Summer Research Final Report

TeleHealth Video Conferencing Program
&
Applications of Electrical Engineering in the search for a Cure for Breast Cancer

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Summary

In a world where medical expertise may be limited, the TeleHealth Med Conferencer is real solution that can help bring experts to the battle front. With further development of this program, medical expertise will be able to be brought anywhere in the world. Currently the software is a windows based teleconferencing program that incorporates a whiteboard application.

To develop this program required an understanding of programming in C++, and the use of Open H323. As there was a requirement of having a working program by then end of the summer, Open CV and the breast cancer detection software component of MedConfrencer may be good additions to next version of the software.

Introduction

In recent years, several advances have occurred in telehealth technology. Engineers have developed smart suits that can detect the health of soldiers. They have developed new methods of tracking glucose levels in patients with diabetes over the internet. Moreover, they have helped update Medicine with current technologies used elsewhere in military and industry. At Stevens, we have been developing a program that brings the power of teleconferencing to the medical world.

Teleconferencing programs have existed for several years now, however they are still not widely used in the medical field. It can be used as a tool for communication between doctors and patients, doctors and other doctors, doctors and hospital administration, or even doctors and their families. Using teleconferencing as a tool between doctors and other specialists could improve the overall treatment provided. In a military setup, for example, doctors or even soldiers untrained in medicine would be able to talk to specialists who could train them on the spot. Furthermore, diagnosis of diseases such as breast cancer would also be available over the net.

The optimal product would be a cross platform program that would work on both Windows and Linux and would provide features such as audio/video chat, a whiteboard, and an ftp client. The whiteboard was to incorporate a code that would detect microcalcifications in mammograms to help doctors detect Breast Cancer.

The goal for this summer was to develop a code that would at least work as a teleconferencing program on one platform, and develop a graphical user interface, GUI, for the software. Our first task was to sift through legacy codes, determine what worked and then debug the program. This required us to get familiar with C++, and libraries used in teleconferencing. Once we were able to find workable code, we then would be able to move on to developing a GUI.

The technologies that needed to be researched included creating GUIs in C++, developing an FTP Client, and Video technologies. Other team members concentrated on

developing the whiteboard. My task was to develop a GUI that would take in modules developed by different people, and to incorporate a FTP client in the program.

Choosing an Operating System:
In developing our program we were given the choice of choosing Linux or Windows as our base operating system. Our decision of Windows was based on familiarity, and compatibility with existing legacy source code.

Choosing a Programming Language:
As a student in electrical engineering my experience with coding was limited. I had used it in two of my classes, and mostly for back-end console applications. It had been two years since I had coded in a language such as C++ or Java. Our team would have to learn a programming language from scratch and develop a GUI for Windows or Linux.

We kept in mind that our program in the future had to become a cross platform program. To develop a cross platform program JAVA would be easier to implement, as it is interpreted in a browser. C++ as a programming language was used to develop the legacy code. Rather than each person relearn two languages, we decided to break up into groups: the first would develop applets in JAVA and the second would create an all-encompassing program in C++ that would be the browser.

Developing a GUI in C++

A GUI is the acronym for graphical user interface. There are several different methods of implementing GUIs. The first method that I learnt about was the MFC based program. MFC stands for Microsoft Foundation Class Library. Another method was to incorporate WinAPI commands directly.

Windows Template Library was also a good source of information on how to make GUIs in C++. It can be downloaded at:
http://www.microsoft.com/downloads/details.aspx?familyid=128e26ee-2112-4cf7-b28e-7727d9a1f288&displaylang=en

Video Conferencing (Open CV and OpenH323)

The legacy codes were the works of several previous projects, each of which did not have fully working code and used different Open Libraries to achieve a teleconferencing program.

Open CV was originally developed by the Intel Corporation so that developers could make video and image analysis programs easily and quickly. It was expanded on over the years. Currently it houses several image processing algorithms in addition to a GUI library one can work with. Although as a team we began exploring OpenCV earlier, OpenH323 allowed us a quick solution to synchronizing the audio and video feed.

Open H323 was used in previous legacy codes, and was expanded on in this program, mostly through the work of Ishtiaq Ali Saeem. To develop a program using the OpenH323 library a portable windows library (pwlib) had to be installed. In addition environmental variables were required to be set. Environmental variables can be set in Windows XP by selecting properties for My Computer and then selecting environmental variables under the advanced tab. This was useful in setting the path of windows. Setting the Path can affect several other programs and the operating system itself. Having a corrupted path is a common place for errors when uninstalling programs and thus must be considered when creating a setup or uninstall program.

FTP An introduction:

FTP stands for file transfer protocol. "It is an application layer protocol that uses Transmission Control Protocol (TCP) and telnet services to transfer bulk-data files between machines or hosts." [1] FTP allows for a client to access a server and mediates a file transfer between the server and a client.

Because FTP is a protocol that makes use of TCP one would think that a firm foundation on TCP would help. Since TCP programming requires knowledge on sockets and how they work, by the transitive property of logic, one also requires knowledge of sockets to develop a FTP program. This is indeed the case, and before someone will be able to develop their own FTP program a strong understanding of socket programming will be needed.

A basic MFC program can be created to develop the GUI for a FTP client in windows. From a user point of view, the major characteristics of a FTP program include the ability to browse another client's shared folder and transfer of files at faster transfer rate than http (HyperText Transfer Protocol). This is relatively easily done using the MFC wizard in Visual C++.

However, information about the specification of FTP is inherent in the design process of a client or server program. I was faced with three choices (**1**) Use an existing FTP server program, (**2**) Use FTP libraries to develop a FTP client, and (**3**) Look up the specification for FTP in my quest to develop a server and client application that will support it for MedConferencer.

(1) What programs FTP clients already exist?

There are several FTP clients already available, some of which are free such as Filezila. There are many others like Bulletproof FTP, WSFTP, and Cute FTP to name a few which can be used for a small fee. There are two major types of FTP interfaces command line or console based and Web Interface. Since our program is a windows based program for doctors, a web interface would be appropriate.

(2) FTP libraries:

Developing a FTP program from scratch can be expensive. Libraries that simplify making FTP clients such as Marshallsoft's *FTP Client Engine for C/C++* goes for $105.00. I have still yet to find an open source C++ ftp library. For a list of FTP and HTTP libraries one can visit: http://tangentsoft.net/wskfaq/resources/libraries.html

(3) The FTP specification:

After searching the web I finally found a website that explained the major types of ftp and how ftp really worked. http://slacksite.com/other/ftp.html

It explains ftp uses two ports to communicate a data port and a command port. Traditionally on the server side, the data port is Port 20 and the command port is 21. On the client side the command port is a random number greater than 1024, and the data port has a value of one more than the command port. Practically, these ports can have different values depending on the mode of ftp.

Furthermore, there are two major methods (modes) in which FTP can work. In both methods, the client requests the server that it wants information, after which one of two things can happen: (1) Active FTP or (2) Passive FTP (a.k.a. PASV).

In active ftp the client connects from random unprivileged port (N> 1024) to FTP server command port, port 21. Then, the client listens to port N+1 and sends the FTP command PORT N+1 to the FTP server. The server will then connect back to the client's specified data port which is port 20.

