
SCCAW Research
A Research and Development Company
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Our Mission

Our mission is to use a software-based non-invasive approaches for detecting cancer early by excavating diagnostic images into its constituent bit planes and carefully analyzing those bit planes where cancer can hide and help in saving lives.

Our Vision

Our vision is to detect cancer and other life-threatening diseases as early as possible by excavating the digital diagnostic images available from the state-of-the-art medical imaging modalities into its bit planes, cumulative sums, or other imaging informatics and help save lives.

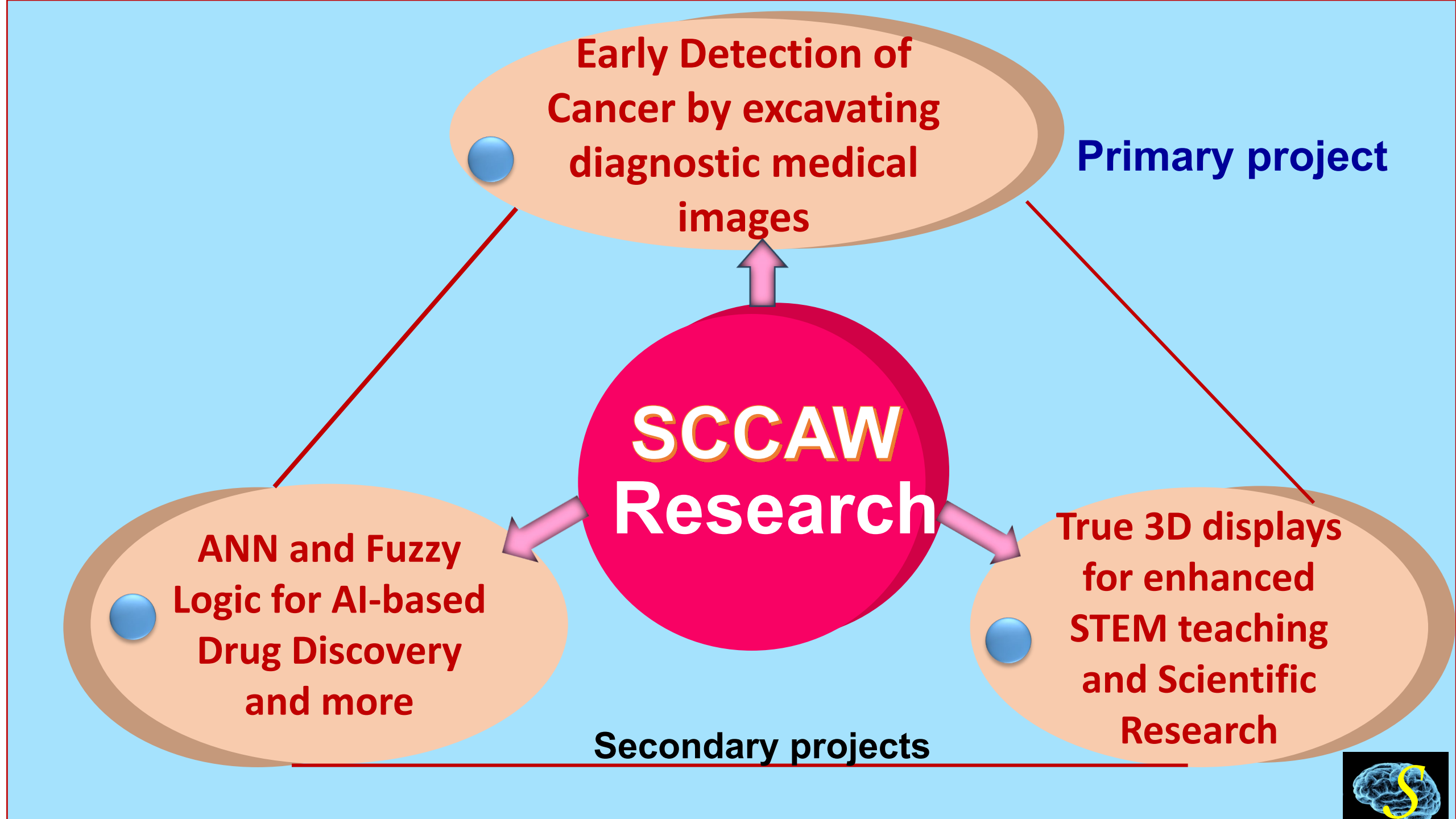
Introduction

Cancer is the number one killer disease. Over the period of last 5 years, it took nearly 3 million lives in the US and more than 50 million lives worldwide.

Physicians agree unanimously that early detection is the key for survival of the patients. Medical images from different modalities such as X-ray, MRI, CT scan, etc., are tried to detect cancer early, but the signature of cancer from its early stages is almost invisible on the 8 bit complete jpg diagnostic images. Thus, there are significant chances for missing the signs of cancer from its early stages.

To overcome this problem, our software excavates those complete images into its constituent 8 bit planes, and then uses cumulative sums to gradually build the complete image from the image of the lowest bit plane (bit plane 1) . This process often reveals how cancer hides either in the jungles of the lower bit planes or in the jungles of the lower cumulatively summed images, called incomplete images.

Software development, testing, and documentation have been completed.


