Niramai

Using Technology to Save Lives

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Founder, CEO and CTO
NIRAMAI Health Analytix

DATAHACK SUMMIT 2019

Breast cancer - leading cause of cancer deaths in women

1 in 17

Women develop a breast abnormality in their lifetime

500,000

Deaths per year

Survival rates in India and many developing countries is just 50%

Early Detection is key to survival!

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There are Several Hurdles for Early Detection today

2 Billion **Women >25 years need screening**

Cost $

Equipment cost and end user price

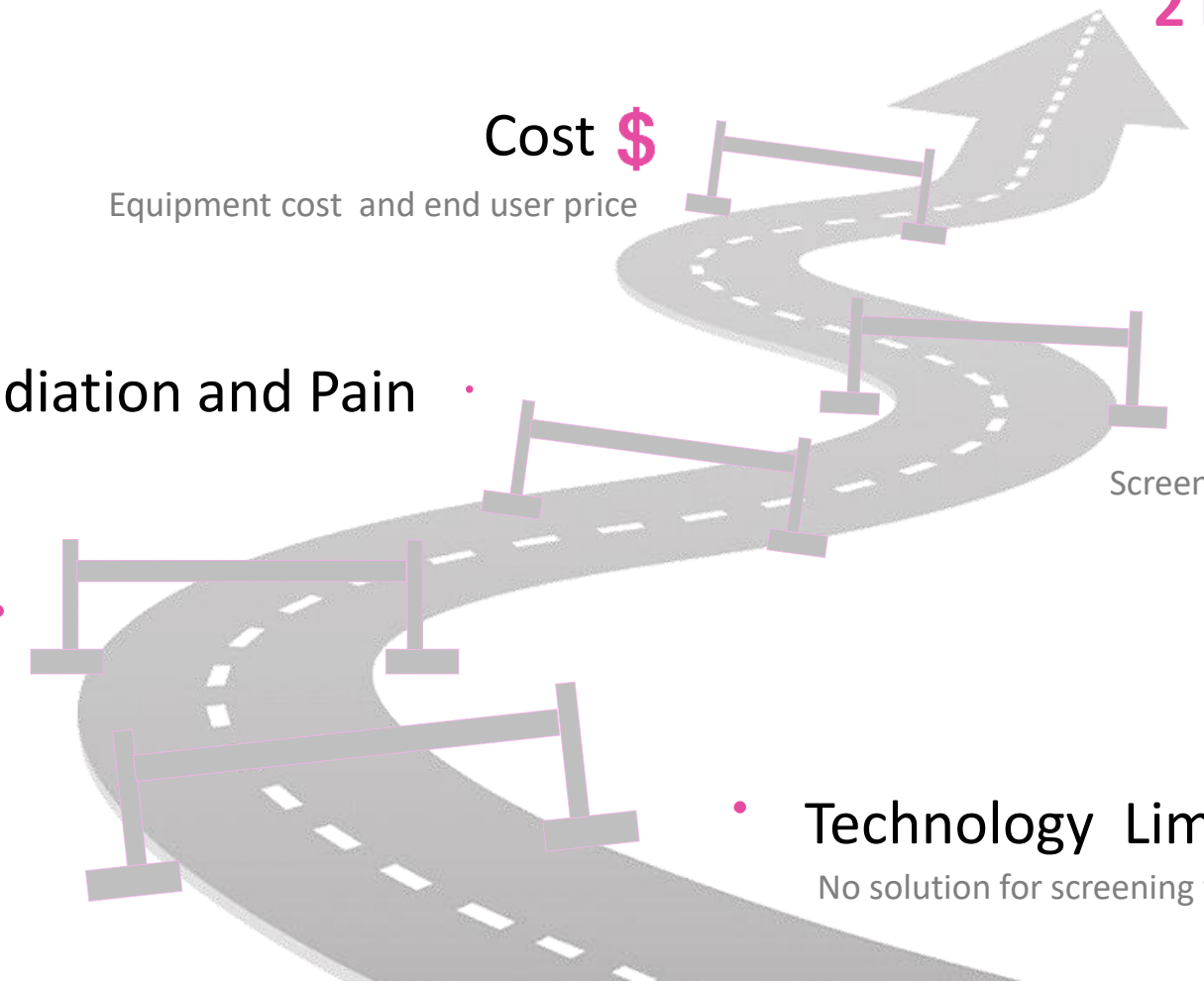
Radiation and Pain

Accessibility

Screening facility only in tier1 and tier 2 cities

Accuracy

Lump ≠ malignancy



Technology Limitation

No solution for screening younger women and women with dense breasts

Less than 200 Million **Women being screened today**

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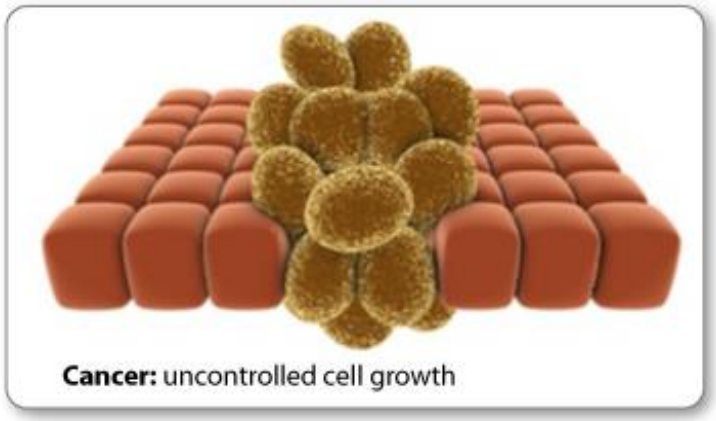
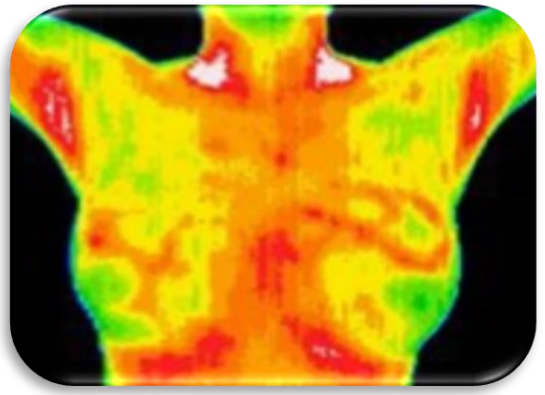
Thermography can detect cancer much earlier than any other modality

Thermography measures infra-red radiation from the body generated due to heat





FDA Approved Adjunct modality for cancer screening

>500

Thermography clinics in US

Limitation of Manual Thermography:

- **Interpretation errors**
- **Subjective Analysis**
- **Cognitive Overload**

(400,000 color pixels of 2000 shades)

Thermalytix© by Niramai

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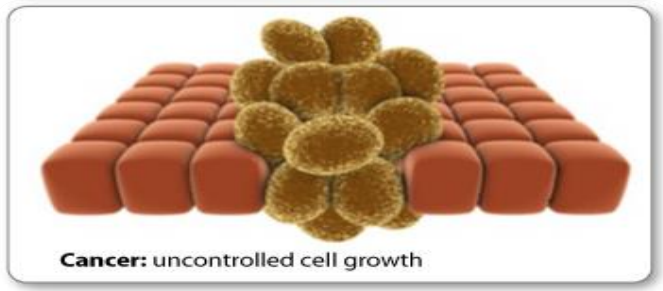
Thermalytix® by NIRAMAI

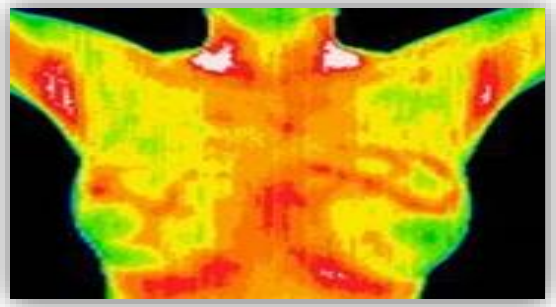
A Novel Fusion of Machine Intelligence + Thermography

9 US patents granted
More patents pending



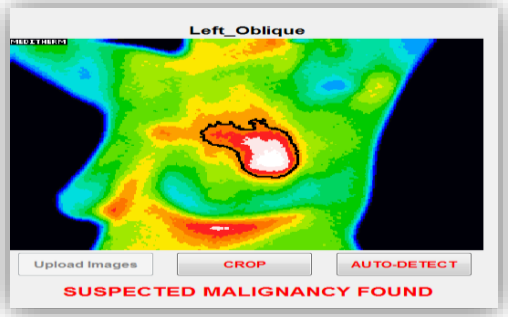
- ✓ Highly Sensitive
- ✓ Early Detection