Step 1: Client connects to server using port N, where N is an integer greater than 1024, and sends command PORT N+1.
Step 2: The server acknowledges the command by sending an ACK command to the clients port N. Upon receiving an ACK the client begins to listen to its N+1 port.
Step 3: Then the server starts the transmission of data from port 20 to the client's port N+1.
Step 4: Finally the client sends an ACK back to port 20 of the server to signal the end of transmission.

Major problems with active mode FTP falls on client side. Client Side Firewall usually will perceive this as outside system initiating a connection to an internal client. This is usually blocked by most firewalls.

In passive ftp the client opens up two random open subsequent ports greater than 1024. The data port contacts the server's port 21 and issues PASV command. The server replies with an arbitrary port number, P, greater than 1024 by sending the command PORT P. Port P then becomes the data port for the server. After receiving the PORT P command, the client then initiates ftp through its data port to the specified port. Once data transfer has occurred, the data port from the servers sends an ACK back to the client data port.

The major difference is that passive ftp makes it appear as though the client initiated the data transfer. Passive FTP creates problems for the server rather than the client.

Data will not be blocked by the client's firewall, but it requires a high number of ports to be opened on the server side (a security issue). Several FTP 'daemons' allow servers to specify the range of these ports.

Finally, the website also gave me the location of the official specification of FTP which can be found at: ftp://nic.merit.edu/documents/rfc/rfc0959.txt

Creating a Windows Installer

Most programs require some sort of installer program that will install the program and the libraries the program requires. These installer programs usually come in the form of *.msi. and are called MSI files or packages.

There are several programs that can make windows installer files on the net. One of which was advance windows installer. This program provided the control of which environmental variables were set and if the environmental variable already existed, whether changes were appended, prepended over overwrote the current value for these environmental variables.

Conclusions:

Accomplishments include developing an icon for the program, and developing a working teleconferencing program that uses OpenH323. In addition our team was able to develop whiteboard and chat JAVA applets that can be integrated into a browser. The final touches would be to add a browser window in the program that would bring up the server site with the whiteboard and chat functions.

Currently I have a better understanding of how ftp works, but implementing a file transfer protocol client in the MedConferencer will still take some time. I will continue to work on a solution until one provides itself over week eleven and twelve. However, I think it would be more prudent to incorporate the Java applets into the main program.

As for creating the installer program, advance program installer is good. The full version of the program allows the programmer more control over what times files are added to the computer and supports update timers so client knows how long a program will take to install. However the free version does not have a blatant message to your clients that the installer was created by their software. Using the free version of the program still allows users to set environmental variables and thus would be the easiest and cleanest method for making a setup file for MedConferencer.

Overall the experience of research at Stevens was overall refreshing and rewarding, but at times frustrating. The greatest challenge in developing this program was learning how the legacy code worked, and debugging it. After that the next hardest part was learning how to use the MFC library. They should really teach this stuff in freshman computer science classes. The code we have is still in separate components and in this last week I will focus on creating a program that combines the two.

References:

Microsoft Template Library:
http://www.microsoft.com/downloads/details.aspx?familyid=128e26ee-2112-4cf7-b28e-7727d9a1f288&displaylang=en

(1) Iomega NAS Terms Glossary Website:
https://iomega-eu-en.custhelp.com/cgi-bin/iomega_eu_en.cfg/php/enduser/std_adp.php?p_faqid=1725

website: Winsock Programmer's FAQ: Winsock Libraries and Controls
http://tangentsoft.net/wskfaq/resources/libraries.html

website: Developing a TCP based program
http://www.fortunecity.com/skyscraper/arpanet/6/cc.htm

website: Active FTP vs. Passive FTP, a Definative Explanation.
http://slacksite.com/other/ftp.html

website: Official specification of the File Transfer Protocol.
ftp://nic.merit.edu/documents/rfc/rfc0959.txt

Appendix

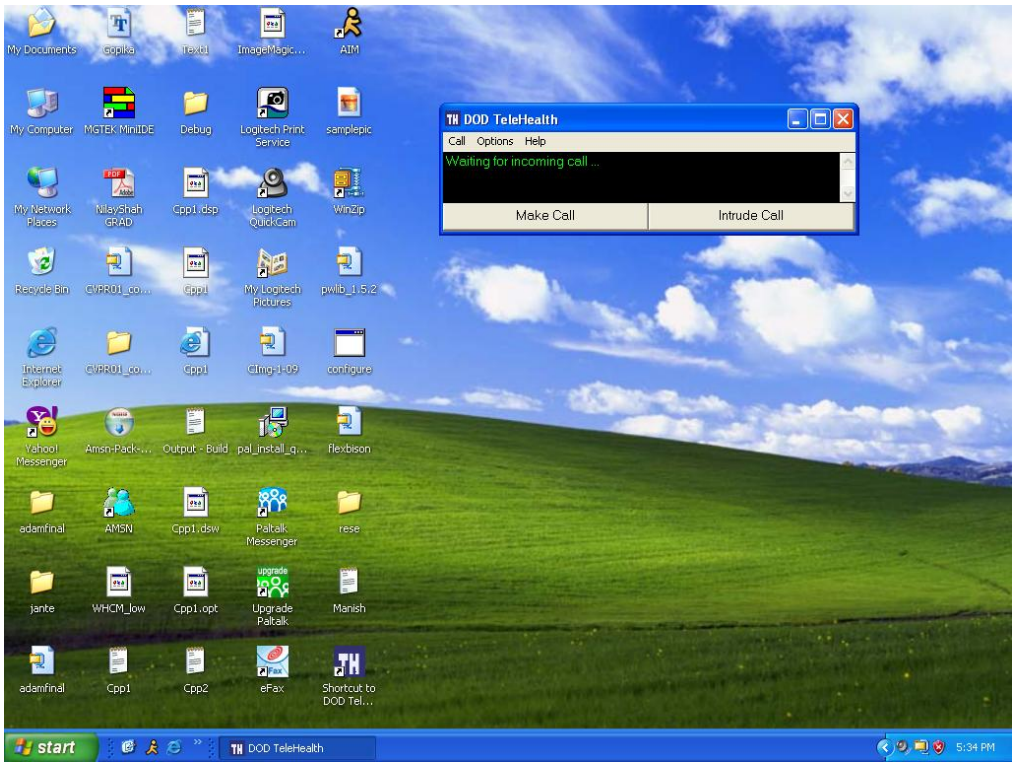
Icons developed for TeleHealth MedConferencer
Screen Shots of Program
Weekly Reports
Breast Cancer Report