Early Detection of Cancer by excavating diagnostic medical images
Primary project
SCCAW Research
ANN and Fuzzy Logic for AI-based Drug Discovery and more
True 3D displays for enhanced STEM teaching and Scientific Research
Secondary projects

Early Detection of Cancer
By Excavating Medical Images

- **What motivates us to pursue research in this field?**
- **Do we have the relevant technologies to detect cancer early?**
- **Does the technology require invasive process on the patients?**
- **Can hospitals use the technology/ software today?**

What motivates us to pursue research in this field?

- In 2021, about 600,000 lives are lost from cancer in the US, and about 10 million lives are lost worldwide
- Physicians agree unanimously that early detection of cancer can help save many lives
- Watching how quickly the wrath of cancer kills our colleagues, friends, and relatives, after cancer was detected, was terrifying
- Having started academic background with analog imaging and then introduced to digital imaging technologies we eventually envisioned that early detection of cancer might be possible by fusing the knowledge from both analog and digital imaging technologies

Do we have the relevant technologies to detect cancer early?

- For analog imaging, a radiologist would have access to one analog plate (such as an X-ray plate) for analyzing the situation.
- On that plate, however, intensities could have varied widely to give a clearer view of the situation. Still, it was just one plate.
- For digital imaging, one 8-bit digital image has 8 binary images embedded in it, and cumulatively summed images can be gradually formed by adding the one bit plane (BP) of information at a time after multiplying by its weights

Do we have the relevant technologies to detect cancer early? (Cont'd)

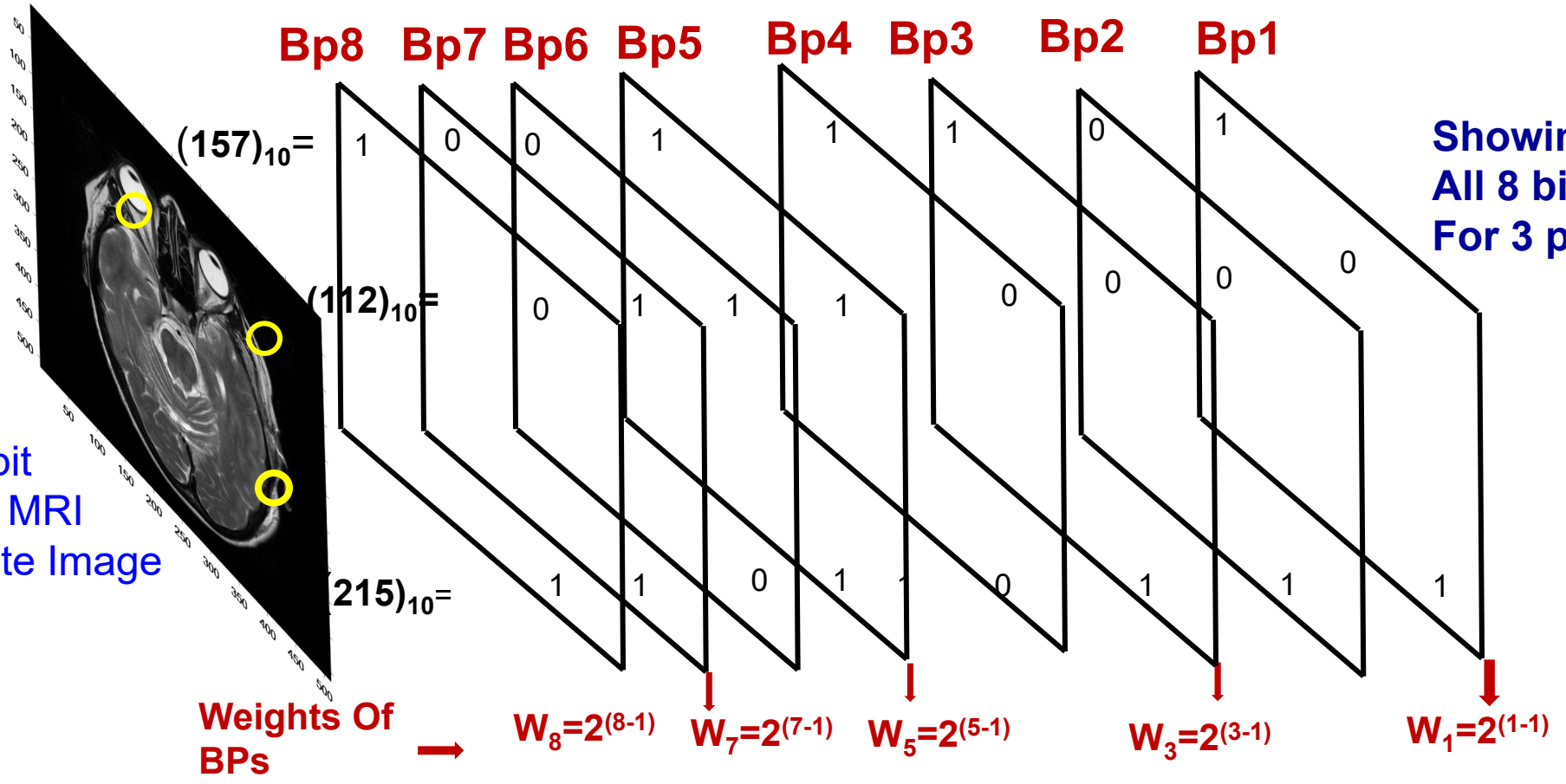
- For digital imaging, one 8-bit digital image has 8 binary images embedded in it, and cumulatively summed images can be gradually formed by adding the one bit plane (BP) of information at a time after multiplying by its weights
- Thus, there will be six cumulatively summed images since the 7th cumulatively summed image is same as the original 8-bit image
- All these terminologies will be explained next with examples to ensure that the subject matter can be followed properly

