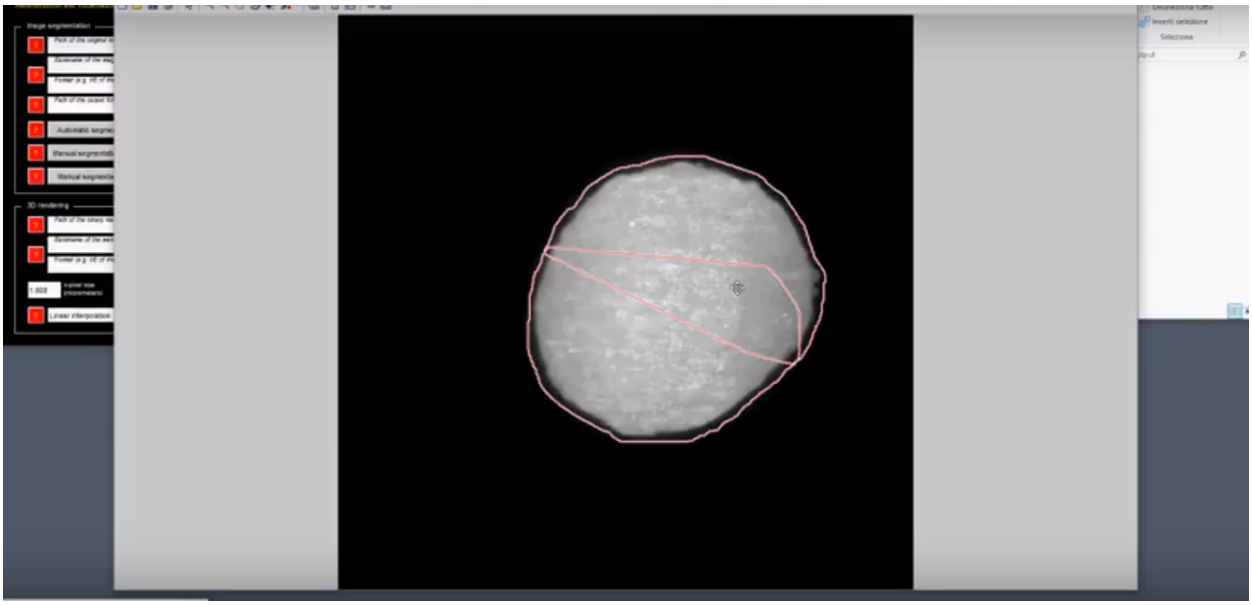


Fig 7.2 Next Stage

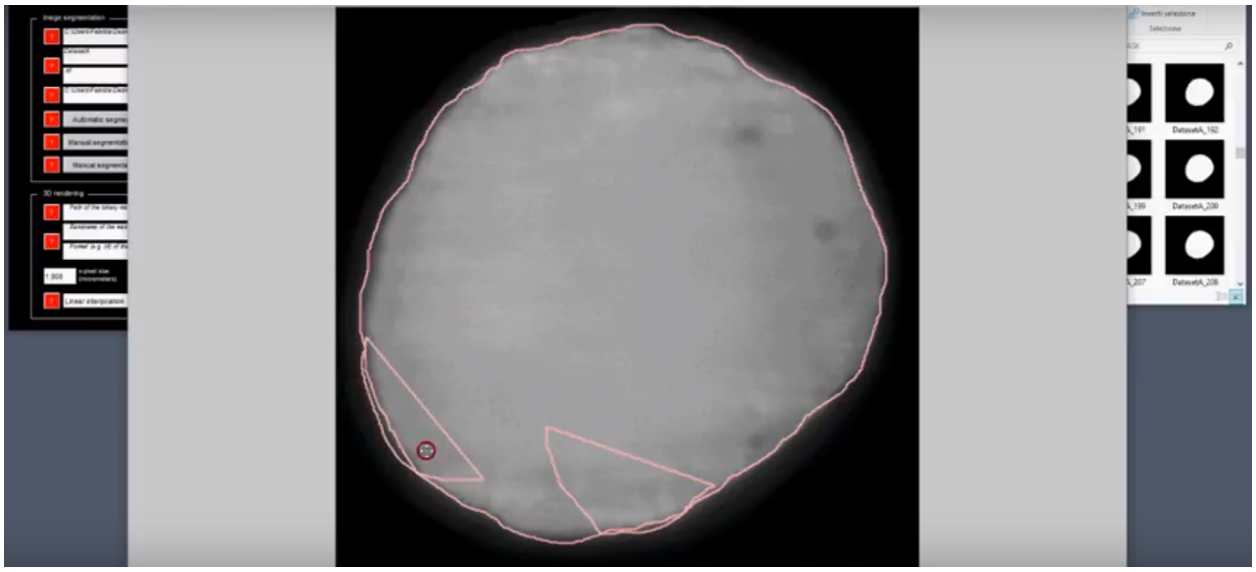


Fig 8. Segmentation

