Report on Guest Lecture:

"Breast Cancer Analysis: Problems of Clinical Interest and AI Challenges"

Report by: - Mohit Lohani, 24901312

Date: 27th August 2024

Time: 10:00 AM

Venue: NKN Center, IT Building

Speaker: Dr. Amit Agarwal, Professor, Electrical & Electronics Engineering, Amrita Vishwa Vidyapeetham

1. Introduction

On 27th August 2024, a guest lecture titled "Breast Cancer Analysis: Problems of Clinical Interest and AI Challenges" was delivered by Dr. Amit Agarwal, a distinguished Professor of Electrical & Electronics Engineering at Amrita Vishwa Vidyapeetham. The event, held at the NKN Center, IT Building, was attended by students, faculty, and professionals interested in exploring the integration of artificial intelligence (AI) in healthcare.

2. Overview of the Topic

The lecture focused on the significant issue of breast cancer analysis, exploring both clinical challenges and the transformative potential of AI in enhancing early detection, diagnosis, and personalized treatment.

3. Summary of the Lecture

Dr. Agarwal began by explaining fundamental aspects of cancer, including:

1. **Failure of Apoptosis:** Disruption of programmed cell death, allowing unchecked cell proliferation.
2. **Failure of Signaling:** Abnormal cell signaling leading to uncontrolled cell growth.
3. **Hormonal Imbalance:** Hormones' role in cancer development, particularly in breast cancer.
4. **Failure of Mutation Before Transcription:** Inability to correct mutations before they are transcribed into RNA.

Breast Cancer Statistics

He noted that there are 5.4 million new breast cancer cases and 670,000 cancer deaths worldwide annually. In India, approximately 100,000 deaths occur each year due to breast cancer.

Dr. Agarwal also highlighted that breast cancer can affect men, accounting for 1-2% of cases. The average age of onset is 55 years for Caucasians and 45 years for Asians. Early detection of breast cancer has a success rate of 90-95%. He emphasized the rising rates of breast cancer in India and noted that breast cancer is extremely rare in fat tissue, with 90% of cancers found in the lobules.

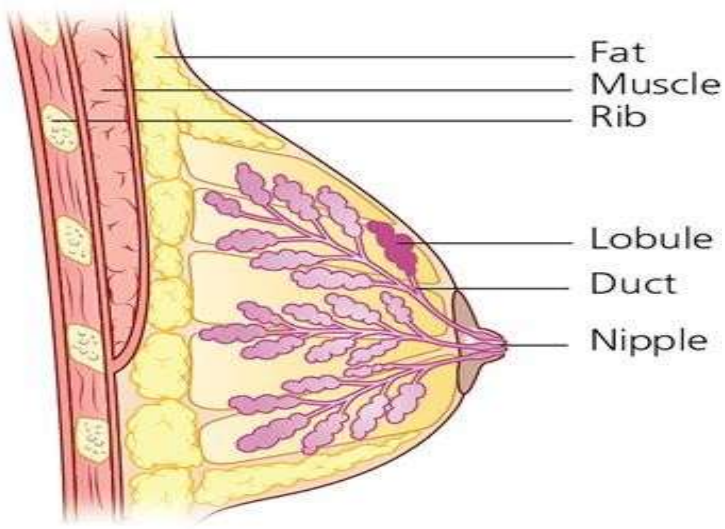

Fig. Breast Structure

Clinical Challenges in Breast Cancer Analysis

Dr. Agarwal emphasized the issue of **false negatives** in breast cancer diagnosis due to conditions such as **abscesses** and **fibroadenomas**. He outlined various screening modalities, including:

- **Self-assessment**
- **Clinical assessment**
- **Mammogram**
- **Ultrasound**
- **MRI**
- **Infrared Thermography** (used as an adjunct)

Applications and needs for AI in Breast Cancer

Dr. Agarwal highlighted several needs for AI in breast cancer analysis:

1. **Increase Throughput:** Enhancing outreach screening processes.
2. **Find What a Clinician Cannot:** Using structural measures instead of radiomics.
3. **Reduce Analysis Time:** Improving efficiency in biopsy analysis.
4. **Reduce Analysis Cost:** Utilizing cost-effective technologies like Infrared Thermography.

5. **Reduce Assessment Variability:** Improving consistency in ultrasound assessments.
6. **Multimodal, Multi-Energy, Imaging Fusion:** Integrating various imaging modalities and energies for comprehensive analysis.

Challenges in AI for Breast Cancer Analysis

Dr. Agarwal discussed several challenges in applying AI to breast cancer analysis:

1. **Explainable AI:** The need for AI systems to provide understandable and interpretable results.
2. **Poorly Labeled Data:** Challenges with the quality and accuracy of labeled datasets.
3. **Low Number of Labeled Datasets:** Limited availability of labeled data for training AI models.
4. **Poor Quality of Retrospective Data:** Issues with the reliability and completeness of historical data.
5. **Expensive to Acquire Prospective Data:** High costs associated with collecting new, forward-looking data.
6. **Computational Power Requirements:** Significant computational resources needed for data processing and analysis.
7. **A Common Vocabulary:** The necessity for standardized terminology across systems and disciplines.
8. **Clinician Engagement:** The importance of involving clinicians in the development and implementation of AI tools.
9. **Need for Multiresolution Analysis:** The requirement for analyzing data at multiple resolutions for comprehensive insights.