Thermal Sensor



- ✓ Portable
- ✓ Safe
- ✓ Non-invasive

Machine Intelligence



NIRAMAI Software

- ✓ Automated
- ✓ Real time
- ✓ Affordable
- ✓ Accurate

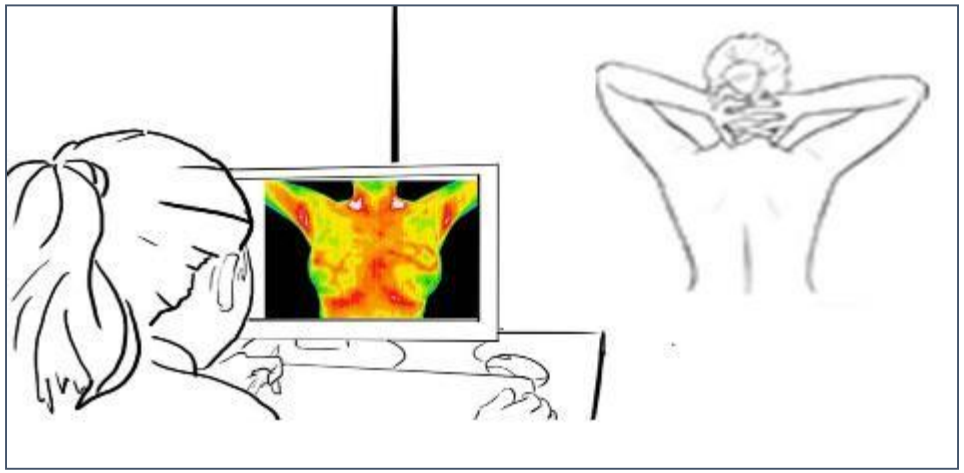
Instead of looking for lumps, we look for cancer.

NIRAMAI Solution

Privacy-Aware, Early Stage Breast Cancer Detection

- Can detect cancer long before a lump is felt
- Non-contact, Non-invasive, Privacy Aware
- No Radiation
- Works for women of all ages, and men too!
- Affordable
- Portable, light, small screening device

Powered by Machine Learning



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50+ Hospitals and
Diagnostic Centres

Corporate Camps

Rural Outreach

500+ Outreach Camps

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Watch this video on here

Thermo-Mammography Report

GENERAL DETAILS

Patient ID: [redacted]149 Gender: Female Age: 57

Scan Date: 08/09/2018 Centre: [redacted]

CLINICAL DETAILS

Menopause: Yes. Age at Menopause: 46 years.

Lactating: No. Pregnant: No. Number of children breast-fed: 2

Patient Complaints: None.

Cancer History: No patient cancer history. No family cancer history.

Surgeries: None.

Hormone Therapy: None.

THERMAL ANALYSIS

Thermobiological Score: **0.25**

Body Temperature: 34.59 °C to 26.54 °C

Symmetry Score: 0 % Areolar Score: 0.66 Vascular Score: 0.75

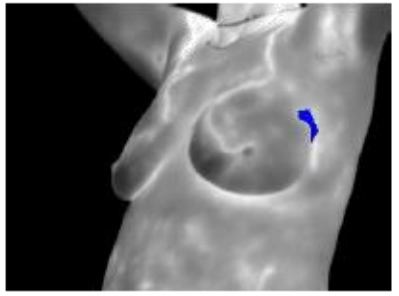
FINAL IMPRESSION

Breast Thermal Impression

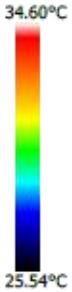
Right Breast: No significant thermal pattern is seen.

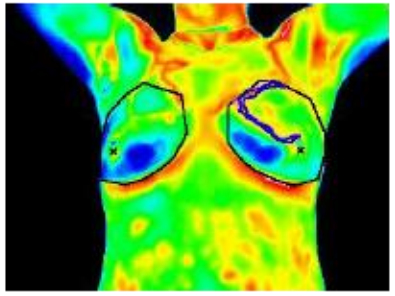
Left Breast: Focal thermal pattern is noted. Thermal increase is seen near areolar region. Slightly distorted and smooth margins are observed. Asymmetrical thermal pattern is observed.

THERMAL PARAMETERS	RIGHT BREAST	LEFT BREAST
Number of Hotspots	**0**	**1**
Extent	**N/A**	**Hot spots seen in 0.0198% of region of interest.**
Hotspot Shape	**N/A**	**0.65 irregular, 579μ distorted**
Temperature	**N/A**	**1.87°C increase wrt surrounding region**
Areolar Hotspot Detected	**No**	**Yes**
Lump Detected	**N/A**	**N/A**

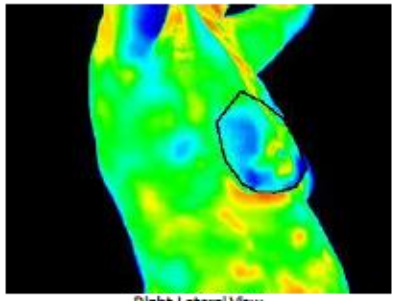


Best View (Grayscale)

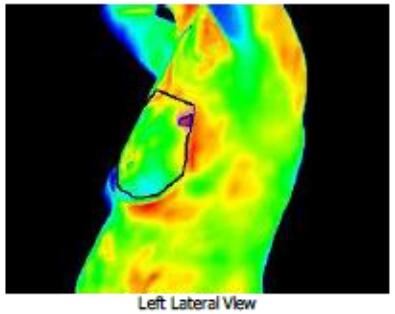




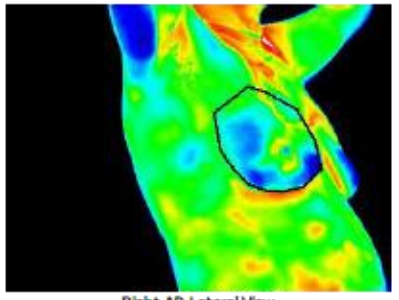
AP View



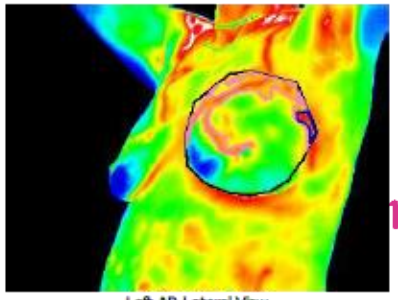
Right Lateral View



Left Lateral View



Right AP-Lateral View



Left AP-Lateral View

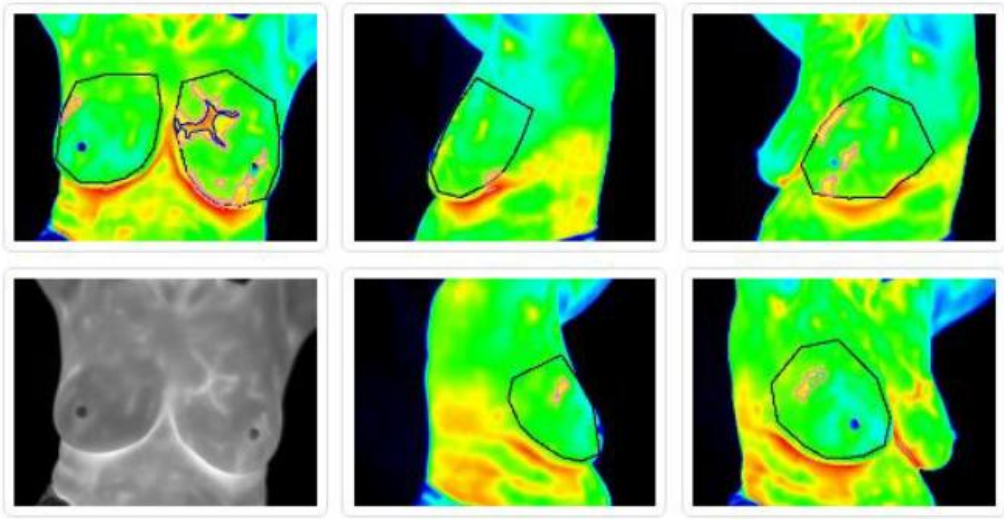
Realtime Automated Screening

THERMAL ANALYSIS

Thermobiological Score: 0.61

Follow up with U/S recommended in left breast

Body Temperature:	35.07 °C to 23.73 °C
Symmetry Score:	0 %
Areolar Score:	0
Vascular Score:	0.64