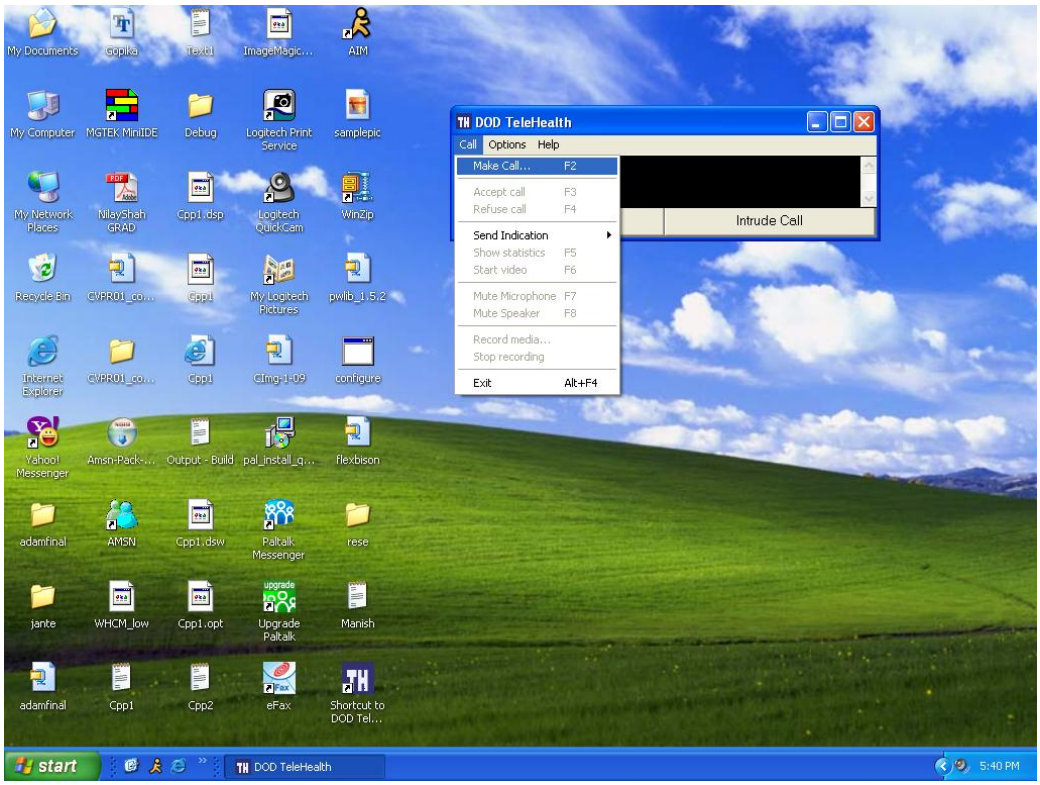
Icons developed for TeleHealth MedConferencer