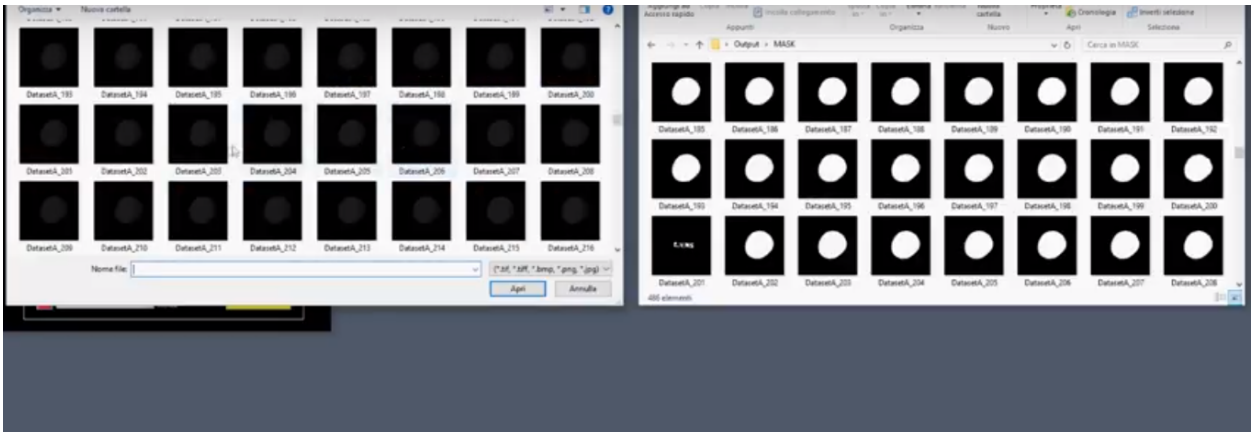


Fig 9. Producing output

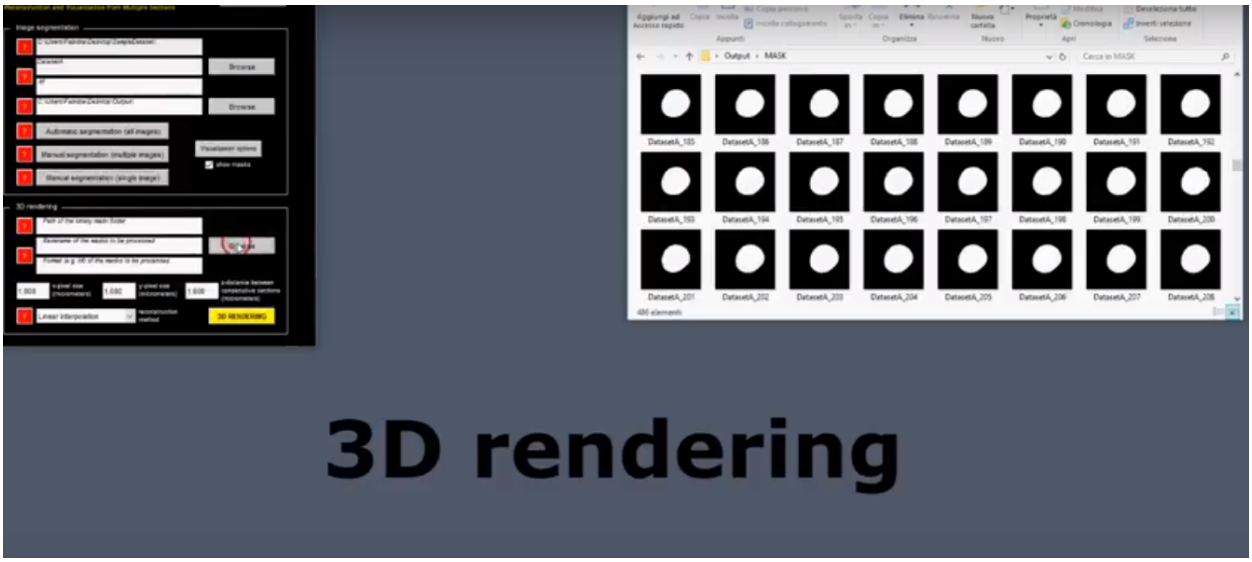


Fig 10. 3D Rendering

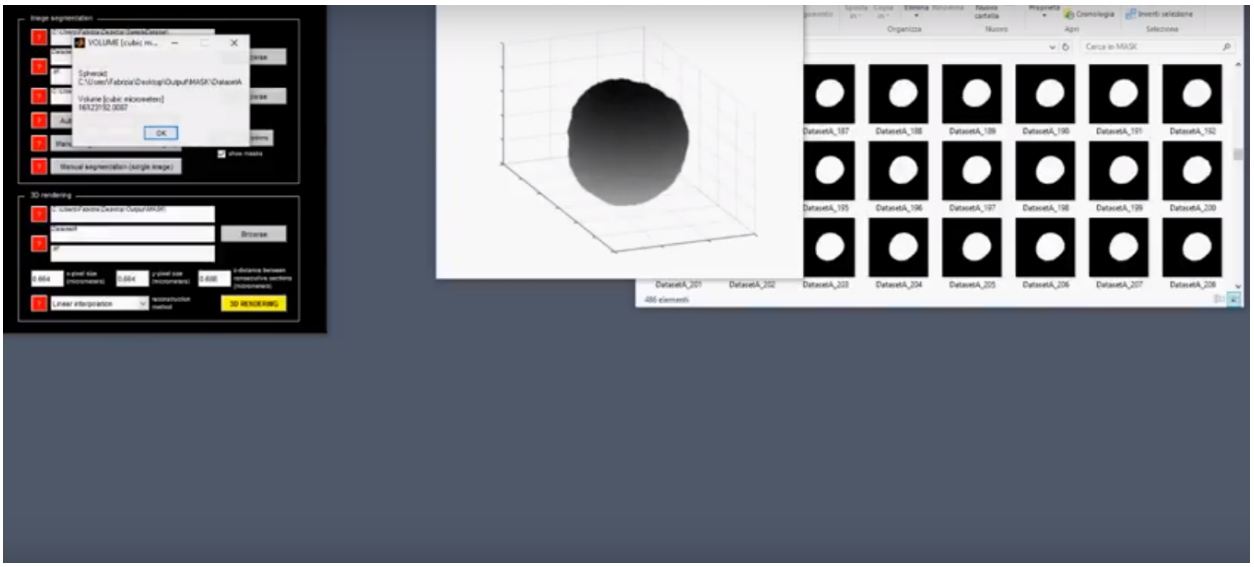