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Our ML Journey …

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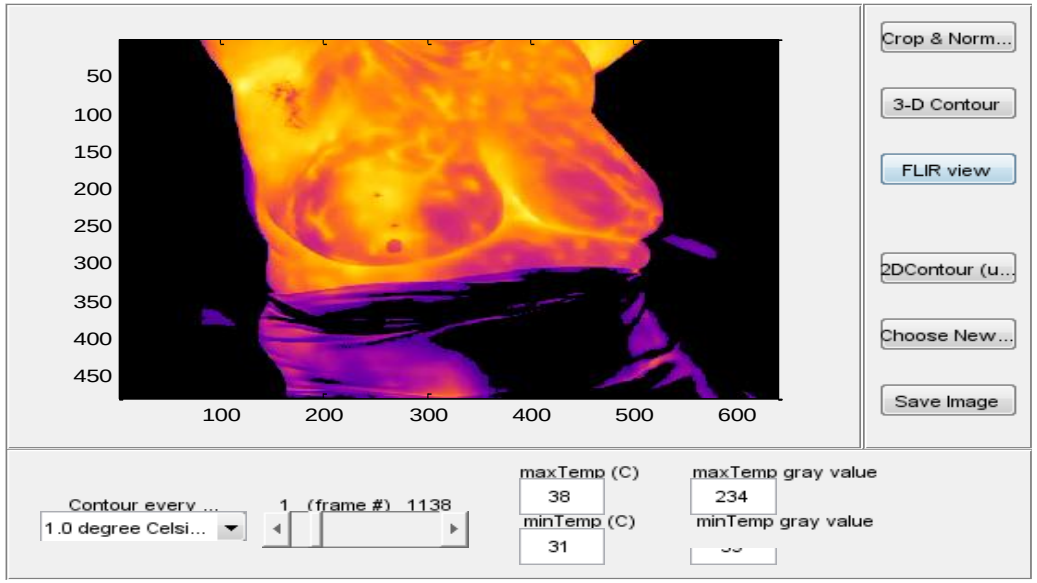
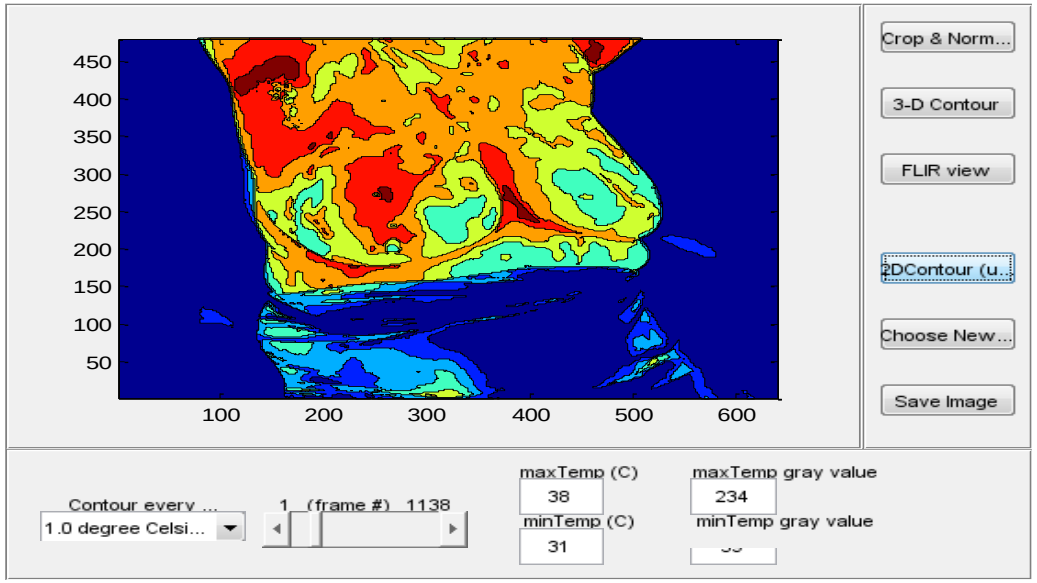
Early Version of the Tool Set (2015)





1. Captured Thermal Video Images
2. Obtained isotherms and localize temperature boundaries.
3. Used by Radiologists to identify hot areas
4. Correlate with Mammogram findings.
5. Understand corresponding thermal patterns

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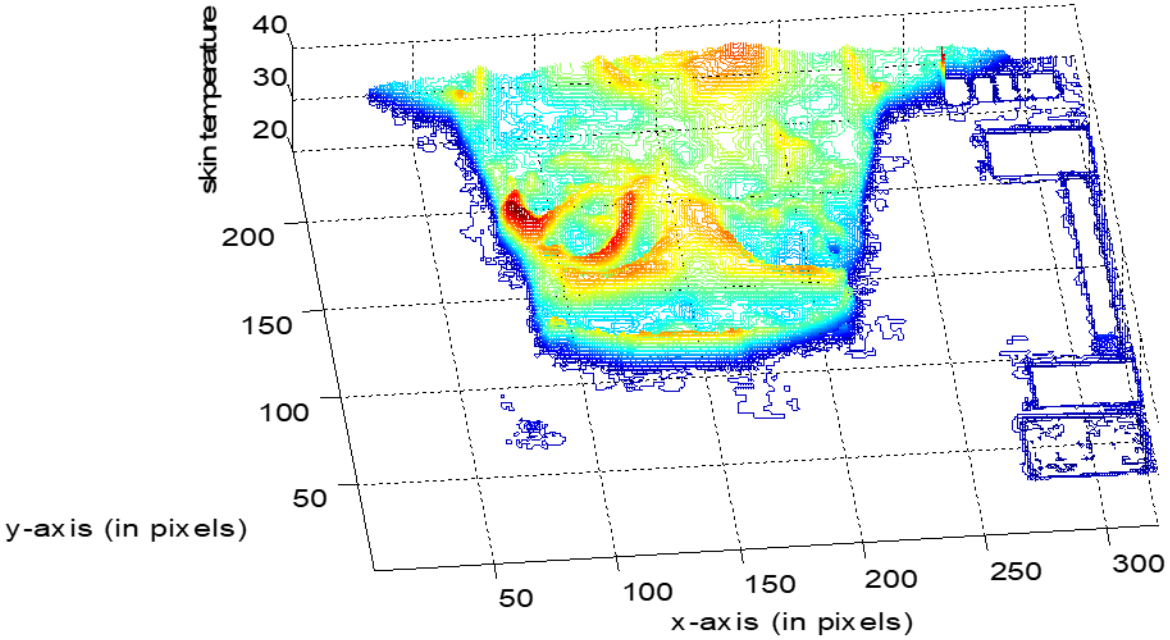
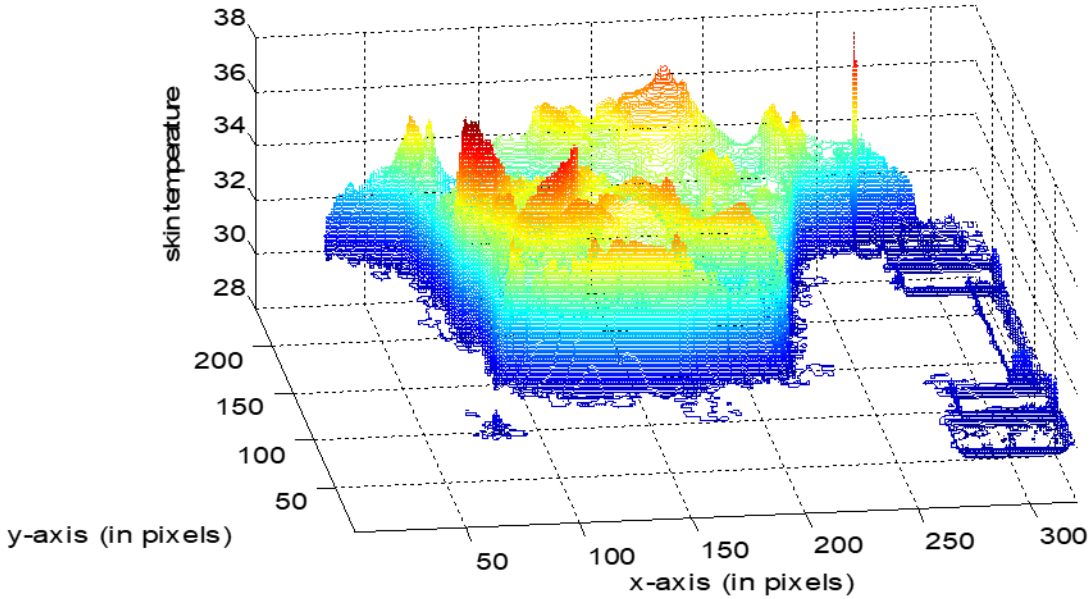
Early Version of the Tool Set (2015)

A 3-D heat map of the skin temperature (intensity)





The asymmetry in the heat map, with a very warm area evident in the upper right quadrant of right breast.