Example of a bit plane model of an 8-bit Complete Image

$157=1*10^{3-1} + 5*10^{2-1} +7*10^{1-1} = 1*10^2 + 5*10^1 +7*10^0$ (Decimal number representation)

Binary number representation of $(157)_{10} = (10011101)_2$

$157=1*2^7 + 0*2^6 + 0*2^5 + 1*2^4 + 1*2^3 + 1*2^2 + 0*2^1 + 1*2^0=128+16+8+4+1$



An 8-bit image of PxQ pixels consists of 8 bit planes of PxQ binary pixels

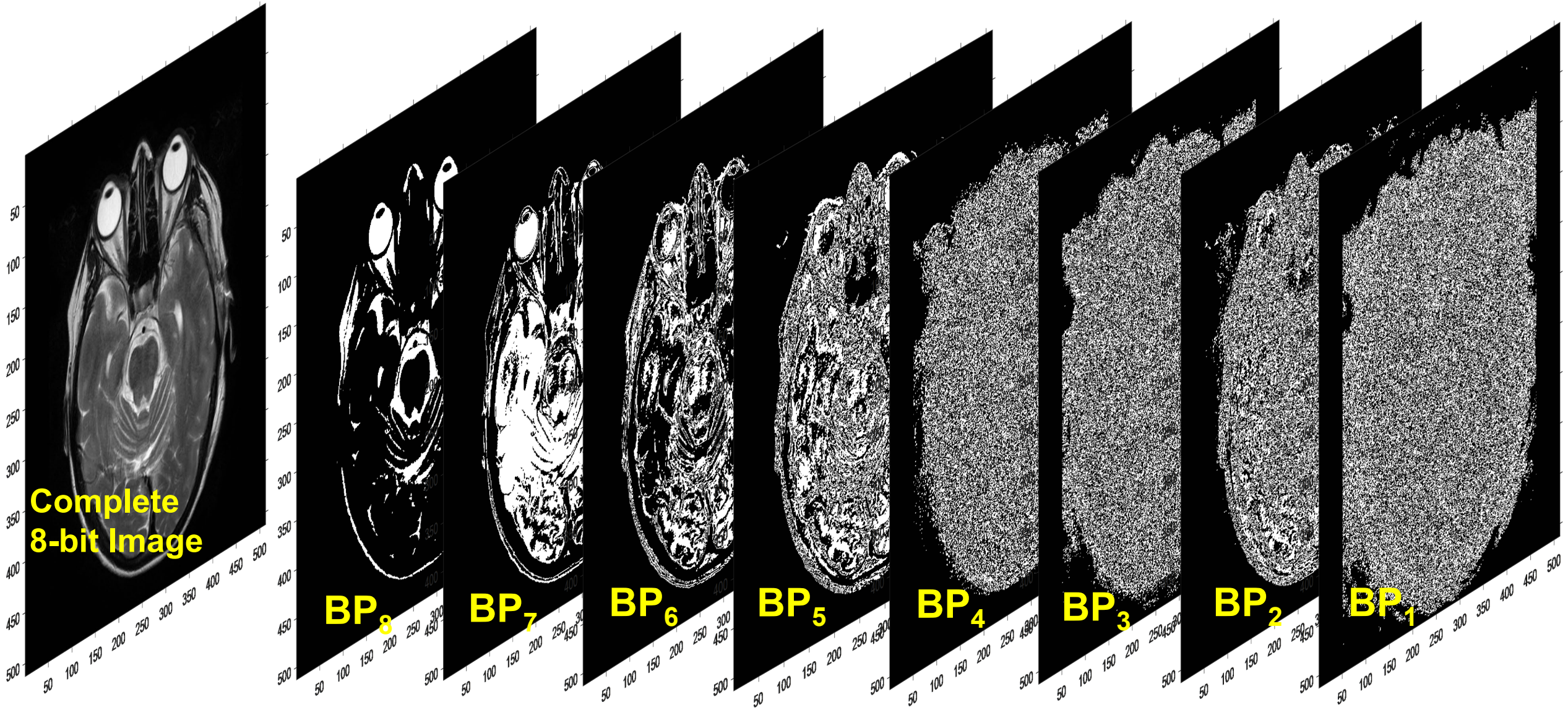
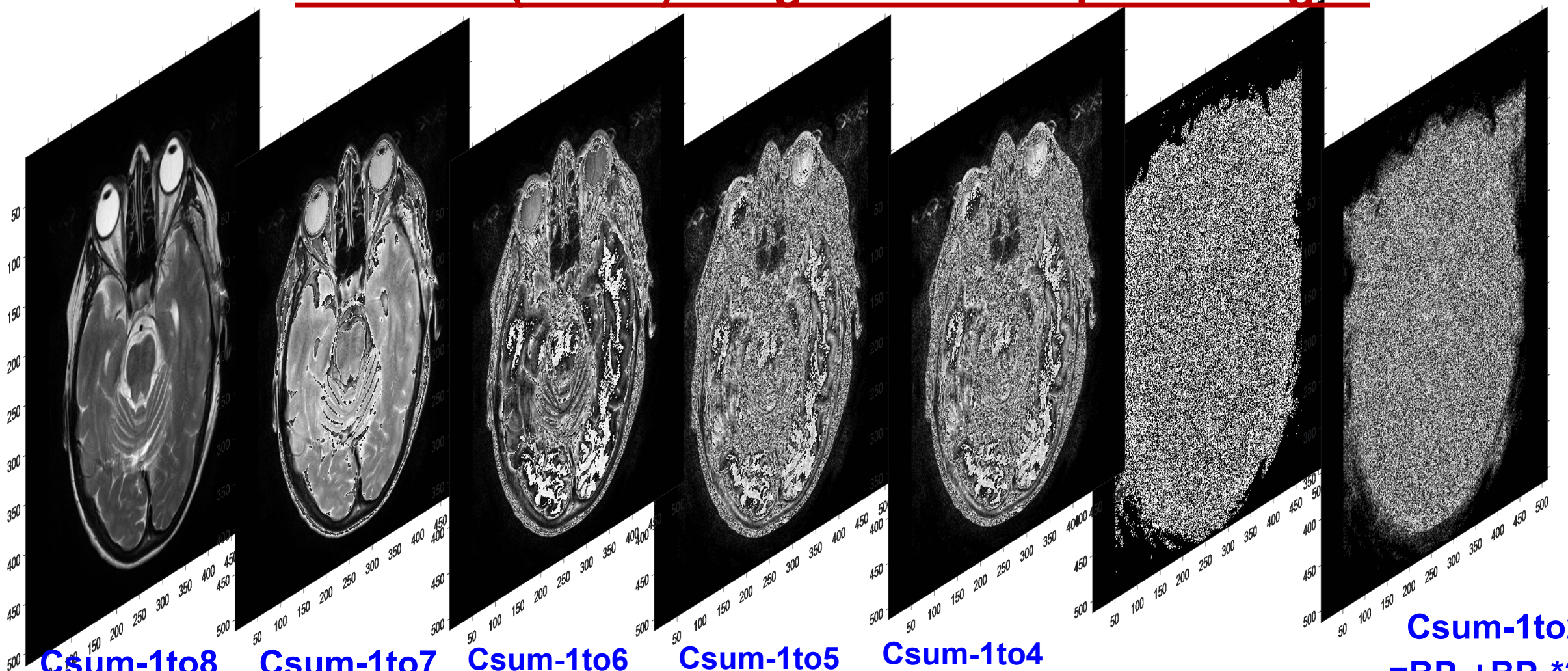


