Radio Sensitivity and Risk Analysis for Cancer Treatment

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Abstract: The treatment of cancer ranges from various kinds of radiation therapy to surgeries in order to remove tumors. Of the said treatments, radiation therapies irrespective of the type of radiation provided have proven to be of utmost concern resulting in the long-lasting side-effects in the patients due to wrong dosages or inefficient recovery methods. As an approach to reduce the aforementioned side-effects one of the prominent procedures is to measure the length of the Telomere. Telomere is the bio-maker which is present at the ends of the chromosomes, which although by age diminishes in length, the notable reduction in size often accounts to the abnormal cellular division or growth. Shorter the length of telomere, greater will be the side-effects of radiation on the individual due to the weaker recovery rate and immunity in the patient. The telomere length is the important factor which is measured by conducting a blood test wherein the telomere is highlighted using fluorescence microscopy image. The images are run on certain models and based on the classification table, assign the dosage of radiation to the patient. The entire details are provided to the doctor and patient through a brief report.

Keywords: Cancer, Radiation, Chromosome, Telomere, Bio-marker, fluorescence microscopy.

INTRODUCTION

Cancer is a disease wherein the growth of the cells is accelerated beyond a normal rate due to which tumors are caused and it affects the immunity and tumors cause other health issues. The cells contain an element called telomer in the chromosome which is present at the ends of the chromosome. As the cells divide these telomeres enable the chromosomes to attach with one another thus forming chromosome strands. These telomeres are counted with respect to base pair counts wherein a child has the count of about 8000 and it decreases in a normal rate to 3000 in adults and 1500 as they get much older. This is due to the normal cell division and growth but in certain situations like the tumor formation the tumor base pair counts are exponentially lower thus being called as a biomarker for aging and for cancer treatment.

The shortened telomere length is used for the classification of medication taking the diagnosis of cancer i.e., the type of cancer, kind of cancer and the stage of cancer the patient is suffering from into perspective. This is done by using a model called U-net model for telomere length measurement. For this, the blood sample is taken and then fluorescence microscopy chromosome image is taken and then it's passed through the U-net model. The U-net model is predominantly a convolutional neural network i.e., CNN model where in its used for image segmentation. In this the structure is in the form the alphabet 'U', here there are multiple layers which succeed in increasing the output resolution. It has contracting and expansive paths which eventually leads to an output with great accuracy. Thus, using this model the length is taken and with the help of the diagnosis as mentioned an analysis and prediction model is constructed which will efficiently recommend treatments so the medical errors and misdiagnosis can be reduced and a highly efficient and customized medication regime is suggested with suggestions to maintain a healthy lifestyle and recover quickly.

NEED OF THE STUDY

The treatment of cancer although has several methods one of prominence which almost all patients go through is chemotherapy or radiotherapy which leads to a lot of radiation side-effects in the term. Along with this, there occurs certain percent chance of the cancer to reoccur in the patient. Thus, there is a need for customization of treatment of cancer to reduce the long-term effects and inculcate a healthy lifestyle and good diet which promotes the recovery rate and reduces the impact of radiation in the patient's body. To know more about it, the kinds of cancer and treatment types is of utmost important of a knowledge that leads us to know the kinds of errors that occurs in the medical field due to misdiagnosis and improper medication being prescribed to the patient. With all this data in hand a model can be constructed based on cancer types, kinds of cancer under the said types along with the stages of cancer to simmer down to a brief report describing the cancer the patient suffers from and the suggestion of treatment to be followed with recovery suggestion. Thus, efficiently customizing cancer treatment for an individual.

LITERATURE SURVEY

The authors of [1], explains the radiotherapy provided for the cancer treatment where in the working and the extent of side effects due to radiation is explained. Along with it the telomere instability is explained in depth with the information regarding the impact

of changes in the telomere on an individual's overall health. Further the impact of unhealthy lifestyle like smoking and drinking substantially leads to decrease in the telomere length. They also mention that in case of telomere length decreased in tumor cells is beneficial as they can be killed with lower radiation exposure while little to no effects on the normal cells hence the term radio-sensitivity is given. In certain cases, if the higher radiation is provided it not only effects the telomere it kills the normal cells which leads to long lasting effects in the individual. Thus, its necessary to go to molecular level for medication to increase efficiency and reduce long term side effects and everyone's ability to sustain the radiation differs hence, its very important of a factor.