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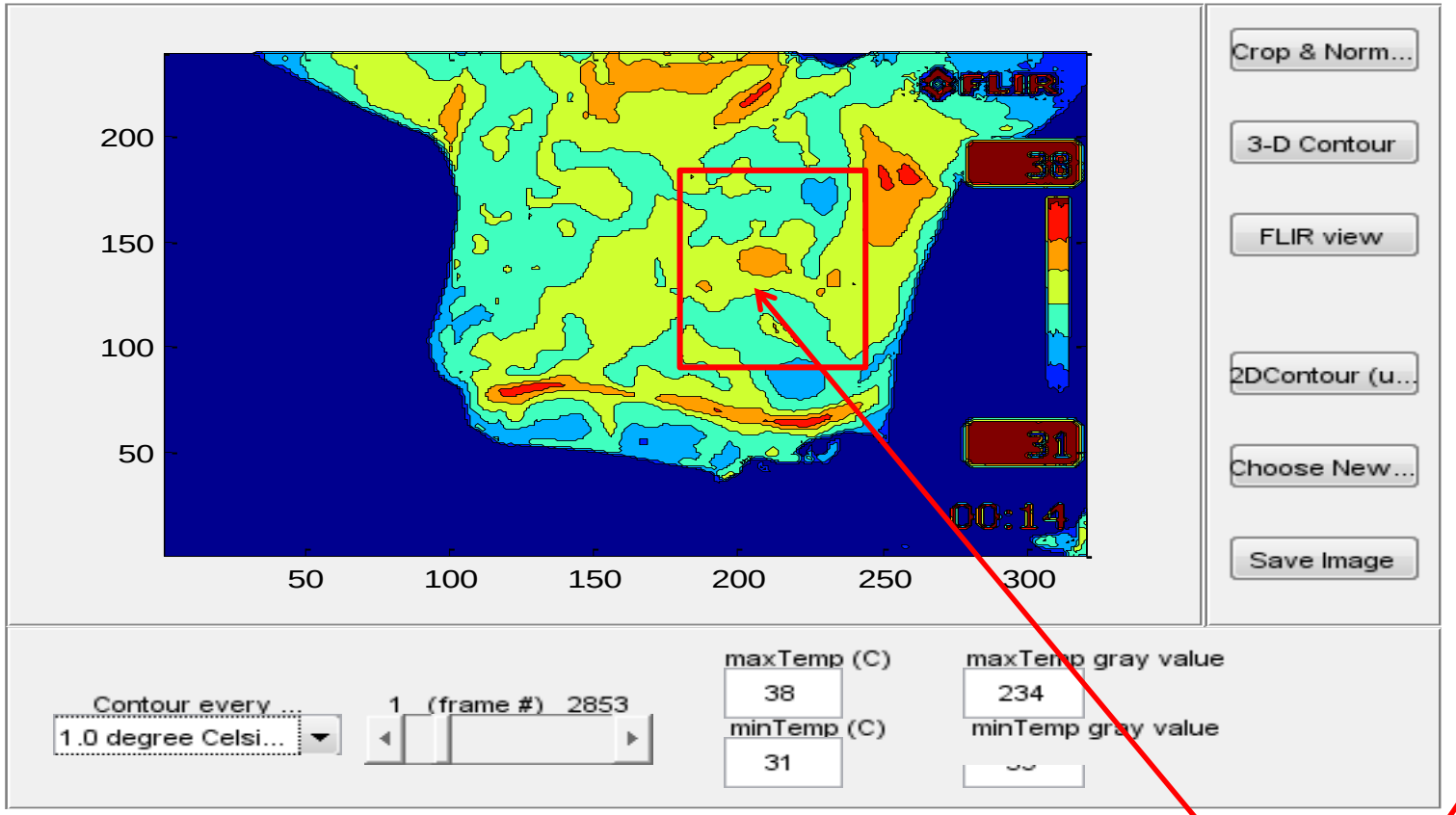
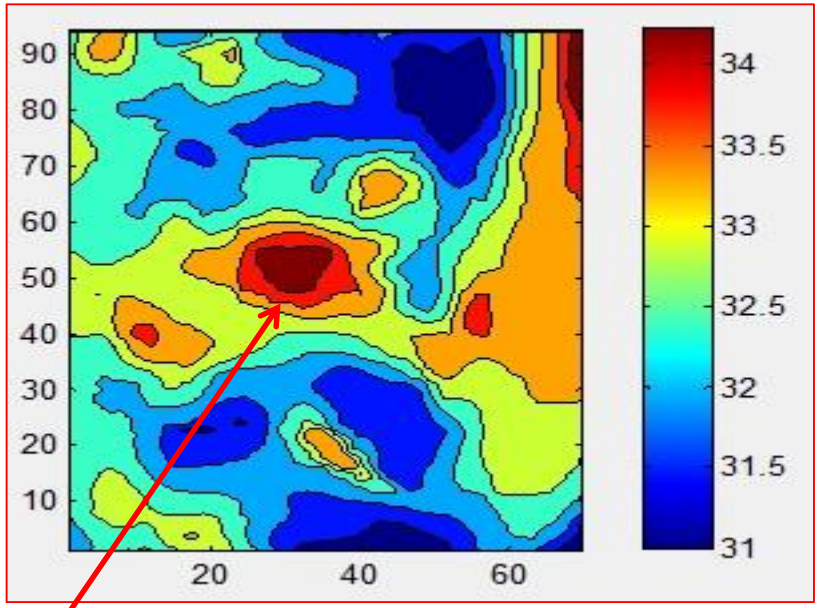
Studied Thermographic patterns in different subject categories

Thermal profiling & examination of suspicious regions





7 isotherms

Detected lump b/w 10 to 12 O'clock position. Matches with clinical findings, mammogram and sonomammogram findings.

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Thermographic Features Extracted (as presented at EMBC 2016)

Non-Vascular Features

- **Boundary Features:** Deviation from Circle and Ellipse, Irregularity and Fractal Dimensionality, Shape Symmetry
- **Contralateral-side comparison:** Mirror Overlap, Thermal Distribution Ratio and Area Difference.
- **Relative Temperature** to surrounding tissues.
- **Warm and hot patches**:: Number, Size, Location

Vascular Features

- Tortuosity
- Vessel Length,
- Mean Temperature
- Vessel width
- No. of branches, mean branch length
- Symmetry of vessels.

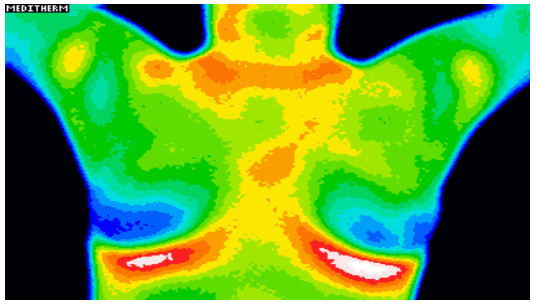
Clinical Features

- Age
- Past Cancer History, Family cancer history and degree of relationship,
- Presence of lumps
- Menarche age
- Menopause
- Lactating
- Past surgery.