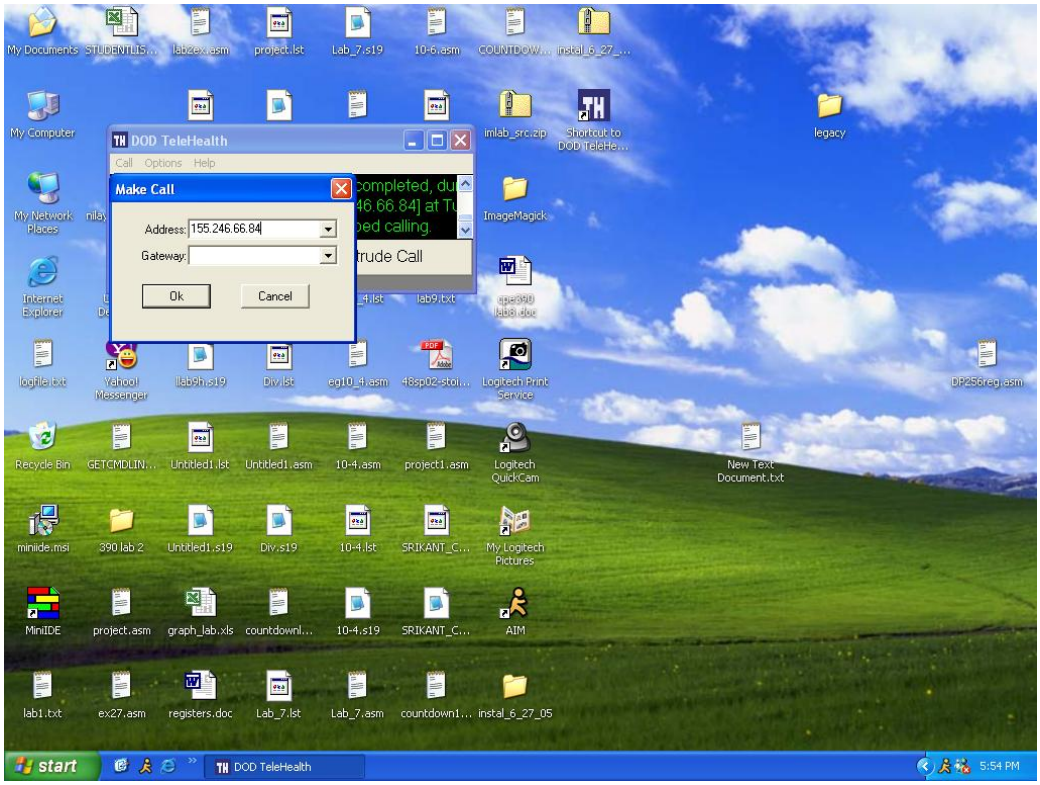
Icon

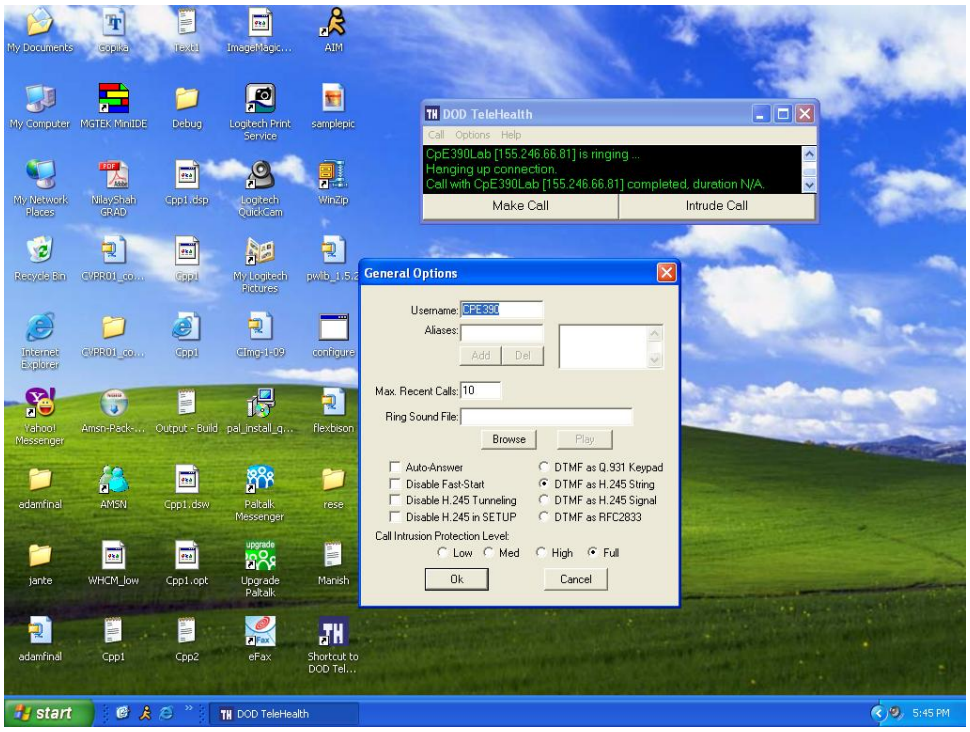
Bitmap

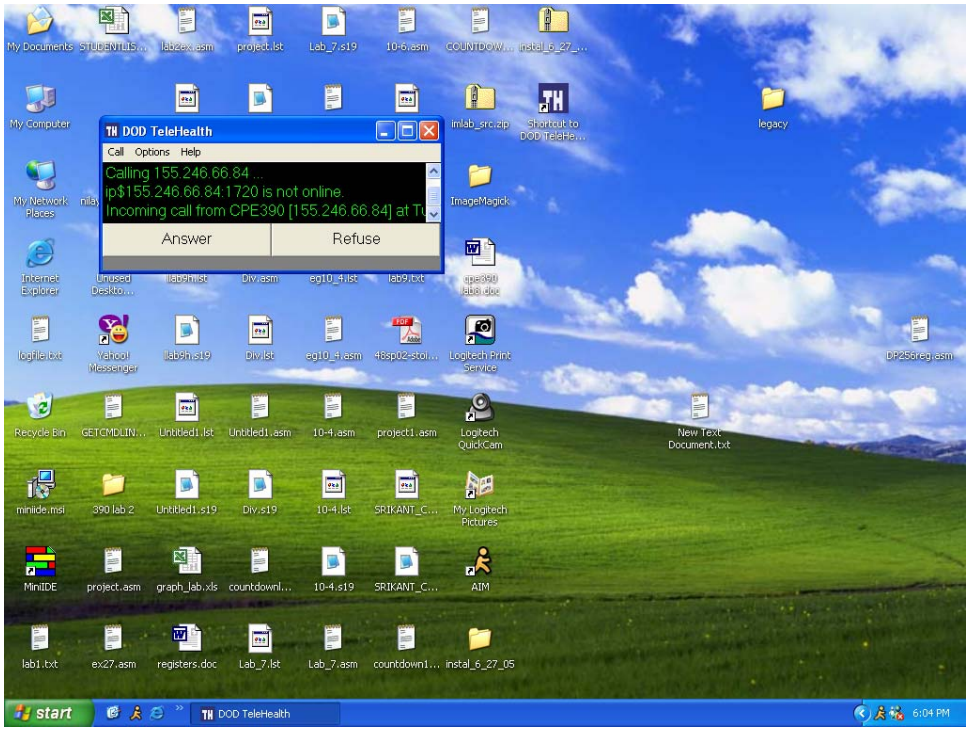
Screen Shots:

