Expert Lectures
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Breast Cancer Analysis: Problems of Clinical Interest and AI challenges

INTRODUCTION

The lecture started with an overview of the importance of breast cancer analysis. The speaker presented various ways of detecting breast cancer, which include - Ultrasound, Mammography, MRI, Biopsy etc. We were then provided with an understanding of the basic question, “What is cancer.” Below points accurately help answer this question -

1. It is an uncontrolled growth of cells,
2. failure of apoptosis,
3. hormonal imbalance,
4. failure to correct mutation before transcription

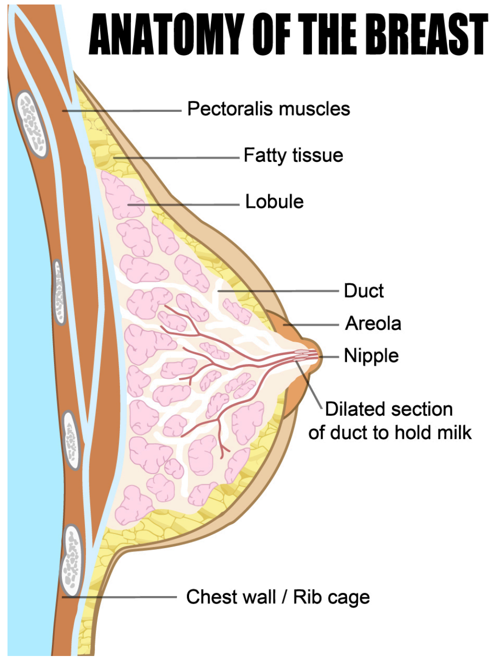
STATISTICS

The statistics presented during the lecture showed that the peak age of breast cancer is lower in Asia as compared to the West. This was accounted mainly because the breast structure in Asia varies slightly as it is more dense.

BREAST STRUCTURE

Breast structure was also discussed as a part of the session. The main parts discussed were -

1. Pectoral - It is the muscle that connects the breast to the body
2. Rib - Bones which form rib cage
3. Milk duct - These tubes/ducts help pass the milk to the nipple when the woman is lactating
4. Lobules - Produce milk when woman is lactating
5. Fat - It refers to the tissue present in the breast.



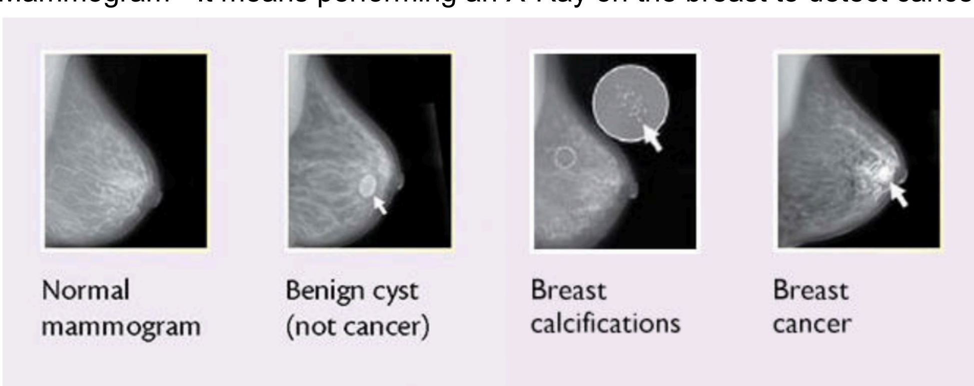
FALSE NEGATIVES

There are certain scenarios which are actually not Cancer, but may be mistaken for one unless checked by a physician. These include - abscesses, fibroadenoma, cysts and tumors