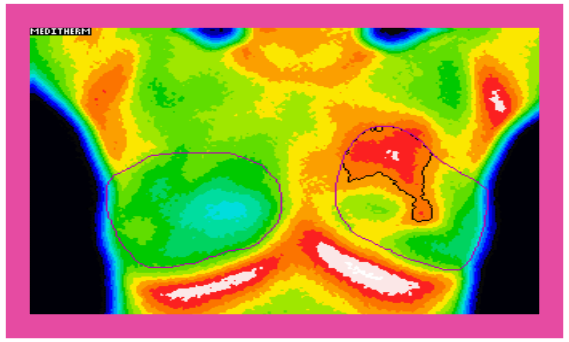
The Core Innovation

Ability to differentiate malignancy from benign conditions

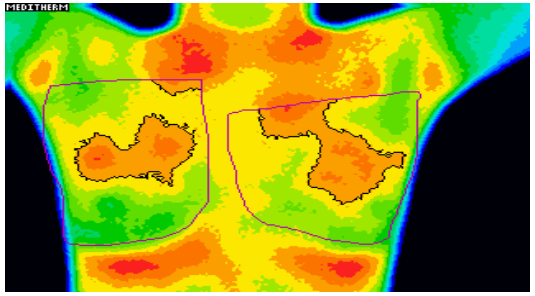
9 US patents granted, more pending



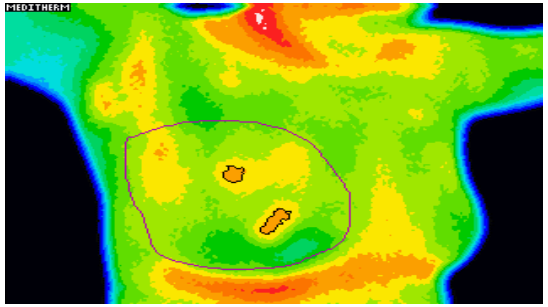
Normal Lady



A Lady with Breast Cancer



A Lady with Hormonal Activity

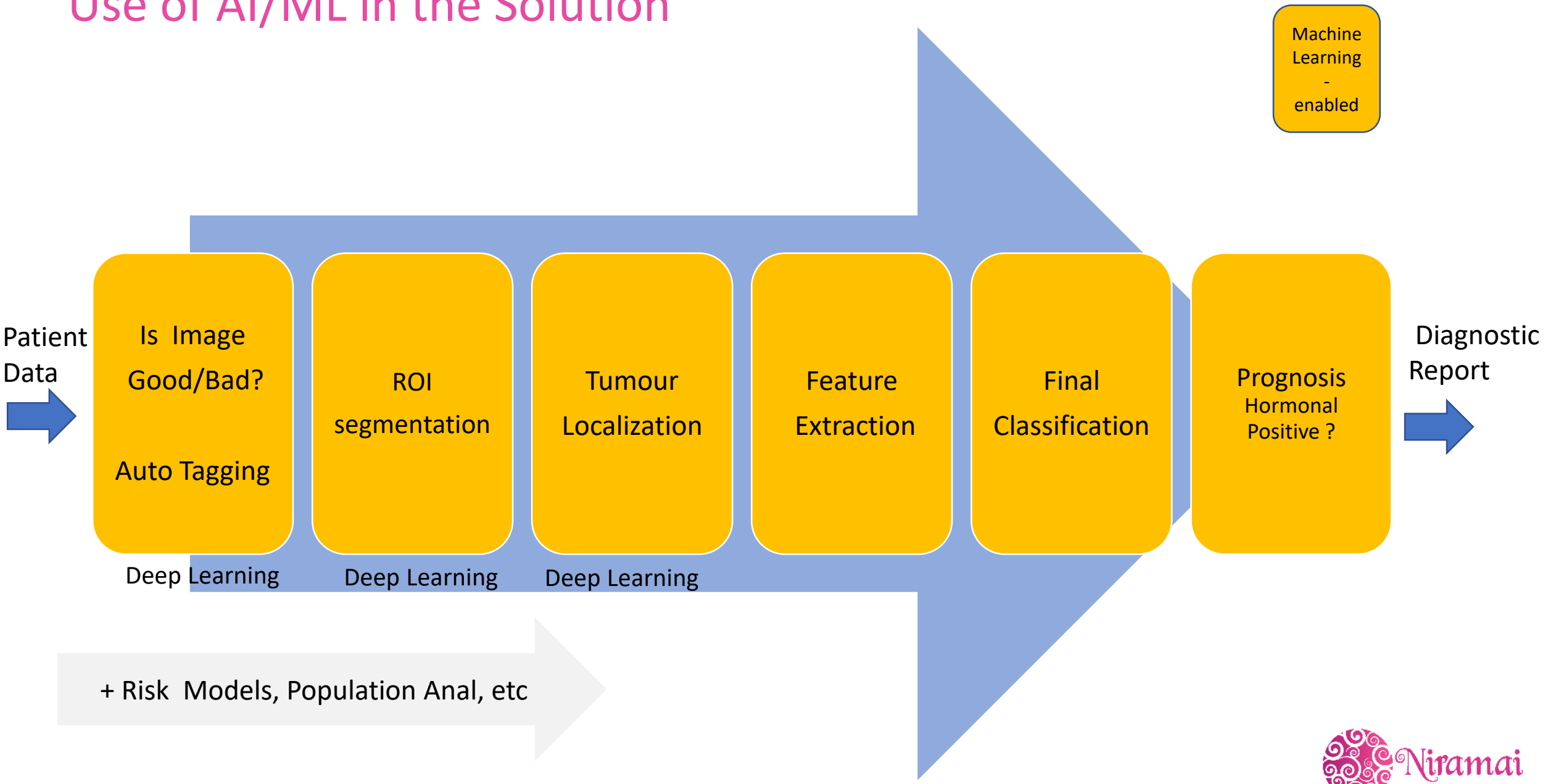


A Lady with a Cyst

Machine Learning and Computer Vision Algorithms to detect early stage cancer

- Demography Data
- Asymmetric Patterns
- Thermal Distribution
- Vascularity Analysis
- Hotspot Boundary
- Hotspot Shape Characteristics

Use of AI/ML in the Solution



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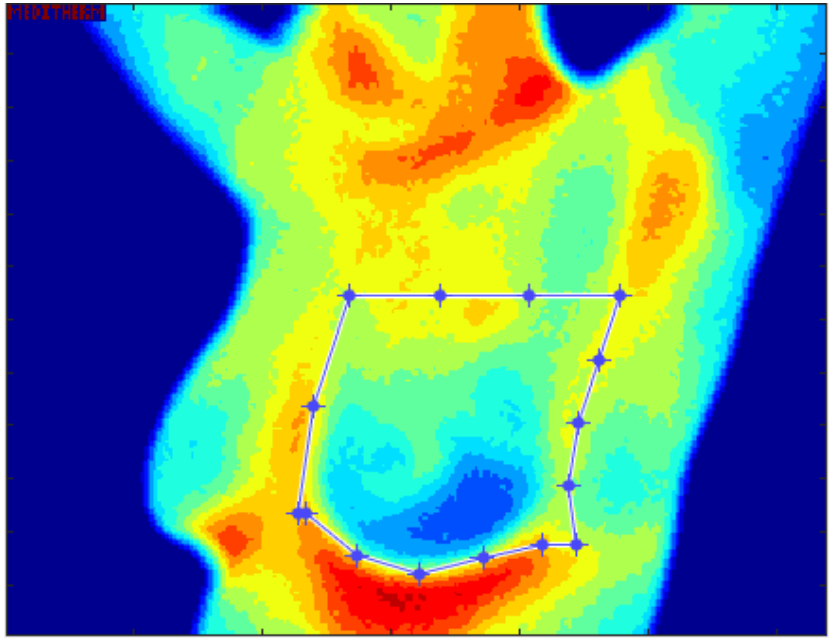
ROI Segmentation with Image Processing



- Though reasonably good results are achieved when imaging protocol is followed, testing on a real-world scenario resulted in
  - 75% accuracy in tagging the views.
  - 70% dice similarity with the actual manual segmentation.
- Results were highly dependent of imaging protocol due to the use of low-level features.

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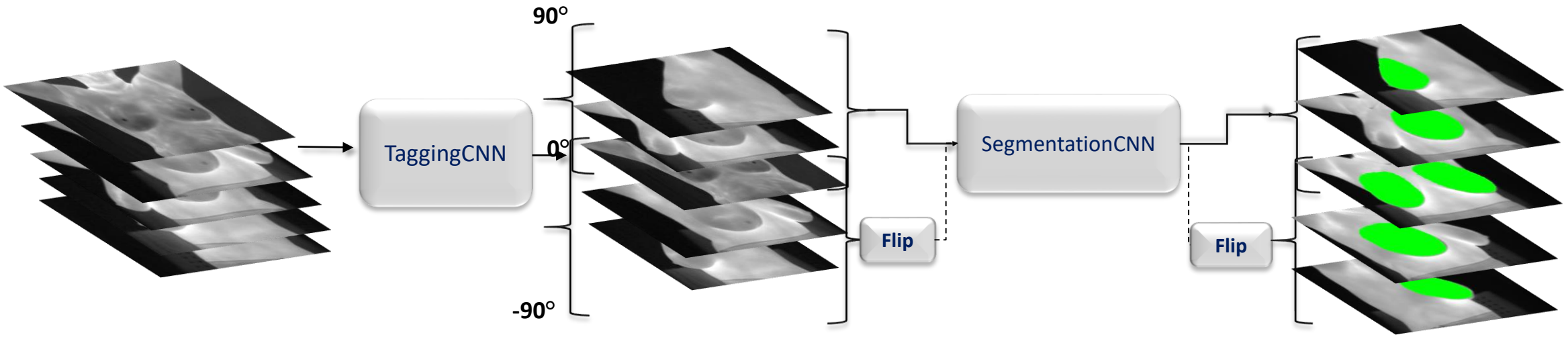
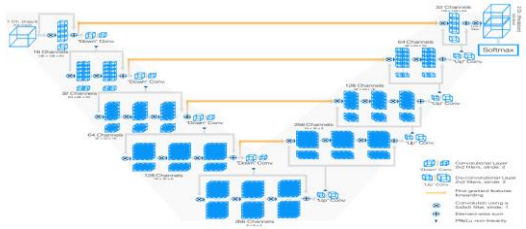
Modified Approach with CNN