Image of bit plane N or BP_N is generated by taking only the Nth bit of 8-bit image

An 8-bit complete image has 8 bit planes and the bit plane number N has the weight $2^{(N-1)}$

Reconstruction of the complete image from its cumulatively summed (Csum) images or incomplete Images



Csum-1to8
Complete
8-bit Image

Csum-1to7

Csum-1to6

Csum-1to5

Csum-1to4

Csum-1to3
=Csum-1to2+$BP_3*2^{(3-1)}$

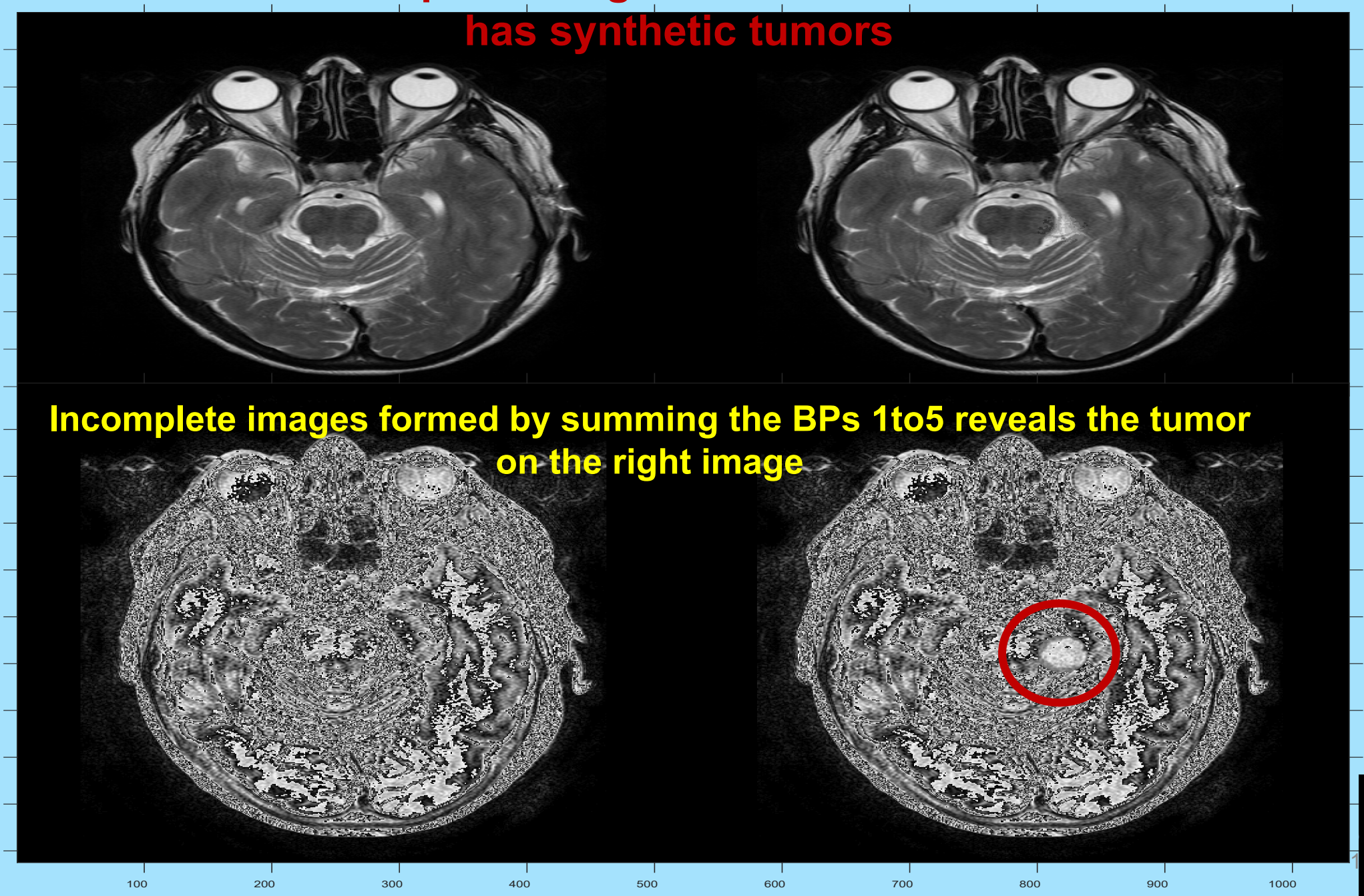
Csum-1to2
=$BP_1+BP_2*2^{(2-1)}$

$$\text{Csum-1toN}=\text{Csum-1to(N-1)}+BP_N*2^{(N-1)}$$

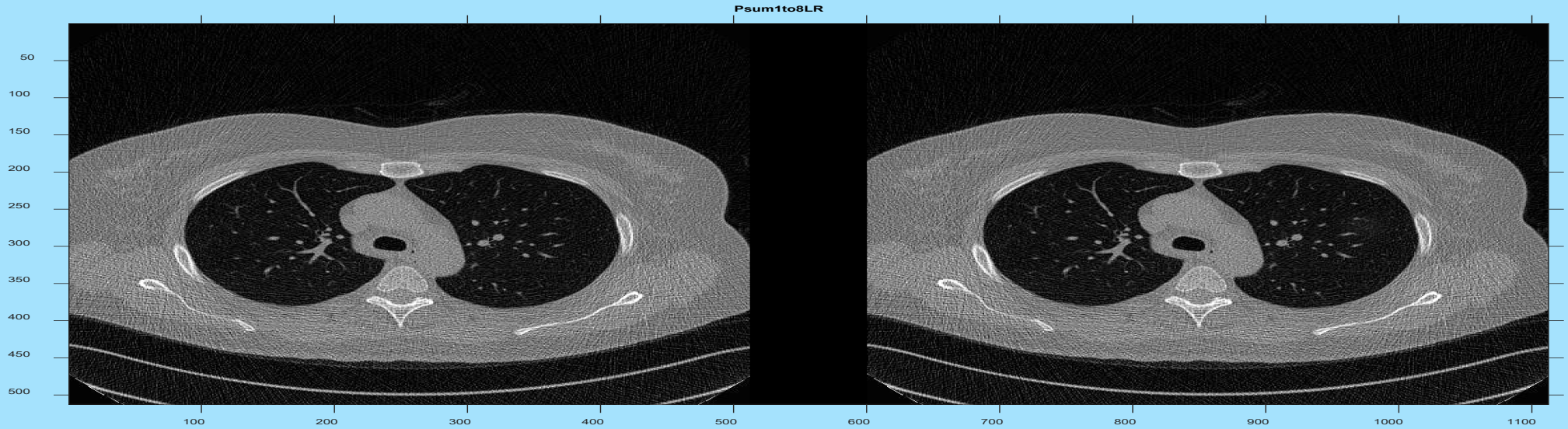