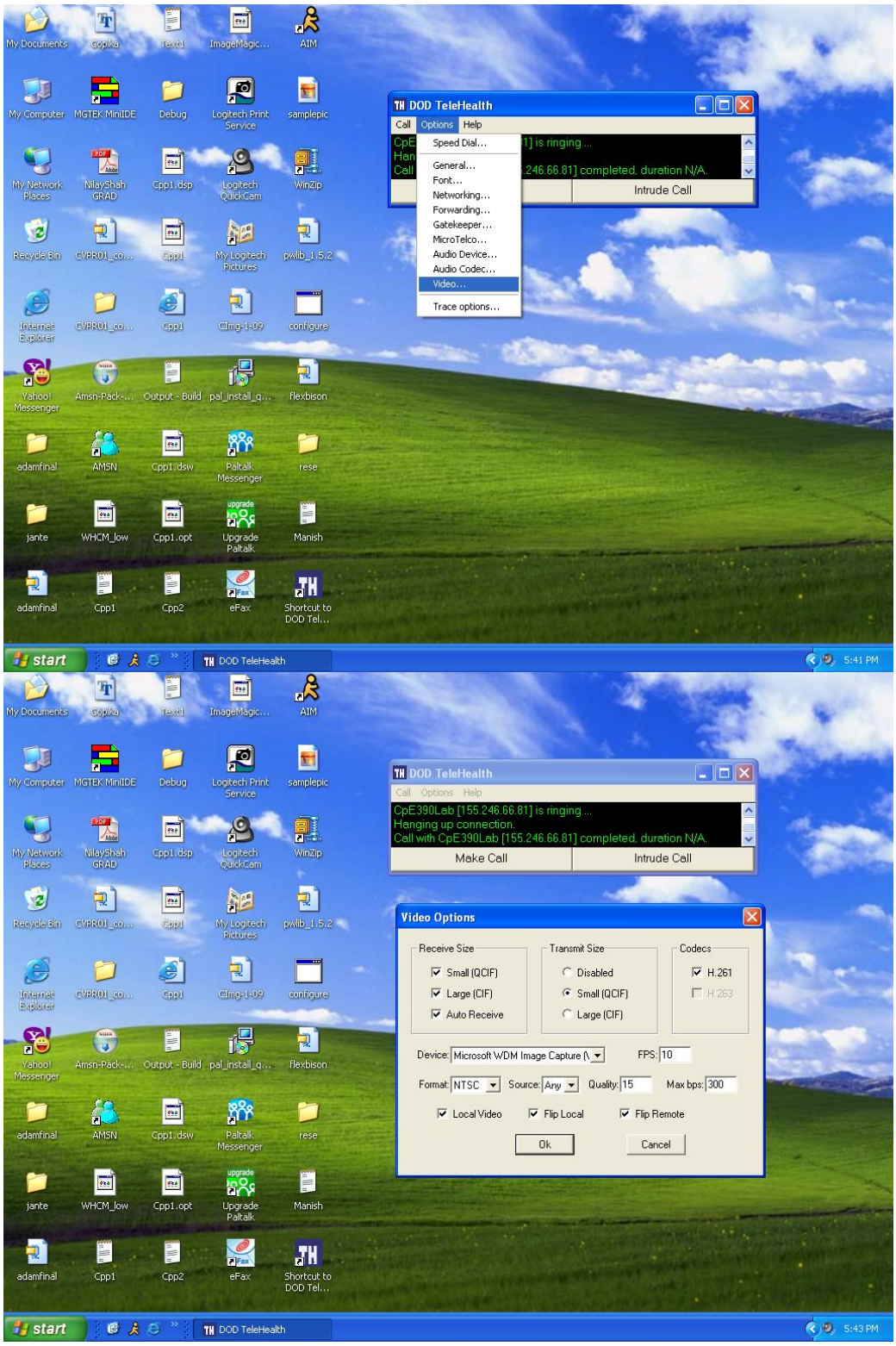


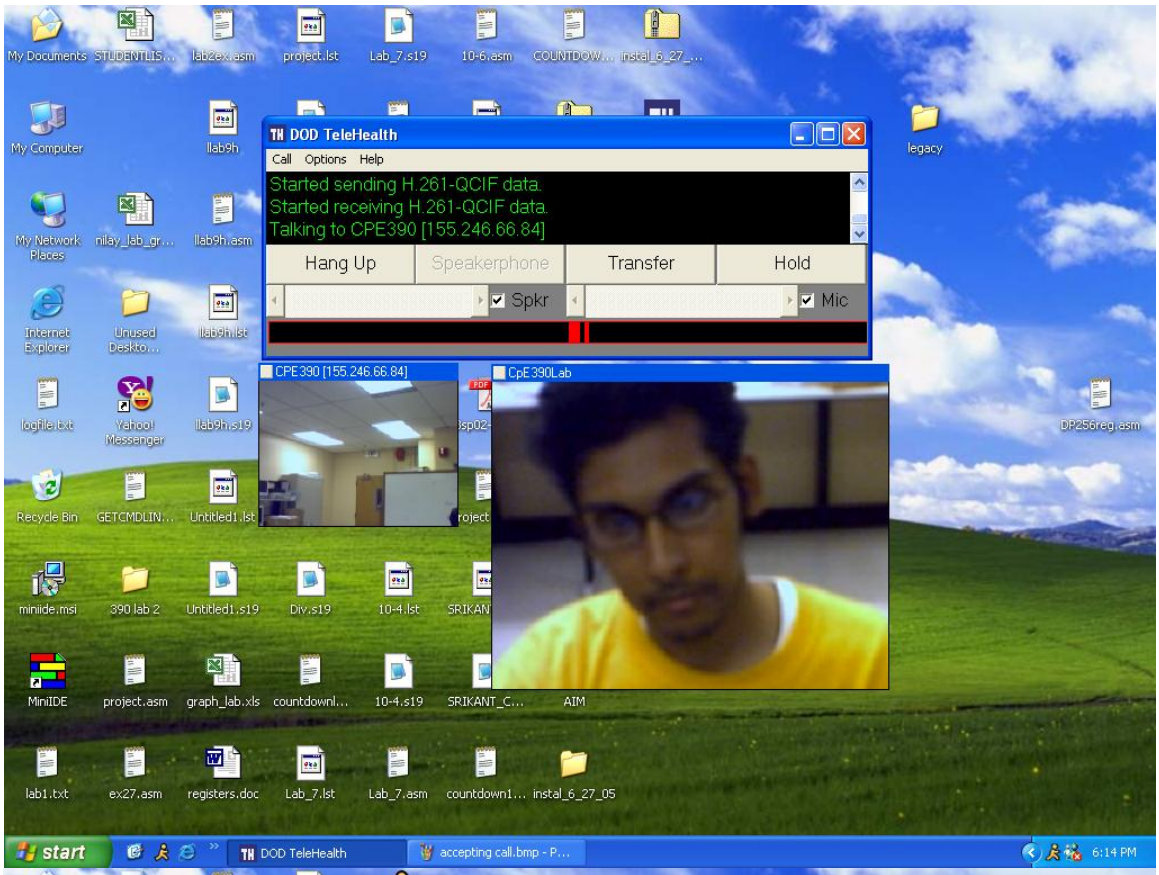

DOD TeleHealth
Call Options Help
Make Call... F2
Accept call F3
Refuse call F4
Send Indication
Show statistics F5
Start video F6
Mute Microphone F7
Mute Speaker F8
Record media...
Stop recording
Exit Alt+F4
Intrude Call
start
DOD TeleHealth
5:40 PM

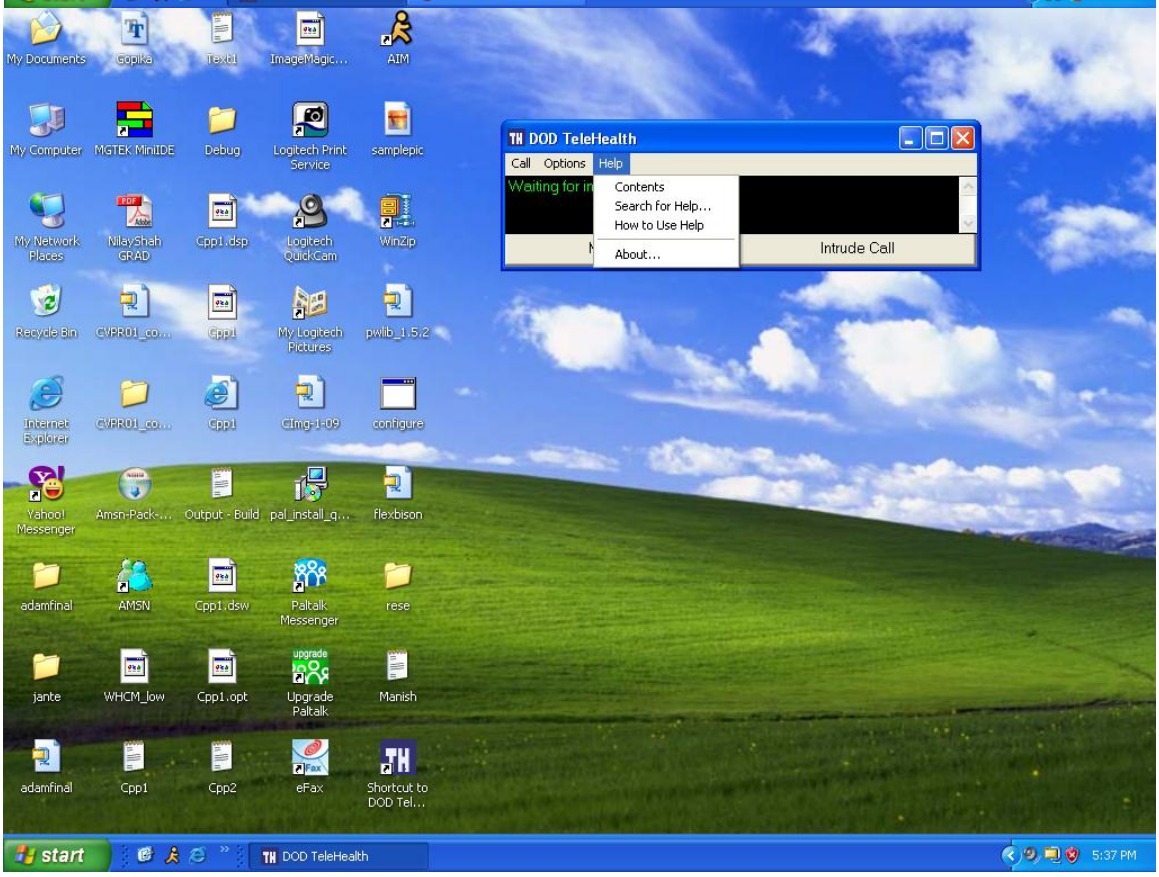

DOD TeleHealth
Call Options Help
Make Call
Address: 155.246.66.84
Gateway:
Ok
Cancel
Intrude Call
start
DOD TeleHealth
5:54 PM