Tagging with Resnet

Segmentation with V-Net



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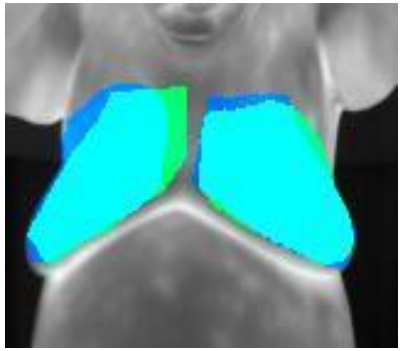
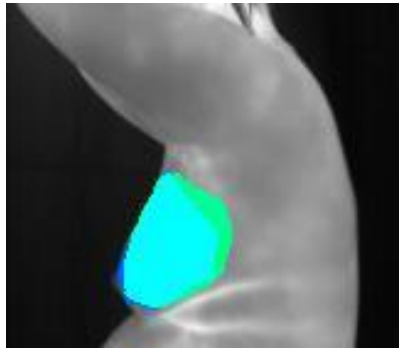
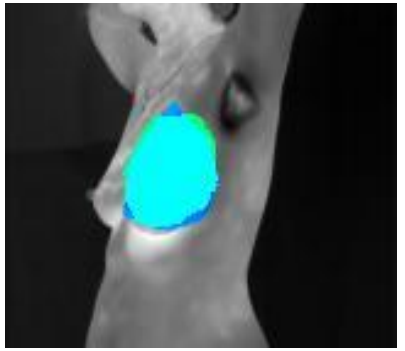
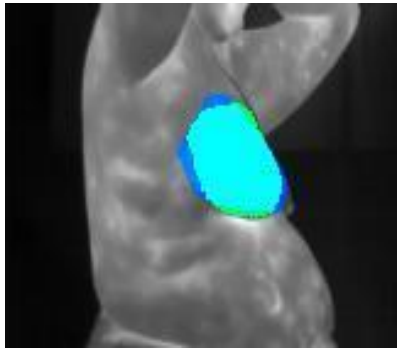
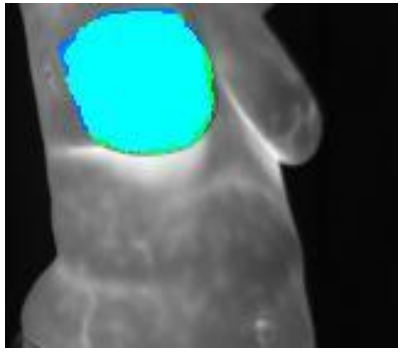
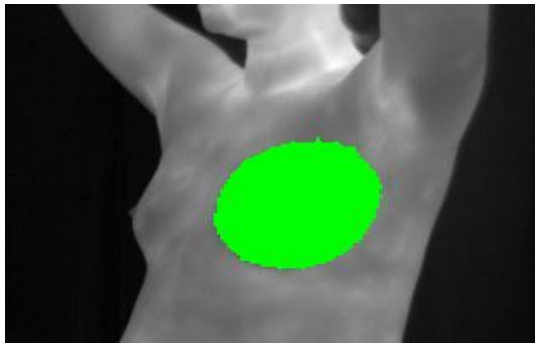
Results with DNNs

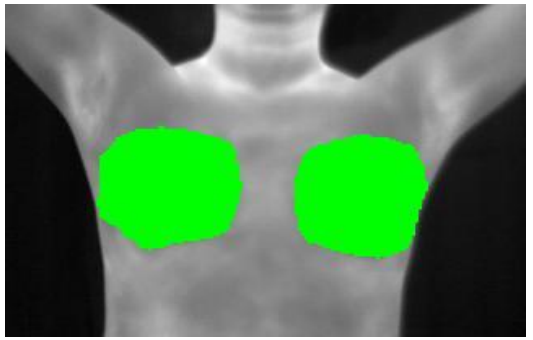
- View Independent
- Robust to position errors
- Highly precise segmentation boundaries

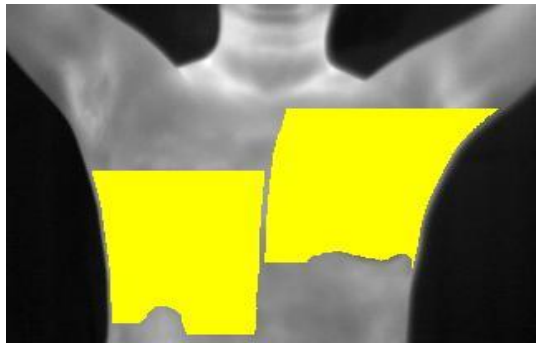



- 99.5% accuracy in Tagging
- 0.92 Dice similarity for segmentation.


DNN segmentation


heuristic based


DNN segmentation


heuristic

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Granted US Patent and Applications

	Patent ID	Title	Grant Date
1	US-9486146-B2	Detecting tumorous breast tissue in a thermal image	08-11-2016
2	US-9622698-B2	System and method for detecting cancerous tissue from a thermal image	18-04-2017
3	US-9865052-B2	Contour-based determination of malignant tissue in a thermal image	09-01-2018
4	US-9898817-B2	Software tool for breast cancer screening	20-02-2018
5	US-10055542-B2	Software interface tool for breast cancer screening	21-08-2018
6	US-10068330-B2	Automatic segmentation of breast tissue in a thermographic image	04-09-2018
7	US-10198670-B2	Blood vessel extraction in two-dimensional thermography	05-02-2019
8	US-10307141-B2	Thermography-based breast cancer screening using a measure of symmetry	04-06-2019
9	US-10368846-B2	Classifying hormone receptor status of malignant tumorous tissue from breast thermographic images	06-08-2019
10	US-2017245762-A1	Privacy booth for breast cancer screening	Pending Grant in US
11	New Application	System and Method for Adaptive Positioning of a subject for capturing thermal image	Pending
12	New Application	System and Method for Identifying errors in Positioning of a subject for capturing thermal image	Pending

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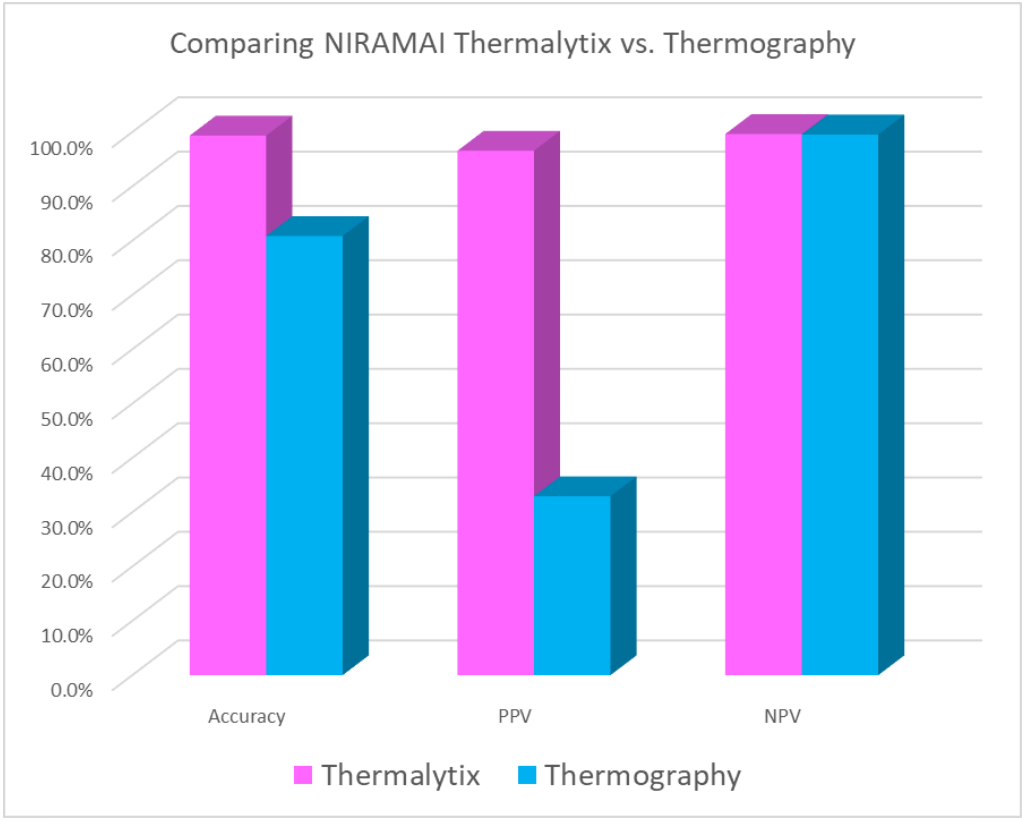
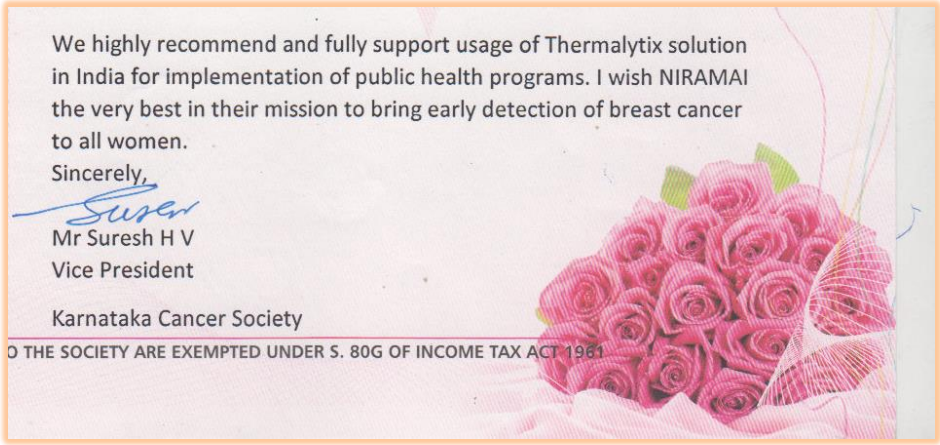
Clinical Validation