How to excavate Life-saving Incomplete images From a complete jpg Image

- Those Csum Images are called as incomplete images which are found useful in detecting cancer early
- While analyzing the gradual formation of the Csum images, from the bit planes, at any stage an image could be formed revealing the presence of tumors/ nodules that were hidden in a complete image
- The physicians will analyze the signature of those anomalies and decide if clinical tests are needed

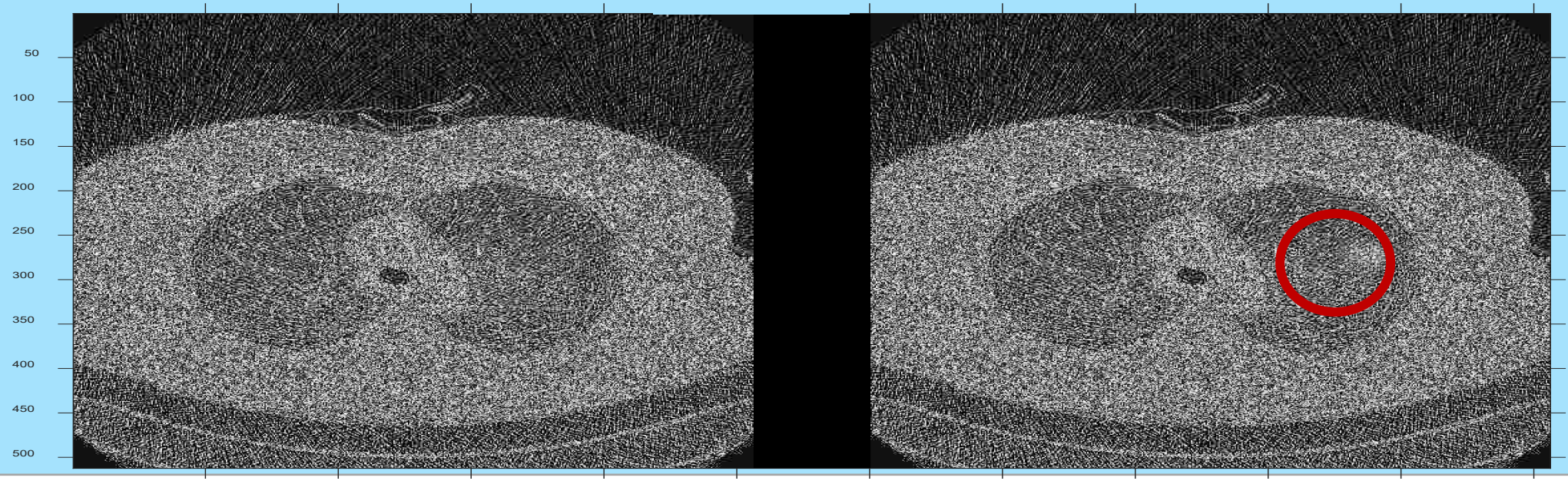
From these two complete images it is difficult to detect which one has synthetic tumors