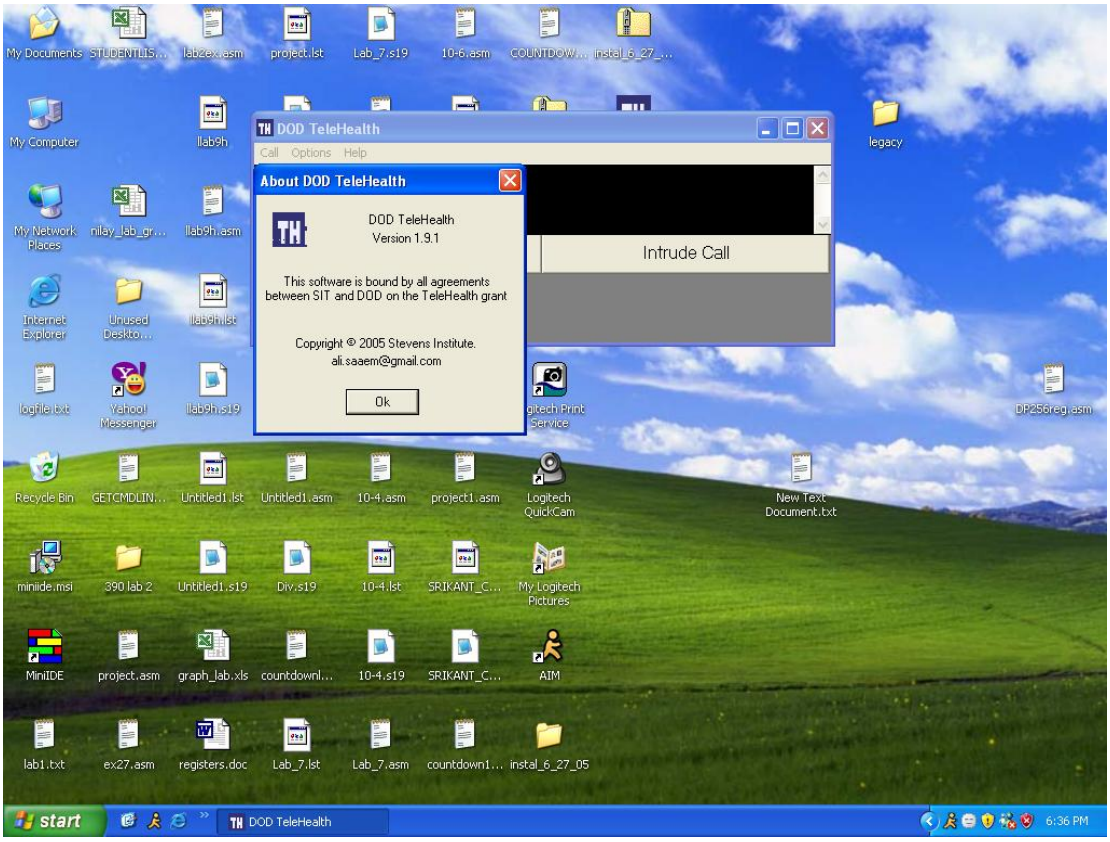

DOD TeleHealth
Call Options Help
CpE390Lab [155.246.66.81] is ringing ...
Hanging up connection.
Call with CpE390Lab [155.246.66.81] completed, duration N/A.
Make Call
Intrude Call
General Options
Username: CPE390
Aliases:
Add
Del
Max. Recent Calls: 10
Ring Sound File:
Browse
Play
Auto-Answer
Disable Fast-Start
Disable H.245 Tunneling
Disable H.245 in SETUP
DTMF as Q.931 Keypad
DTMF as H.245 String
DTMF as H.245 Signal
DTMF as RFC2833
Call Intrusion Protection Level:
Low
Med
High
Full
Ok
Cancel
start
DOD TeleHealth
5:45 PM


DOD TeleHealth
Call Options Help
Calling 155.246.66.84 ...
ip$155.246.66.84:1720 is not online.
Incoming call from CPE390 [155.246.66.84] at
Answer
Refuse
start
DOD TeleHealth
6:04 PM


DOD TeleHealth
Call
Options
Help
Speed Dial...
General...
Font...
Networking...
Forwarding...
Gatekeeper...
MicroTelco...
Audio Device...
Audio Codec...
Video...
Trace options...
Intrude Call
start
DOD TeleHealth
5:41 PM
DOD TeleHealth
Call Options Help
CpE390Lab [155.246.66.81] is ringing ...
Hanging up connection.
Call with CpE390Lab [155.246.66.81] completed, duration N/A.
Make Call
Intrude Call
Video Options
Receive Size
Small (QCIF)
Large (CIF)
Auto Receive
Transmit Size
Disabled
Small (QCIF)
Large (CIF)
Codecs
H.261
H.263
Device: Microsoft WDM Image Capture (\
FPS: 10
Format: NTSC
Source: Any
Quality: 15
Max bps: 300
Local Video
Flip Local
Flip Remote
Ok
Cancel
start
DOD TeleHealth
5:43 PM


DOD TeleHealth
Call Options Help
Started sending H.261-QCIF data.
Started receiving H.261-QCIF data.
Talking to CPE390 [155.246.66.84]
Hang Up
Speakerphone
Transfer
Hold
Spkr
Mic
CPE390 [155.246.66.84]
CpE390Lab
start
DOD TeleHealth
accepting call.bmp - P...
6:14 PM


DOD TeleHealth
Call Options Help
Waiting for in
Contents
Search for Help...
How to Use Help
About...
Intrude Call
start
DOD TeleHealth
5:37 PM


DOD TeleHealth
Call Options Help
Intrude Call
About DOD TeleHealth
DOD TeleHealth
Version 1.9.1
This software is bound by all agreements between SIT and DOD on the TeleHealth grant
Copyright © 2005 Stevens Institute.
ali.saaem@gmail.com
Ok
My Documents
My Computer
My Network Places
Internet Explorer
Recycle Bin
legacy
New Text Document.txt
DP256reg.asm
start
DOD TeleHealth
6:36 PM

Weekly Reports

[Week1:] So far I have been working with Professor Man to develop a GUI for the telehealth program. I have made a working website for the project and have started learning basic concepts in Visual C++. At this point I have learned about the Application Framework and was successful in creating a few "hello world" programs. I also was able to create a preliminary Gaant chart.

[Week2:] I was able to develop a few GUIs, and created a program that allows a user to input text. Taking in user keystrokes proved to be a good challenge. I also was able to develop some icons for the telehealth program.

WEEK 3: See extended report

WEEK 4: See extended report

[Week5:] This week I continued to learn about Open CV and was able to finish a working GUI for the TeleHealth program. The teleconferencing components it incorporated included code from Ben and Erin's Code, Tom, and Hesham's code. The code also incorporated the h231 library. With Ali's help, I finished developing a GUI for the teleconferencing functions and installed the Open H323 library onto three of computers in the downstairs computer lab. In addition, we were able to implement the code and show that the program works in windows. I have included screenshots of the program below.

On the presentation for breast cancer I have read through two more of the papers Professor Yao sent me, and I am continuing researching the field.

(Screen Shots were presented)

WEEK 6: See extended report

[Week 7:] Linux was finally installed on to a laptop and I began developing my part of the program in linux. I also started research on FTP and how to incorporated a client in the GUI. I started making slides for the power point presentation and took a look at the final report outline and started developing the body for the final report.

WEEK7: wk7.txt

Power Point on FTP Basics ftp.ppt

[Week 8:]

- Continued research for presentation
- Prepared laptop to run whiteboard and telehealth program
- Continued working on FTP integration and final paper

[Week 9:]

- Finished up final Power point presentation!

[Week 10:] See extended report

Extendended Weekly Reports:

Week 1:
Date: May 23, 2005
Time in: 8:08 AM

Progress Report 1

Objectives:
0) Prepare I-9 forms and get on the Pay roll. Help familiarize out of towners with Stevens.
1) Meet team members and develop personal webpage
2) Meet with Professor Man and develop a list of tasks needed to accomplish
3) Delegate tasks based on abilities
4) Determine what has been done
5) Learn how to develop a GUI
6) Learn how to use Win32 API calls

I was successful in developing a web page for myself and creating a page for progress reports.
I also was able to read through Tom's paper and skim over Ben's and Erin's paper on cross platform video conferencing applications. I also created an Excell file to record my hours. As I did not have an ethernet cable, I went to the library to work in the computer lab.

Meeting with Professor Man scheduled for 2:00PM in his Burshard Office.
-- received programming windows book
-- received source code for applets

Recommendations: bring Ethernet cable with me, and download/install Microsoft Visual Studio on to my computer.