Ongoing Projects

Dr. Agarwal concluded the lecture by discussing several ongoing projects in breast cancer research:

1. **Clinical Assessment of Infrared Thermography as an Adjunct Breast Screening Modality:** Evaluating the effectiveness of Infrared Thermography in breast cancer screening.
2. **Non-Invasively Assess NAC Response from Longitudinal Images and Clinical Risk Factors:** Developing methods to evaluate the response to Neoadjuvant Chemotherapy (NAC) using longitudinal imaging and clinical risk factors.
3. **Validation & Recalibration of MIRAI Personalized Screening Model:** Ensuring the accuracy and effectiveness of the MIRAI personalized screening model.
4. **Breast Density Estimation Model:** Creating models to estimate breast density, which is a significant factor in cancer risk.
5. **Non-Invasively Assess Tumor Aggressiveness & Natural History:** Developing methods to evaluate tumor aggressiveness and its natural history without invasive procedures.

6. **Predicting Cumulative Probability & Sentimental Organ of Systemic Failure:** Predicting the likelihood of systemic failure and its impact on related organs.
7. **ROI and Segmentation Analysis:** Performing region-of-interest (ROI) and segmentation analysis to improve diagnostic accuracy and treatment planning.

4. Interactive Session

During the interactive session, Dr. Agarwal addressed questions about the practical implementation of AI in clinical settings, its potential to reduce diagnostic errors, and future prospects in healthcare AI.

5. Personal Reflections

The lecture provided valuable insights into the role of AI in addressing breast cancer's clinical challenges. Dr. Agarwal's discussion on the biological, environmental, and clinical aspects of cancer, alongside the transformative potential of AI, was particularly enlightening.

6. Conclusion

Dr. Amit Agarwal's lecture on "Breast Cancer Analysis: Problems of Clinical Interest and AI Challenges" was a profound exploration of AI's potential in healthcare. It underscored the importance of technological innovation in improving patient outcomes while addressing the ethical and practical challenges associated with AI integration.

Report on Guest Lecture:

" Digital Agriculture: Problems and AI Challenges"

Report by: - Mohit Lohani, 24901312

Date: 27th August 2024

Time: 02:00 PM

Venue: NKN Center, IT Building

Speaker: Dr. Amit Agarwal, Professor, Electrical & Electronics Engineering, Amrita Vishwa Vidyapeetham

1. Introduction

On 27th August 2024, Dr. Amit Agarwal, a leading Professor of Electrical & Electronics Engineering at Amrita Vishwa Vidyapeetham, delivered an insightful lecture on "Digital Agriculture: Problems and AI Challenges." The session, held at the NKN Center, IT Building, was a deep dive into the intersection of AI and agriculture, addressing contemporary challenges and proposing innovative solutions.

2. Overview of the Lecture

Dr. Agarwal covered various aspects of digital agriculture, from the effects of climate change on crop management to the utilization of advanced satellite technology for monitoring agricultural conditions.

3. Summary of the Lecture

INRAE and Climate Change

Dr. Agarwal began by discussing the role of the **French National Institute for Agriculture, Food, and Environment (INRAE)** in advancing agricultural research. He emphasized the need to address the challenges posed by **climate change**, particularly the increasing number of dry days, which severely impacts water availability for crops.

Water Management for Crops

He highlighted the critical need for effective **water management** strategies to counter the adverse effects of climate change. The sharp increase in dry days necessitates innovative approaches to optimize water use in agriculture.

The Copernicus Program: Sentinel 1 & 2

Dr. Agarwal introduced the **Copernicus Program** and its key satellites, **Sentinel 1** and **Sentinel 2**:

- **Sentinel 1:** Equipped with radar bands, it operates on a 6-day cycle and provides crucial data on soil moisture and crop conditions with a 10-meter pixel resolution.
- **Sentinel 2:** -Also, with a 5-day cycle, this satellite offers optical imaging to assess crop health and environmental conditions, complementing the data from Sentinel 1.

These satellites are instrumental in monitoring and managing agricultural practices by providing real-time data crucial for decision-making.

Theia S2MP Soil Moisture Product

Dr. Agarwal discussed the **Theia S2MP soil moisture product**, which provides an average value per plot and is designed to:

1. **Assess Precision:** Evaluate the precision of S2MP under operational conditions across diverse agricultural plots, particularly where NDVI (Normalized Difference Vegetation Index) is less than 0.75.
2. **Manage Water Use:** Better manage water resources, particularly in irrigated areas facing local tensions over severe water use.
3. **Optimize Irrigation:** Understand crop water requirements and optimize the distribution of irrigation water.

He emphasized the need to develop methods that spatialize the variability of soil moisture content and crop water needs, aiding decision-making at both plot and territory scales.

4. Research Protocols and Methodologies

Materials and Methods: Research Protocol

Dr. Agarwal outlined the research protocol, which involves **continuous soil moisture measurement** in orchards using capacitive probes at different depths. This is critical for understanding soil moisture dynamics and managing water resources effectively.

Modeling Surface Soil Moisture and Water Stock

To model surface soil moisture and water stock, the following steps were highlighted:

1. **Linear Regression with Variable Selection:** Using stepwise regression with Sentinel 1 (VV, VH, ZA) and Sentinel 2 (FCover, RI).
2. **Machine Learning Methods:** Utilizing Random Forest and Support Vector Machines (SVM) with Sentinel 1 SWI (1Km) and Sentinel 2 Rainfall data from local stations.

The variables to be predicted include ground measurements (daily), water stock (0-50cm), and surface soil moisture. Currently, the models are trained with a balanced 50-50 approach.

5. Interactive Session

The lecture concluded with an interactive session, where attendees engaged in discussions on the practical applications of AI in agriculture, the challenges of data accuracy and availability, and the future potential of these technologies. He talked about How areas of Assam can be benefitted by this research.

6. Conclusion

The lecture by Dr. Amit Agarwal was a thought-provoking exploration of how AI can revolutionize agriculture, particularly in the face of climate change. His insights into the application of satellite technology and machine learning in agricultural practices underscored the potential for significant advancements in this critical sector.