Fig 11.1 Result Generating

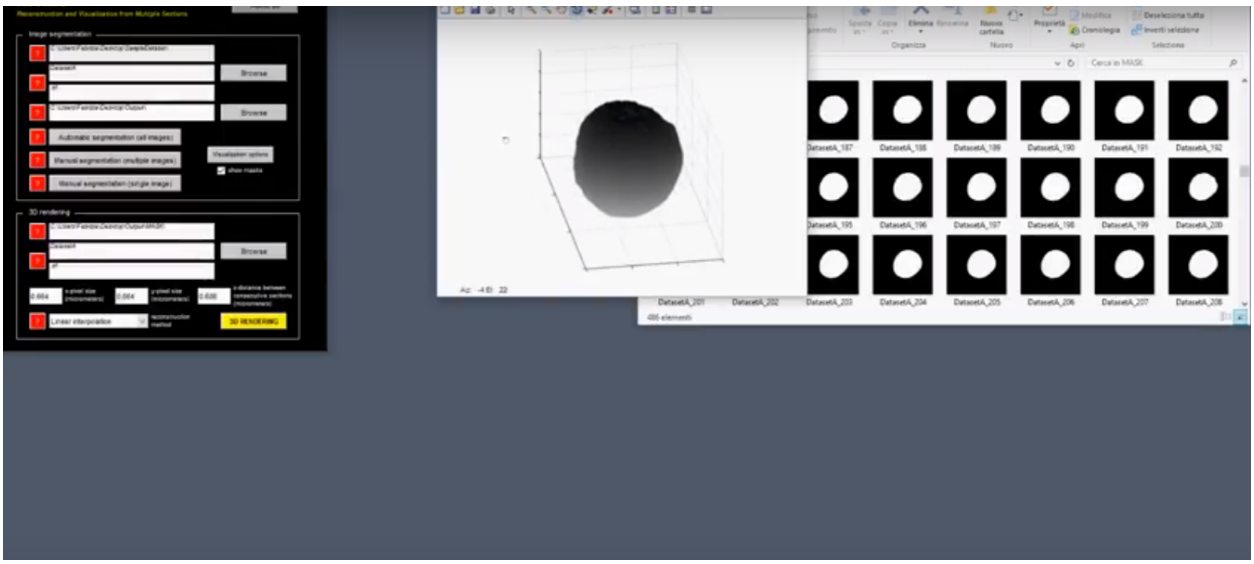


Fig 11.2 provides the dimensions of the nodule