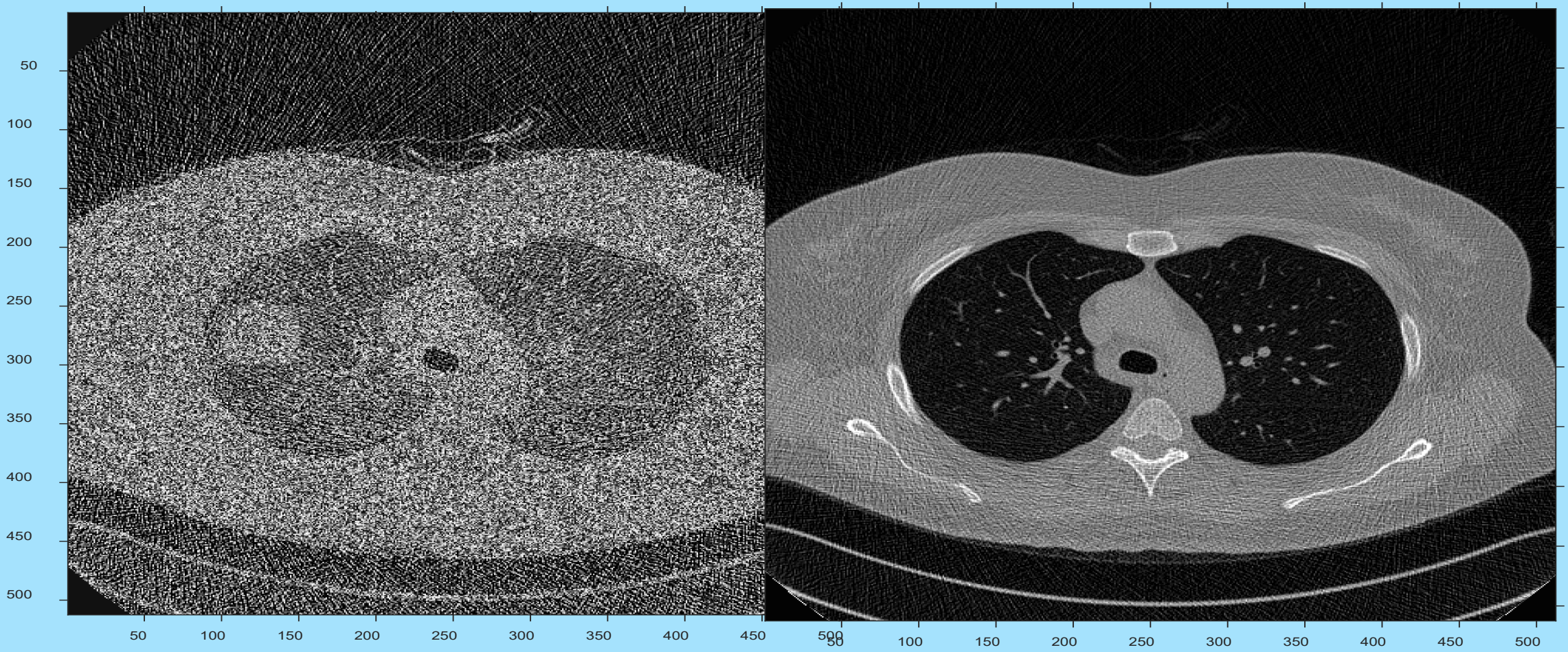
From these two complete images (CT Scans) it is difficult to detect which one has synthetic nodules