Jared J, Miles J. McKenna, Aidan M. Lewis [2] proceed to explain how the telomere length is taken using the blood samples and the Telo-fish method used for the measurement of the telomere length. They particularly focus on the prostate cancer and with a great accuracy classify the stages and treatment. They are successful in predicting the radiosensitivity using just the telomere length.

The authors of [3], explain the various methods available to measure the length of telomere namely, Q-fish method, TRF analysis, Telomere shortest length assay (TeSLA), Single telomere length analysis (STELA), and finally Quantitative polymerase chain reaction method (aPCR), in all methods mentioned they describe the challenges, how to overcome the challenges and benefits of using the methods and the type of results according to the type of method. They describe in depth how the measurement procedure works and the structure they use for measurement.

Carol W. Greider [4], mentions the molecular level working of telomeres and cell division and the telomerase activity in the cells and the relation of cancer with cancer. Cancer in simple words is the abnormal cell multiplication which occurs due to various reasons but the cell growth is based on the general principles of cell division. Thus, these activities are monitored

The authors of [5], talks about the working of radiation on cancer and the effects it has on both cancer cells and the normal cells in general. They explain how the radiation is medicated, the types of radiation given to the patients, They also explain the long term effects the radiation has on the overall health of the recipient of radiation.

METHODOLOGY

The proposed methodology involves the forms being filled one for the clinic to register while the other is the patient form which is filled by authorized clinics only. The patient form has an image field which constitutes the telomere imaging image followed by certain personal details. This frontend is connected to the backend that stores the data into the database from which the details regarding type, kind, stage of cancer along with the image is sent to the model. The image is processed and sent to another model where the length of the telomere is determined followed by an analysis which has constitutes the all the details pertaining to the diagnosis of the patient from which the classification takes place. In the end the report is generated based on the findings and then the report is sent to both the clinic and the patient through the email id given during the clinic registration and the patient form filled.

The prerequisite of the entire process is that the patient is diagnosed with cancer and the stage and type is known. They approach the clinic with the intent to give blood sample for the process to begin. When in clinic post taking the blood sample, the sample is processed and the fluorescence microscopy chromosome image is taken. The form is then filled by the technician which constitutes the type, kind, and stage of cancer along with the said image uploaded to the form for report generation. The figure given below shows the entire methodology of approach towards customized treatment suggestion.

The form data then passes through four main stages:

1. Retrieval

The data is retrieved from the database and processing is done so the required details are sent to the analysis. The very first analysis is done using the image that was uploaded followed by another set of analysis using the results from image processing and the data entered in the form, namely, age, type of cancer, kind of cancer, and stage of cancer.

2. Analysis

The image is taken as input. Using the trained model and shape, the input image is converted to that particular size and shape i.e., the masking process. Once a clear image is obtained the image is given as an input to U-net model were in the length of the telomere is received as an output. The output is in the form of unit pixel which is taken as the measurement count for the prediction of treatment for the patient.

3. Prediction

Under the prediction phase the pixel value along with other criteria like age and cancer diagnosis is taken and based on rules we segregate the treatments and additional suggestions which would be useful for the doctor during the time of consultancy. As the process is entirely done by machine, we can assure that no errors would take place when compared to the diagnosis done by an individual thereby reducing the side-effects and ensuring efficient results.