Week 2
Tasks completed:
Open CV was installed on Husna's computer.

4 test GUIs using Inside Visual C++ Fourth Edition was prepared
the first utilized the MFC (Microsoft Frame Class) application framework
the second allowed user input and added toolbar functionality
the third and the fourth incorporated icons and other function settings in the

application wizard.

In the tutorial I was successful in creating a program in C with the Win32 API, a C++ Windows class library that uses Win32, and the MFC application class.

I also took a look at Microsoft NetMeeting to get a better idea of choices users may need on a task bar.

From my research on making GUIs in Visual C++, the common method to make the GUI is in another part of the studio, particularly Visual Basic. Although Visual Basic makes it a lot easier to make a nice looking GUI, the background coding is not C++.

Tasks for next week:
Go through Open CV. Inparticular I have to look through the Image Processing and the Structure analsis. by the end of next week we hope to have a program that can interface with the camera.

In a sense this when the real research begins because we have to determine what functions we'll need to call, and use to develop the program. Concurrently... in my spare time I plan to learn some basic, and the interacts between VB and c++ so if need comes I can use VB to develop the GUI.

Week 3
Date: 06/15/05

Tasks accomplished:

I became familiar with two components of Open CV. In particular, I looked through the Image Processing and the Structure analysis. I updated the compilers on two of the computers in the mocroprocessor lab to support .net, and with Hasna and Husna implemented the cameras and microphones on two windows machines.

We tested the device and the microphones provided by professor Man using WindowsNetMeeting. At the end of last week we tested an open program that was able to capture video and perform teleconferencing. With Ali's help, I now was successfully able to compile a tutorial program that made use of CImg.h file. Unfortunately, neither the tutorial or the teleconferencing program implement the opencv.h file directly.

Plans for this week:
To install Linux on two laptops.
Create executables that incorporate OPenCV algorithms
Start research for Breast Cancer presentation

Week 4
Synopsis of week's work:

I did some more research on developing programs in Visual C++, and looked through the documents that professor Yao sent me and other articles on breast cancer. The installation of Linux has been delayed for a week because our group is waiting for the install CD.

This week: our group will be testing the cameras with the java applets Ali developed and debugging them. In addition I will also continue to learn about Windows and Windows API, and try to incorporate a palette in one of my programs in preparation for the whiteboard apps.

Breast Cancer Power Point links:
http://www.dukehealthraleigh.org/healthservices/cancer/screenings/index/breast_cancer_treatment_options.pdf

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12889511&dopt=Abstract

Week 6

Tasks Achieved:
Networking Update:
Wireless G ROuter Acquired
Wireless G Card Acquired
Infrastructure Topology implemented

SSID: Belkin54g

IP TABLE:
ROUTER: 169.200.2.1
DESKTOP: 169.200.2.40
LAPTOP: 169.200.2.32

cHANNEL: 11
sECURITY: WPA-PSK (NO SERVER)
PASSCODE: TelehealthNetworkKey
Cloned MAC Address

Desktop: Dell Pentium III Windows XP
Laptop: Compaq E500 Pentium III Win 2K
Router: Belkin Wireless G Router
Card: Belkin Wirless G card

Successfully created a microsoft network, and transfered over telehealth and H323 libraries/Source Code to prepare for the installation of the software.

I continued researching Breast Cancer articles given by Professor Yao and some off of Google.

Enjoyed Fiddler on the Roof; Helped Jeremiah find alligator clip connectors; Helped Hasna with implementing CImg Library; Updated Jerry's Computer to include Visual Basic, Gave access to MSDN.

Enjoyed July 4th Weekend.

Week 7

Overview:
Our group finally recieved SuSE 9.2 CD in the mail, and I set up a laptop to dual boot in windows XP and SuSE. Program supports Win2k.
Daily tasks:
Thursday:
Concentrated on developing a better GUI that would incorporate FTP. The program as it stands is an executable in windows, it will have to be changed to a java applet so that it can be used in both Linux and Windows. With the help of Ali, the bug that prevented the program from compiling on some compters was corrected. Then I was able to test our program on windows 2000 and successfully was able to get connection.

I also met with Professor Man for our weekly meeting.

Friday:
I concentrated on the Breast Cancer Power Point Presentation; first 4 slides were made
I installed a wireless card and tested the program over the wireless network.
Video/Sound Delay increased slightly compared with the wired connection.

Monday:
I installed linux and updated to windows XP. However, there were configuration problems with the laptop that prevented me from testing the program on win XP over the wireless. I found that win2k would not configure the Belkin router, however with the upgrade to xp I could configure the router.

Tuesday:
I concentrated on developing an FTP client for the TeleHealth
Created a gmail account for the project, and sent loggin info to the rest of the group.
created a power point presentation on FTP and how it works I also added 3 more slides to the final power point presentation I tested the program over the wireless network to see if the program would work over the
wireless network with Win XP.
Finally I updated my site and created a progress report.

Week 10

This week's goal was to develop a combination of the programs.

To do this I need to make my GUI act as a browser and give FTP support.

There are a few different methods available to do this:

(1) One possible way would be to create our own browser.
MFC Application Wizard can be used when trying to do this.
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/vcsample/html/_sample_mfc_MFCIE.asp

By changing the class to include CHtmlView, one can create a program that acts as a webbrowser.

(2) We could take an open source browser such as mozilla and
configured it,to include our telehealth features.
I have already downloaded the source code for Mozilla and have started looking through it for the best way to add our program to it.

For FTP Support
Also I am continuing attempts to implement FTP into my code.

FTP example using WINAPI commands for a MFC Application.
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/vcsample/html/_sample_mfc_MFCIE.asp

Breast Cancer Research Continues:
I met with Professor Yao, and discussed the possibility of adding audio to the slides.
Finally I made additions to Breast Cancer Powerpoint to include information that was not in the slides. That information follows.
Harmonal Therapy
http://cancer.stanfordhospital.com/healthInfo/cancerTreatment/methods/hormone/default

Different Drugs are used to treat Breast Cancer. Tamoxifen is used to help both men and women. It prevents the effects of estrogen in the breast.
Other drugs are also used to treat breast cancer:
Aromatase Inhibitors prevent the receptors (in the entire body not just the breast) from accepting estrogen. These drugs are: anastrozole (Arimidex®) and letrozole (Femara®)
The history of Breast Cancer can be found at:
http://www.bcsc.ca/bcsc_html/about/about_historybc.html

A note on Breast Cancer:

Breast Cancer is a disease that affects both women and men and has lead to the death of many of our people. Over 40,000 people die in the US each year due to this disease.

Cancer is one of the trickiest diseases to defeat, as it is the patient's own cells that are performing a mutiny in the body. These cells take in too many resources, and are not complient with the cell life cycle. By taking in these resources, other nearby cells are not able to get the nutrients they need and die off. When this mutiny spreads to vital organs, the cancer is considered to be internal, and deadly. Current therapy is chemotherapy and drugs such as tamoxofen. A complete history of Breast Cancer can be found at: http://www.bcsc.ca/bcsc_html/about/about_historybc.html

As Electrical Engineers, we can find better methods of detection that can lead to earlier diagnosis of the disease, and use our knowledge of electricity to provide better equipment to remove malignant cancer spots. Currently EE's are applying themselves to work for a world without this disease, by dedicating time to research Ultra-Wideband Microwave Imaging, Space-Time Beamforming, Automated Target Recognition, and the application of wavelets to Mammograms to name a few.