16000+ patients tested so far…

- 5 International Clinical Trial Publications
- 27% better Accuracy than Mammography
- 70% better predictive value than manual Thermography
- Identified all cancer patients without lumps
- Effective in 32% more patients than Mammography





HCG adding life to years — The Specialist in Cancer Care

Narayana Health

Anjana Diagnostics

Niramai

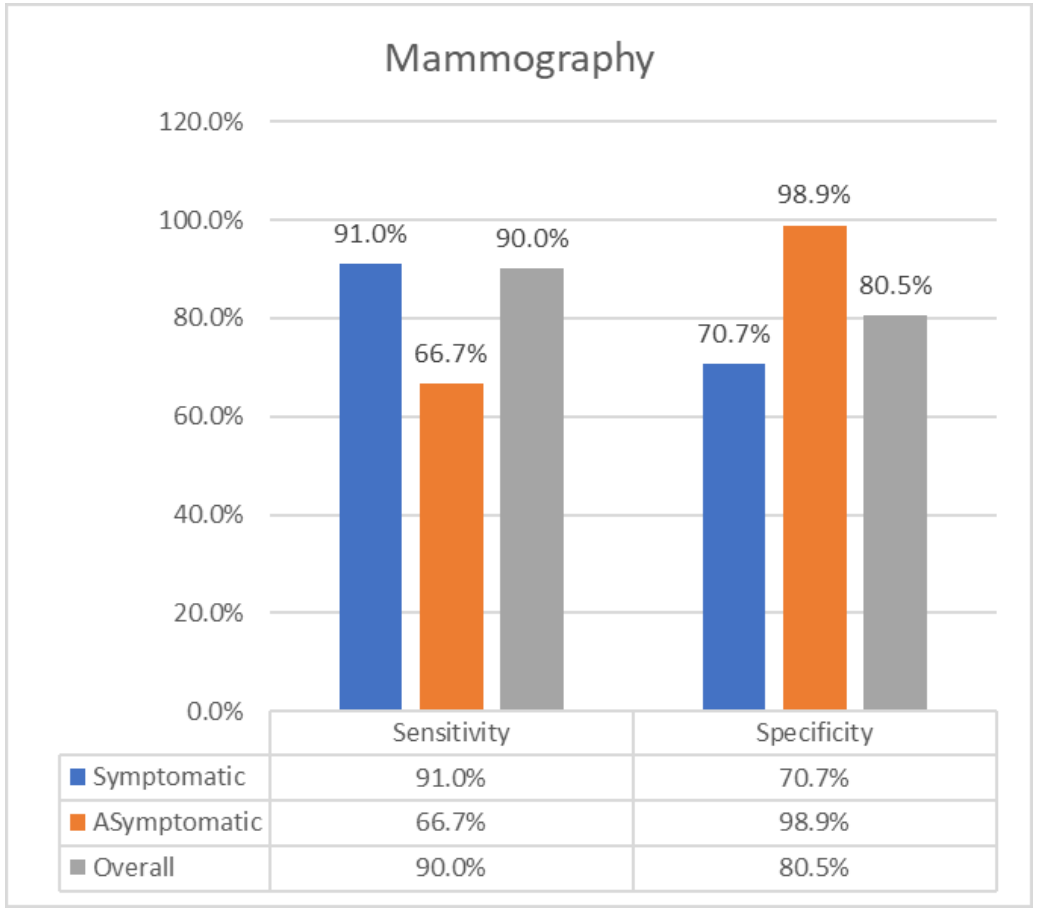
Results Published in ASCO Breakthrough Summit, Oct 2019

Abstract Title: AI for early stage breast cancer screening.
Breakthrough: A Global Summit for Oncology Innovators (October 11-13, 2019) in Bangkok

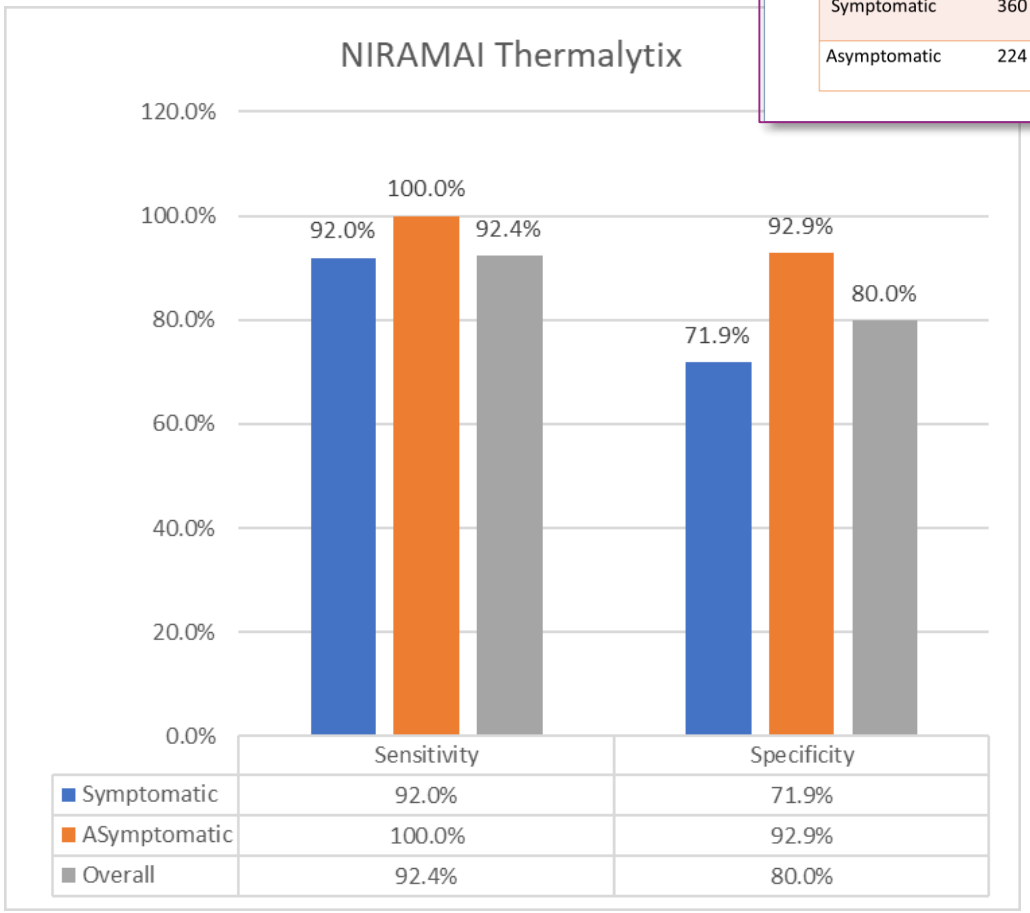
Dataset Description

- Out of 769 subjects, 185 subjects were concluded to have a breast malignancy by the radiologists at the respective sites.
- 100 out of these 185 were histopathologically confirmed malignancies.

	Normal	Malignant
Symptomatic	360	174
Asymptomatic	224	11



	Sensitivity	Specificity
Symptomatic	91.0%	70.7%
ASymptomatic	66.7%	98.9%
Overall	90.0%	80.5%



	Sensitivity	Specificity
Symptomatic	92.0%	71.9%
ASymptomatic	100.0%	92.9%
Overall	92.4%	80.0%

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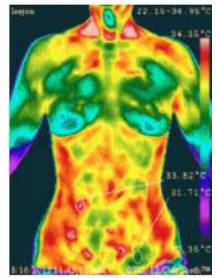
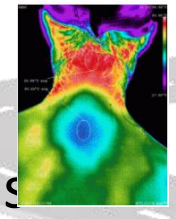
Beyond Breast Cancer