4. Report generation and mail

The results are stored altogether along with all inputs given at the filling of form. This data is converted to pdf and a mail is sent to both the clinic and the patient for reference.
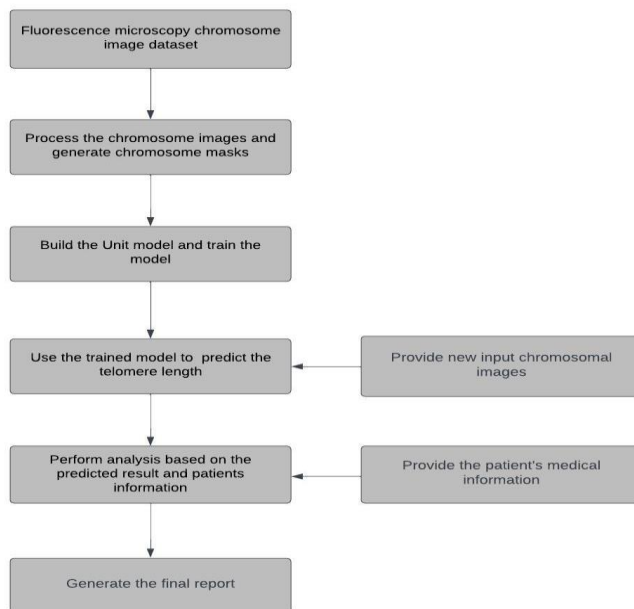
Fig 1. Methodology of Radio Sensitivity and Risk Analysis for Cancer Treatment
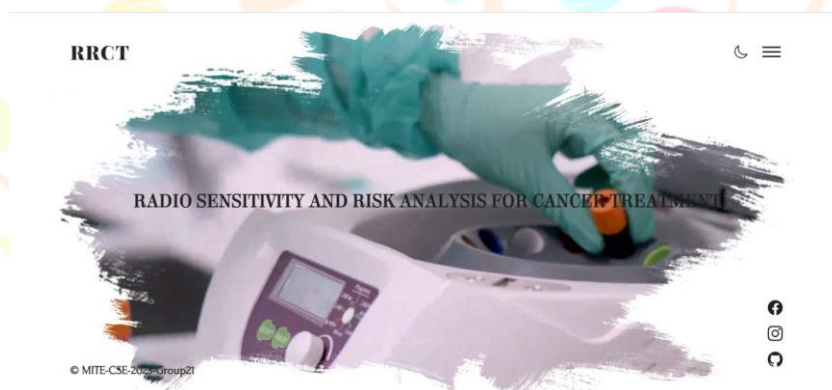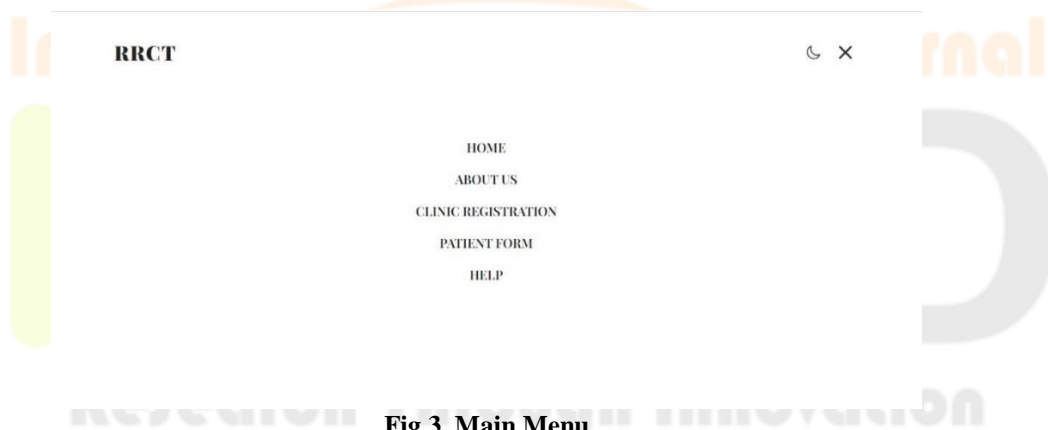
RESULTS AND DISCUSSION

Fig 2. Landing page

Fig 3. Main Menu

The menu page constitutes of links home page, about us page, Clinic Registration, Patient form and Help page.

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REGISTER

Clinic ID	102341
Clinic Name	Arogya Medicals
Clinic Email	arogyamedicals@gmail.com

Submit Reset

Fig 4. Clinic Registration Form

The Clinic Registration Form consists of clinic id, clinic name, clinic email wherein the clinic email is stored for email purpose and the clinic id is to check if the clinic is registered in the portal.