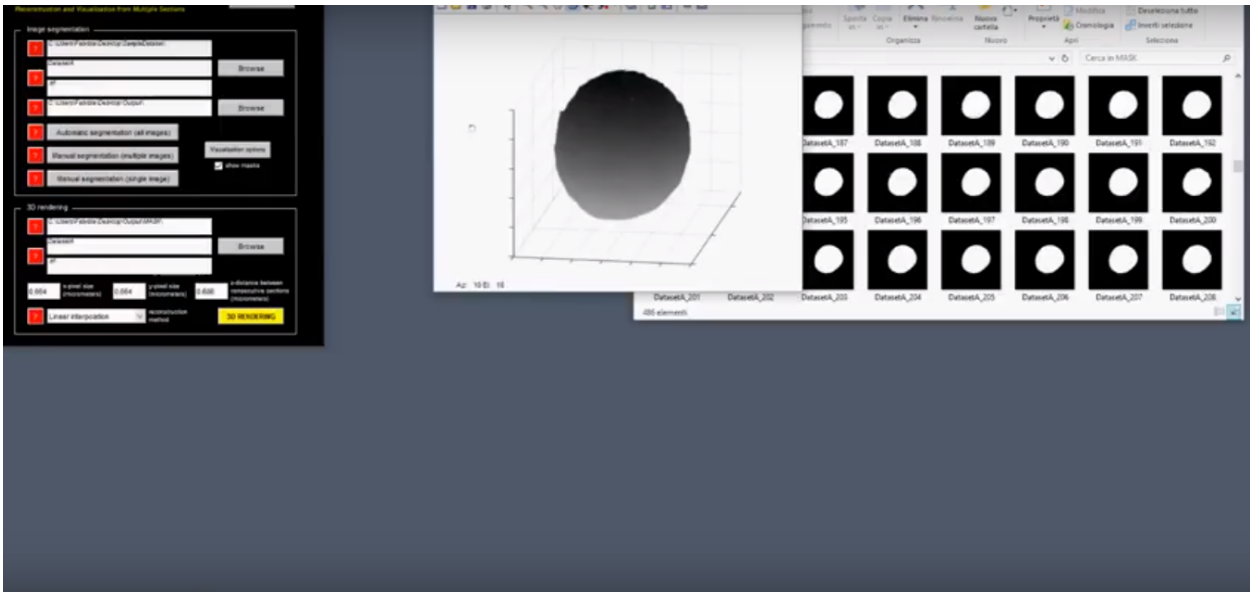


Fig 11.3 Cancer detected and the dimension of the nodule: 5mm

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