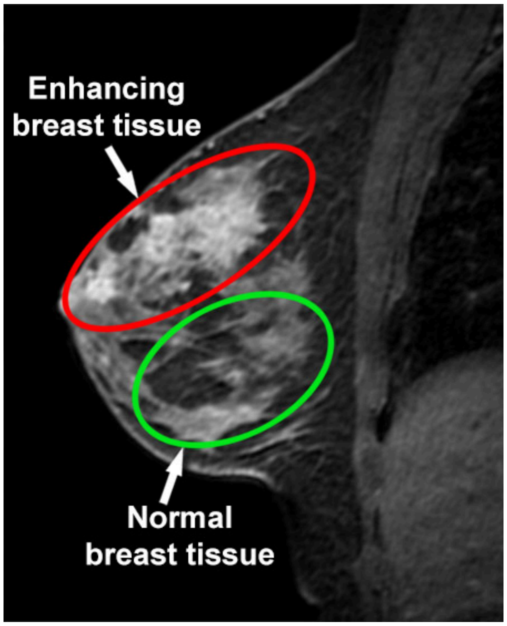
SCREENING MODALITIES

Screening modalities include -

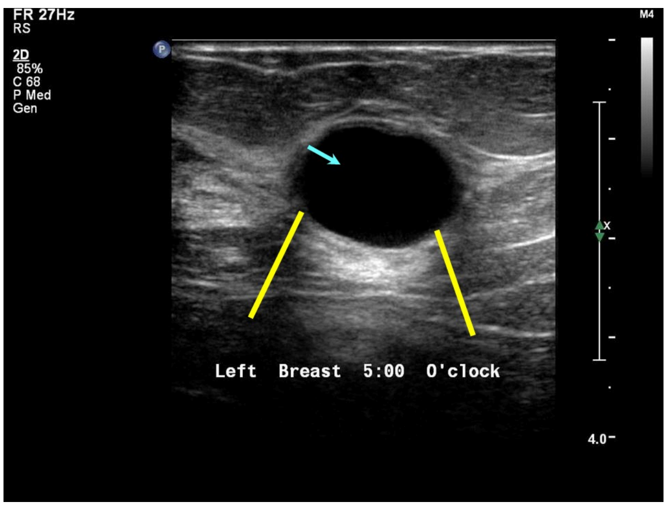
1. Self assessment - These include performing various steps as suggested by the medical professionals by our own self. It includes visual examination, checking for lumps using suggested methods
2. Clinical assessment - Manual assessment done by doctors
3. Mammogram - It means performing an X-Ray on the breast to detect cancer.



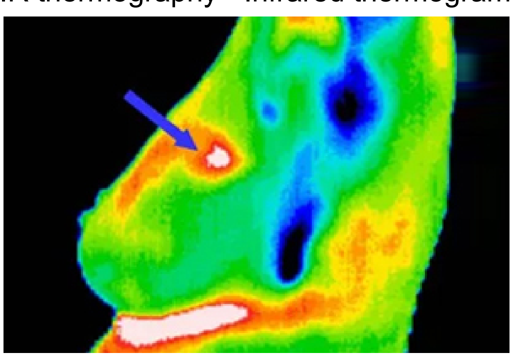
4. MRI - It stands for Magnetic Resonance Imaging and uses radio waves to detect cancer inside the breasts.



5. Ultrasound - Sound waves are used to perform breast imaging



6. IR thermography - Infrared thermograms are used to measure temperature patterns



WHY IS AI NEEDED

1. Increase throughput
2. Find what clinician cannot - AI can be used to identify patterns which a clinician is not able to, based on its training data.
3. Reduce analysis time and cost- Biopsy is an extremely invasive process and causes a lot of pain to the patient. Thermograms are expensive for the general public, due to which, they are usually not the first option for most people for cancer detection
4. Reduce assessment variability - Clinicians with varied levels of experience may detect cancers differently. This variability will be taken care of with AI.
5. Multimodal image fusion and multi imaging

CHALLENGES

- Explainable ai - The models developed by the AI development team will not be understandable by the doctors. Hence, there is a need to write code which can easily be explained to the experts in order to identify issues and get appropriate suggestions from them.
- Data-related issues -
    - Poorly labelled dataset
    - Low amount of dataset
    - Poor quality of retrospective data
    - Expensive to acquire data,
- Computational power requirement
- Clinician engagement - The work in this domain will be highly inter-disciplinary and will require engagement from multiple parties including AI experts as well as the Doctors
- Need for multiresolution analysis

CONCLUSION

The lecture ended with an emphasis on the need for continued research and collaboration in the field of Breast Cancer AI. Multiple ongoing/expected projects were discussed in the end to spark the student's interest in this field.