Creating a Whole New Way of Detecting abnormalities in the body



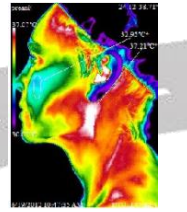
Whole Body Scan

Pain Management

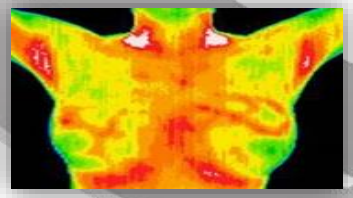


Sports Injuries

Diabetic Foot



Head and Neck Cancer

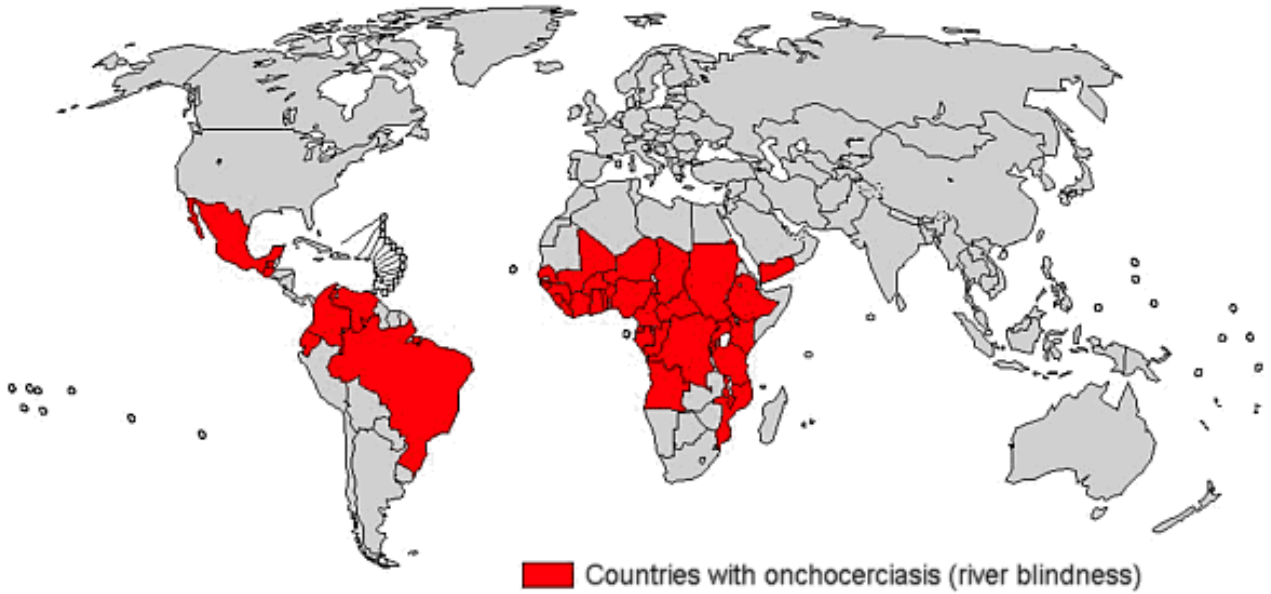


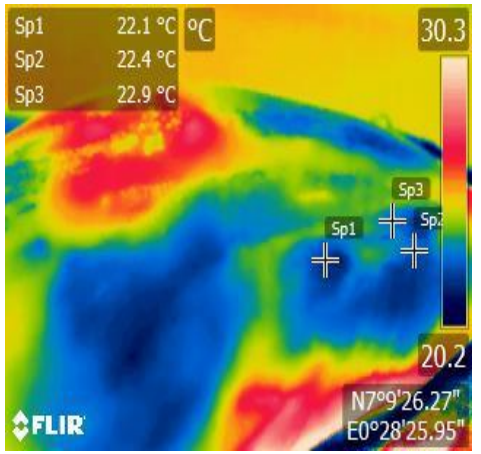
Breast Health

Breast Cancer Screening

Niramai

Thermalytix for River Blindness - Onchocerciasis





BILL & MELINDA GATES foundation

Thermalytix enables a Non-invasive way of detecting Live Parasitic Worms

Niramai

Awards and Media Mentions

Bill & Melinda Gates foundation

Amazon AI Conclave

Winner of AI Award Healthcare

2nd Indian Cancer Congress — AROI ISO IASO ISMPO — ICC 2017 08-12 Nov Bengaluru

Top Cancer Startup

Graham Bell Award in Data Science

NVIDIA INCEPTION PROGRAM

PHILIPS HealthWorks

HackOsaka 2019

Gold Prize Winner

BNP Best Preventive Insurance Idea

Google Developers Launchpad Accelerator

These Four Indian Startups Are Revolutionizing How To Detect Cancer

Forbes

AI healthcare startup Niramai raises $6M Series A funding led by Dream Incubator

YOURSTORY

Philips HealthWorks bets on 4 Indian startups for its accelerator programme

Amazon AI Awards 2017: Recognising the future of AI

HEALTH TECH

Fighting breast cancer with AI & ML

Niramai's Thermalytix screens patients for breast cancer, overcoming the limitations posed by mammography or ultrasound

SANDHYA MICHU

BENGALURU-BASED NIRAMAI'S break-

expert radiologists ; rollout. "The first big was the funds needed tual property since th oped by us when we w previous organisatic seed round within th to ensure that Niram Manjunath recalls. Dr. Sudhakar, brea HCG, a leading cance chain which uses Ni diagnosis of breast patients, sees immer

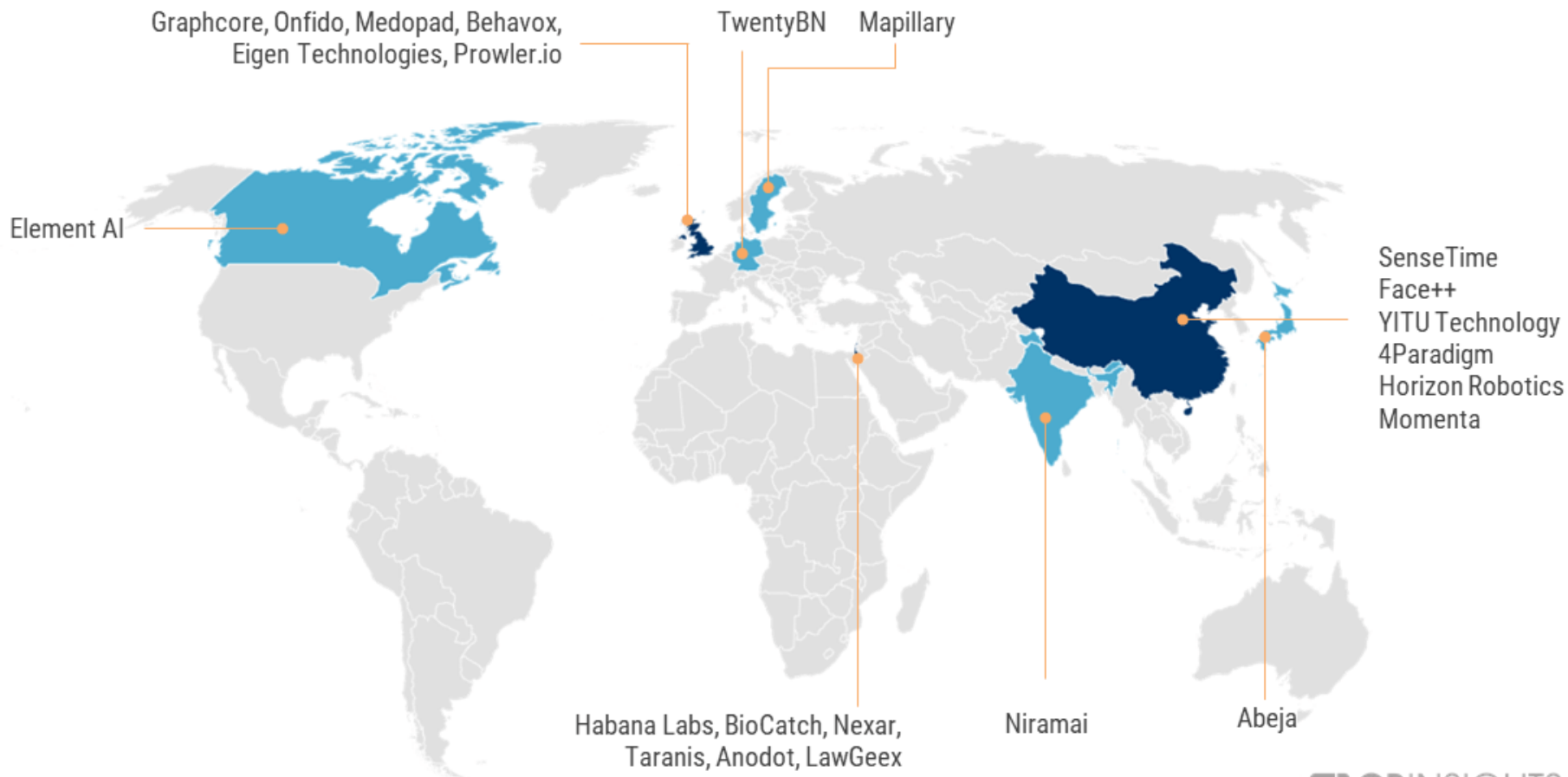
Analytics India MAGAZINE

10 Leading AI Startups India 2018

10/22/2018 'Our breast cancer solution addresses cultural issues' - The Times Of India - Delhi, 10/21/2018

'Our breast cancer solution addresses cultural issues'

2019 AI 100: Startups outside the United States



Source: cbinsights.com

CBINSIGHTS

Liramai

Saving Many Lives ...

THANK YOU

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Niramai