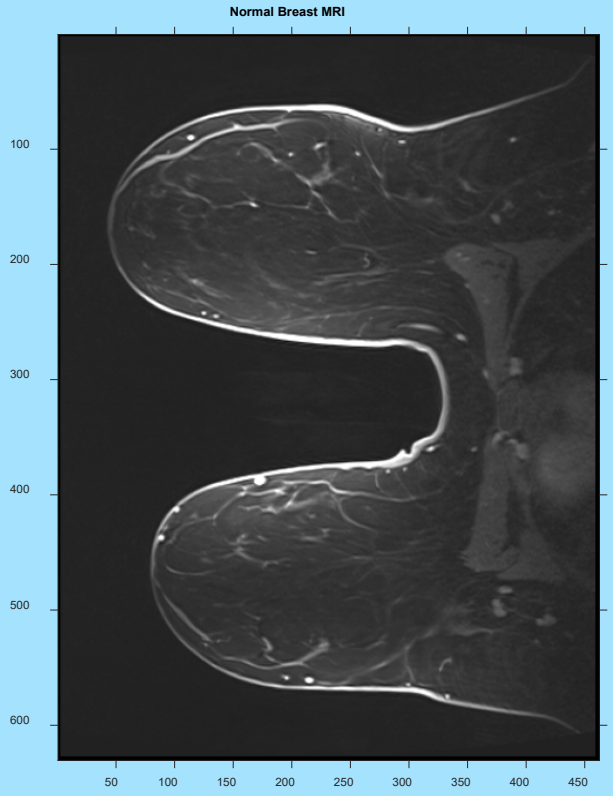
Incomplete Images formed by summing the BPs 1 to 5



Incomplete Image with Csum1to5 Complete 8-bit jpg Image



Synthetic cancer is added to a breast MRI



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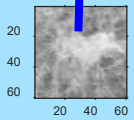
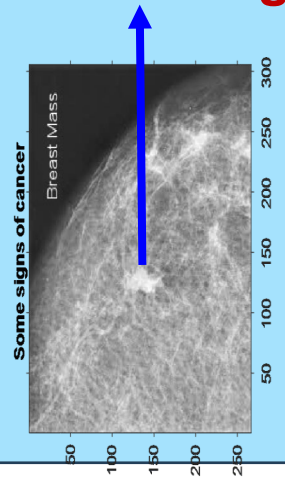
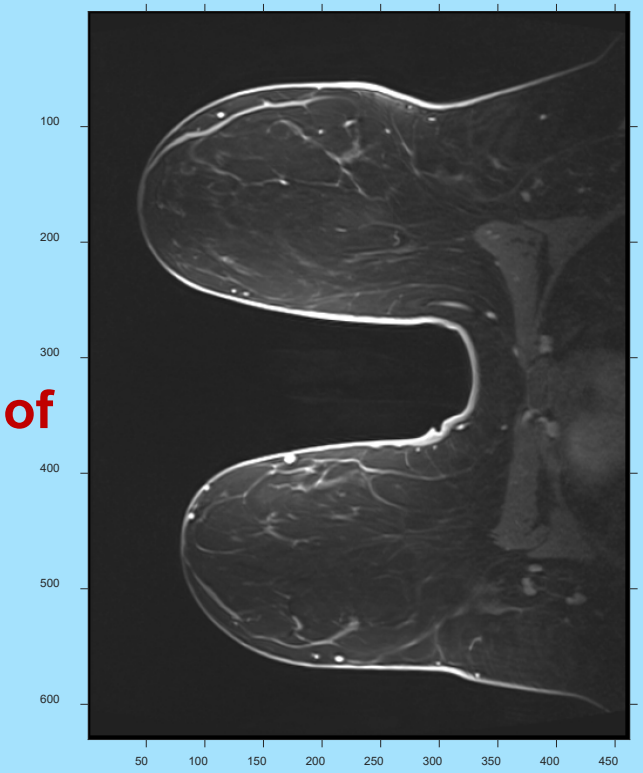