Digital Agriculture: Problems and AI Challenges

INTRODUCTION

Digital agriculture leverages modern technologies to address challenges in farming, particularly in the context of climate change and water management. The expert lecture discussed the assessment of sentinel products for quantifying soil water status in agricultural systems, with a focus on understanding where water goes within these systems and the role of satellites in combination with AI to overcome the limitations of ground-based sensors .

CONTEXT AND OBJECTIVES

Water management is a critical concern in agriculture, especially under the influence of climate change. The primary objectives of this study include:

- Understanding Water Distribution: Analyzing where water goes in agricultural systems—through drainage, evaporation, photosynthesis, and transpiration—is essential for efficient water management.
- Managing Crop Water Use: Optimizing the distribution of irrigated water by understanding crop water requirements.
- Developing Spatial Methods: Creating methods to spatialize soil moisture content and crop water needs for better decision-making at both plot and territory scales.
- Leveraging Satellite Data: Using remote sensing data from satellites as a cost-effective alternative to installing expensive ground sensors.

The context of this study is particularly relevant to dry days, where efficient water management becomes even more crucial.

WHERE WATER GOES

Understanding where water goes within agricultural systems is fundamental to improving water management strategies:

- Drainage: Water that percolates through the soil and eventually drains away from the root zone.
- Evaporation: Water loss from the soil surface into the atmosphere.

- Photosynthesis: The process by which plants use water, carbon dioxide, and sunlight to produce energy.
- Transpiration: Water vapor loss from plants through stomata during respiration.

Accurately monitoring these pathways is vital for optimizing water use in crops, particularly under conditions exacerbated by climate change.

NEED FOR SATELLITE BASED MONITORING

Installing ground-based sensors to monitor soil moisture and other parameters is often prohibitively expensive, especially over large areas. Satellite-based remote sensing offers a more feasible solution, providing extensive coverage and frequent data updates. This approach is particularly useful in managing water resources during dry periods when water availability is limited.

MATERIALS AND METHODS

The assessment of sentinel products for quantifying soil water status involves several key steps:

1. Modeling Surface Soil Moisture and Water Stock:
    - Sentinel-1 and Sentinel-2 satellites provide crucial data for modeling surface soil moisture and estimating water stock within agricultural systems.
2. The Copernicus Program:
    - Sentinel-1: A radar imaging satellite, Sentinel-1 is sensitive to soil moisture, surface roughness, slope, and vegetation. However, it is only effective on non-cloudy days due to its reliance on radar signals.
    - Sentinel-2: An optical imaging satellite, Sentinel-2 focuses on monitoring vegetation health and land use. It captures imagery in multiple spectral bands, including green (G) and red (R), which are vital for assessing vegetation cover and health.
3. Data Processing and Analysis:
    - The data collected from these satellites is processed using advanced algorithms to generate accurate maps of soil moisture and vegetation status. These maps are then used to model water stock across different plots and regions.
4. Spatial Analysis:
    - Geographic Information System (GIS) tools are employed to spatialize the variability in soil moisture content and water crop needs, enabling more precise irrigation strategies and water management practices.

CHALLENGES AND FUTURE DIRECTIONS

While the use of sentinel products offers numerous advantages, several challenges remain:

- Weather Dependence: Sentinel-1's effectiveness is limited to non-cloudy days, which can be a significant drawback in regions with frequent cloud cover.
- Data Integration: Integrating data from multiple satellites and ground-based sources requires sophisticated processing techniques.
- Accessibility and Usability: Ensuring that the technology is accessible and user-friendly for farmers and agricultural managers is crucial for widespread adoption.

Future research should focus on improving the reliability and resolution of satellite data, enhancing data processing methods, and developing tools that are easily deployable in various agricultural contexts.

CONCLUSION

The assessment of sentinel products for quantifying soil water status is a critical component of digital agriculture, particularly in the context of climate change. By utilizing Sentinel-1 and Sentinel-2 satellites, along with advanced modeling techniques, it is possible to achieve more efficient and effective water management practices. This approach not only addresses the limitations of traditional ground-based sensors but also provides a scalable solution for monitoring large agricultural areas.