RRCT

REGISTER

Drop files here
or
Choose file   image32.png

Gender	Male			
Cancer	Lung Can	Non-Smal	Advanced	
Clinic ID	102341			

Patient ID	10023412	Email Address	heytraily@gmail.com
First Name	Amith	Phone Number	9617432859
Last Name	Prabhu	Address Line 1	3-13/4 Shri Devi House, Moodabidri
Age	36	Address Line 2	Mangalore - 574143

Submit Reset

Fig 5. Patient Form

The patient form constitutes all fields which will be extracted from database for the model and report generation. The clinic id is used to confirm if the clinic id is in the database or not. If not present the clinic has to register in the clinic from.
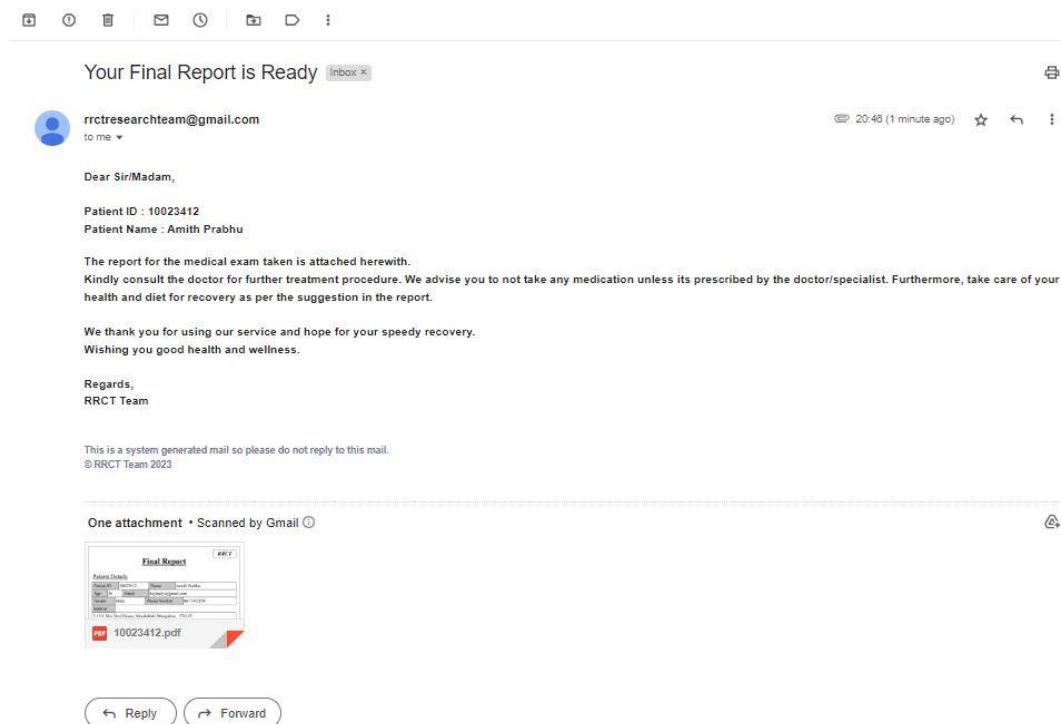
Your Final Report is Ready Inbox ×

rrctresearchteam@gmail.com
to me

Dear Sir/Madam,

Patient ID : 10023412
Patient Name : Amith Prabhu

The report for the medical exam taken is attached herewith.
Kindly consult the doctor for further treatment procedure. We advise you to not take any medication unless its prescribed by the doctor/specialist. Furthermore, take care of your health and diet for recovery as per the suggestion in the report.

We thank you for using our service and hope for your speedy recovery.
Wishing you good health and wellness.

Regards,
RRCT Team

This is a system generated mail so please do not reply to this mail.
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One attachment • Scanned by Gmail

10023412.pdf

Reply   Forward

Fig 6. Email received by Patient and Clinic

The email is sent to both the patient email specified in the patient form and also the clinic email which is specified during the clinic registration.

Fig 7. Report generated

The results are stored altogether along with all inputs given at the filling of form. This data is converted to pdf and a mail is sent to both the clinic and the patient for reference.

Fig 8. Background Processing

The command prompt shows the hidden layer processing completion at each stage. This helps in visualizing the processing done, in case of any error in the location the error can be identified and rectified.

CONCLUSION

This procedure is very much effective in providing an in-depth knowledge and suggestion regarding the cancer treatment and diagnosis at the molecular level leading to an effective decrease in misdiagnosis and wrong prescription of medicines which often is the cause of multiple kinds of side-effects. Certain mistakes might be due to medical negligence while others might be due to incorrect conclusion. While the method mentioned above successfully classifies and suggests the treatment procedure it also guides the patient into speedy recovery with certain guidelines that needs to be followed. At present, although the model is limited to 5 types of cancer the same can be extended to other types of cancer or even more so to other diseases that involve telomere as a biomarker.

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