60x60 pixels extracted from a Cancerous zone of another image

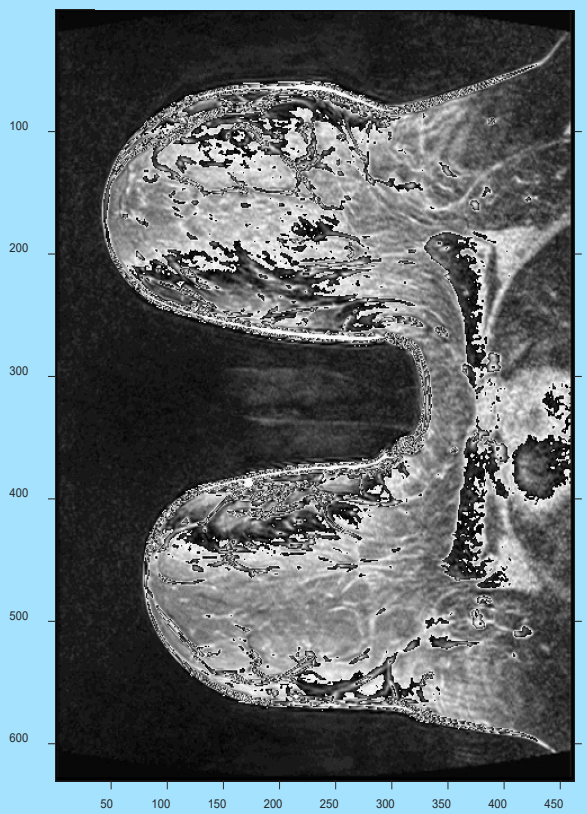


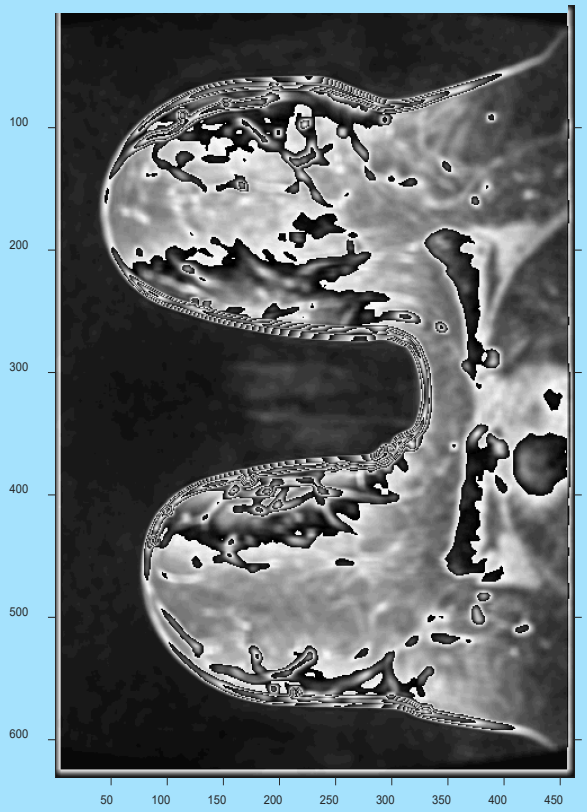


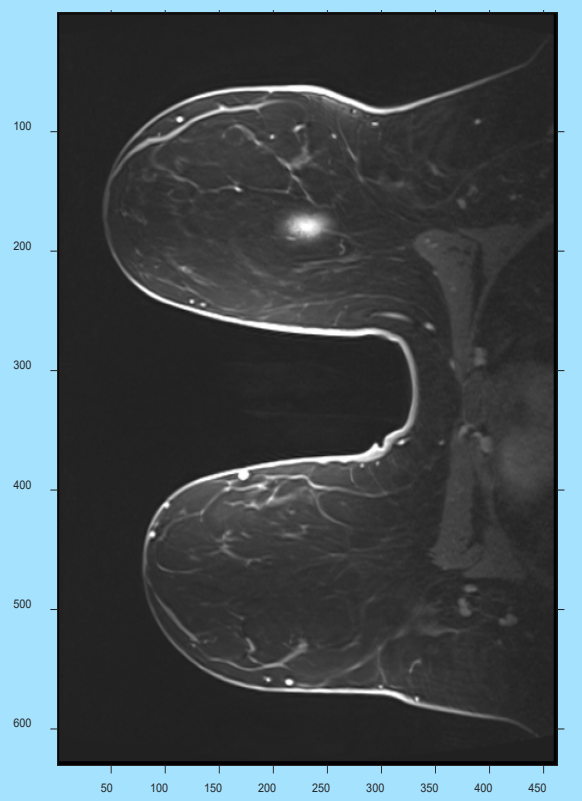
Cancer is added to an unknown location with low intensity

Sum of the bit planes 1 to 5 before (Left) and after (Right) slightly smoothing the Input Test Image

Intensified Cancerous zone of the input test image shown <u>for validating our result</u>







Do we have the technology to detect cancer early? (Cont'd)

- On combining the images of the bit planes and the cumulative sums, we have in total 8+6=14 different images to analyze instead of one jpg image
- Each of these images provide a different digital information about the contents of the image
- Since in early stages the signature of cancer will have lower strength, its information will lie on the lower bit planes of an image
- Thus, when a cumulatively summed image is formed by using 5 lower bit planes, this summed image will contain more information from the lower 5 BPs and no information from the 6 to 8 BPs

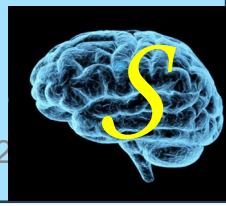
Do we have the technology to detect cancer early? (Cont'd)

- **The cumulatively summed information from BPs 1 to 5 will be able to provide more information about the low intensity part of the image and not get overwhelmed by the high-intensity part of the image**

- **Thus, such images might be able to provide some insights about the early stages of cancer, and this is our primary motivation for using cumulatively summed images to detect cancer early**

Does the technology require invasive procedures on the patients?

- NO!
- The image analyzing process to detect cancer early involves the decomposition of the 8-bit diagnostic image into its 8 bit planes and the formation of cumulatively summed 6 images
- The diagnostic image is that image which is used by a physician to perform his or her investigative process.
- Thus, our approach do not require any additional images and so the procedure in non-invasive for the patients



- **Yes! Since the approach works with a non-invasive device that just assists physicians with their investigations, we may not require FDA's approval.**

- **Our software has been successfully tested with DICOM images available from MRI, CT Scan, and X-rays.**

- **Since all useful medical imaging instruments produces the results or data in the DICOM format, our software should be able to read data from ultrasound, petscan, etc., without any modification**

- **Software testing and documentation have been performed carefully to complete the package which can be run without the need for any external support**

A Brief Review of four steps to use to Detect Cancer Early

- Collect a diagnostic (complete) image from the required medical image modality such as: MRI, CT scan, X-Ray, Ultrasound, etc.
- Compute and display the binary images of the 8 bit planes
- Compute and display all the images of the cumulative sums or incomplete images
- These images will be rich in information content and help Radiologists in diagnosing the Medical Condition accurately

Concluding Remarks

- We showed that we first need to simply extract a jpg image from a DICOM image, and then visualize the images of the 8 bit planes of that jpg image to detect the presence of cancer in the image

- Then, if needed, we should also visualize the six images of the cumulative sums to detect cancer early

- This process can not only be used to detect cancer early but also can be used to detect other deadly diseases early from their medical images and help save lives

Software development and documentation have been successfully completed

More Information will be coming soon