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Applying wavelets to mammograms
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Characterization of architectural distortion in mammograms
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Head, J.F.; Elliott, R.L.;
Engineering in Medicine and Biology Magazine, IEEE
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Computer assisted diagnosis for digital mammography
Wei Qian; Clarke, L.P.; Baoyu Zheng; Kallergi, M.; Clark, R.;
Engineering in Medicine and Biology Magazine, IEEE
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Google: Breast cancer detection

Improving Methods for Breast Cancer Detection and Diagnosis
http://cis.nci.nih.gov/fact/5_14.htm

Breast Cancer: Steps to Finding Breast Lumps Early
http://familydoctor.org/018.xml

Mammograms: A consumer guide to breast cancer detection
http://www.nclnet.org/mammogram.htm

Breast Cancer Research

Presented by

Manish Modi

STEVENS Institute of Technology

Stevens Institute of Technology REU SUMMER 2005

Statistics

- More than 180,000 new cases of invasive breast cancer are diagnosed and more than 40,000 deaths result from the disease each year.[1]
- Each year, about 1,300 men in this country learn they have breast cancer [2]

What is Breast Cancer?

- Cancer that starts in the breast. The main types of breast cancer are ductal carcinoma in situ, invasive ductal carcinoma, lobular carcinoma in situ, invasive lobular carcinoma, medullary carcinoma, and Paget's disease of the nipple. www.abcgonline.com/archive/2000/diction/diction.htm

2005 Estimated US Cancer Deaths*

Men 295,280	
Lung and bronchus	31%
Prostate	10%
Colon and rectum	10%
Pancreas	5%
Leukemia	4%
Esophagus	4%
Liver and intrahepatic bile duct	3%
Non-Hodgkin Lymphoma	3%
Urinary bladder	3%
Kidney	3%
All other sites	24%

Women 275,000	
27%	Lung and bronchus
15%	Breast
10%	Colon and rectum
6%	Ovary
6%	Pancreas
4%	Leukemia
3%	Non-Hodgkin lymphoma
3%	Uterine corpus
2%	Multiple myeloma
2%	Brain/ONS
22%	All other sites

ONS=Other nervous system.
Source: American Cancer Society, 2005.

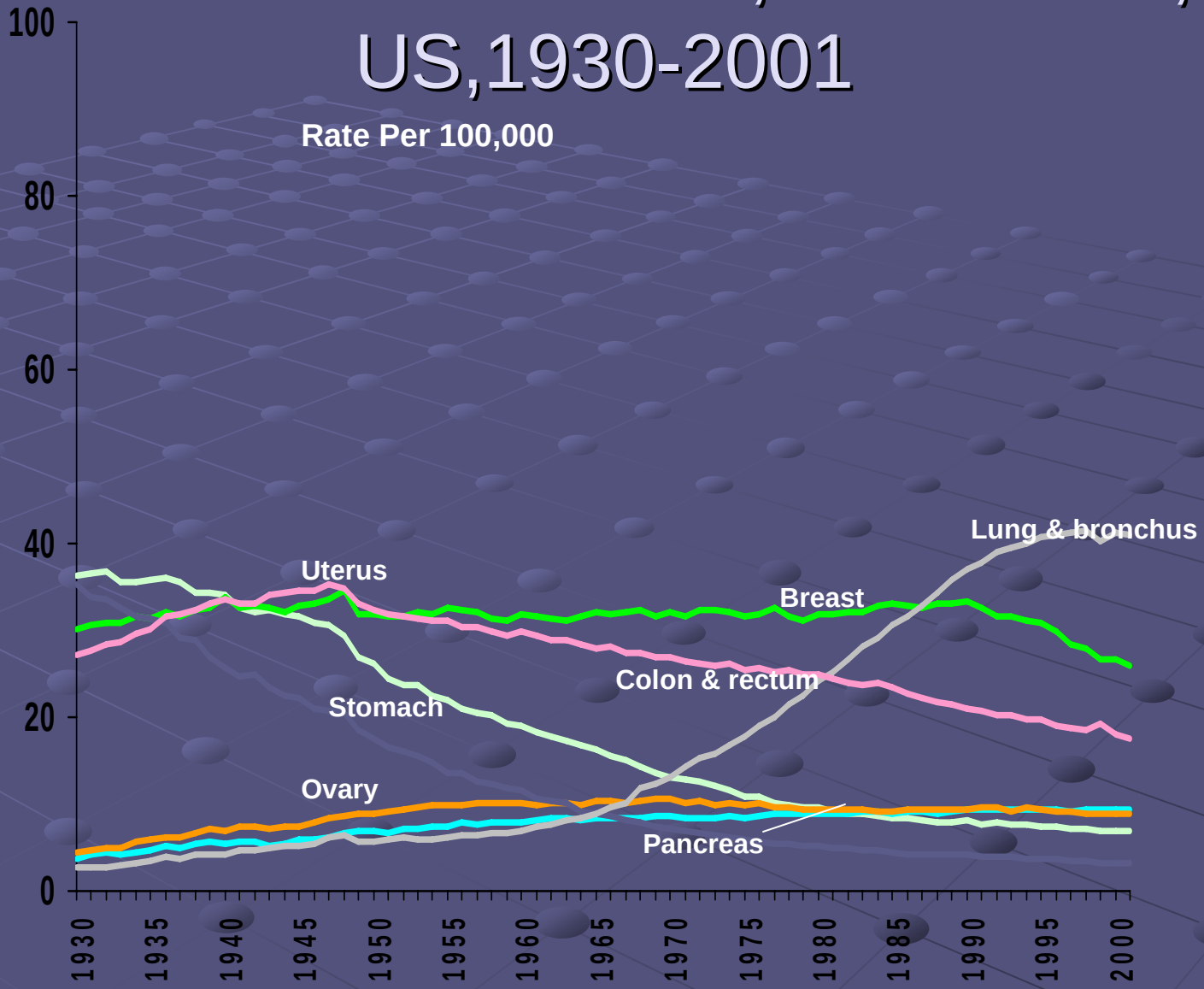
2005 Estimated US Cancer Cases*

Men 710,040	
Prostate	33%
Lung and bronchus	13%
Colon and rectum	10%
Urinary bladder	7%
Melanoma of skin	5%
Non-Hodgkin lymphoma	4%
Kidney	3%
Leukemia	3%
Oral Cavity	3%
Pancreas	2%
All Other Sites	17%

Women 662,870	
32%	**Breast**
12%	Lung and bronchus
11%	Colon and rectum
6%	Uterine corpus
4%	Non-Hodgki lymphoma
4%	Melanoma of skin
3%	Ovary
3%	Thyroid
2%	Urinary bladder
2%	Pancreas
21%	All Other Sites

***Excludes basal and squamous cell skin cancers and in situ carcinomas except urinary bladder.**
Source: American Cancer Society, 2005.

Cancer Death Rates*, for Women, US,1930-2001



*Age-adjusted to the 2000 US standard population.
Source: US Mortality Public Use Data Tapes 1960-2001, US Mortality Volumes 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention, 2004.

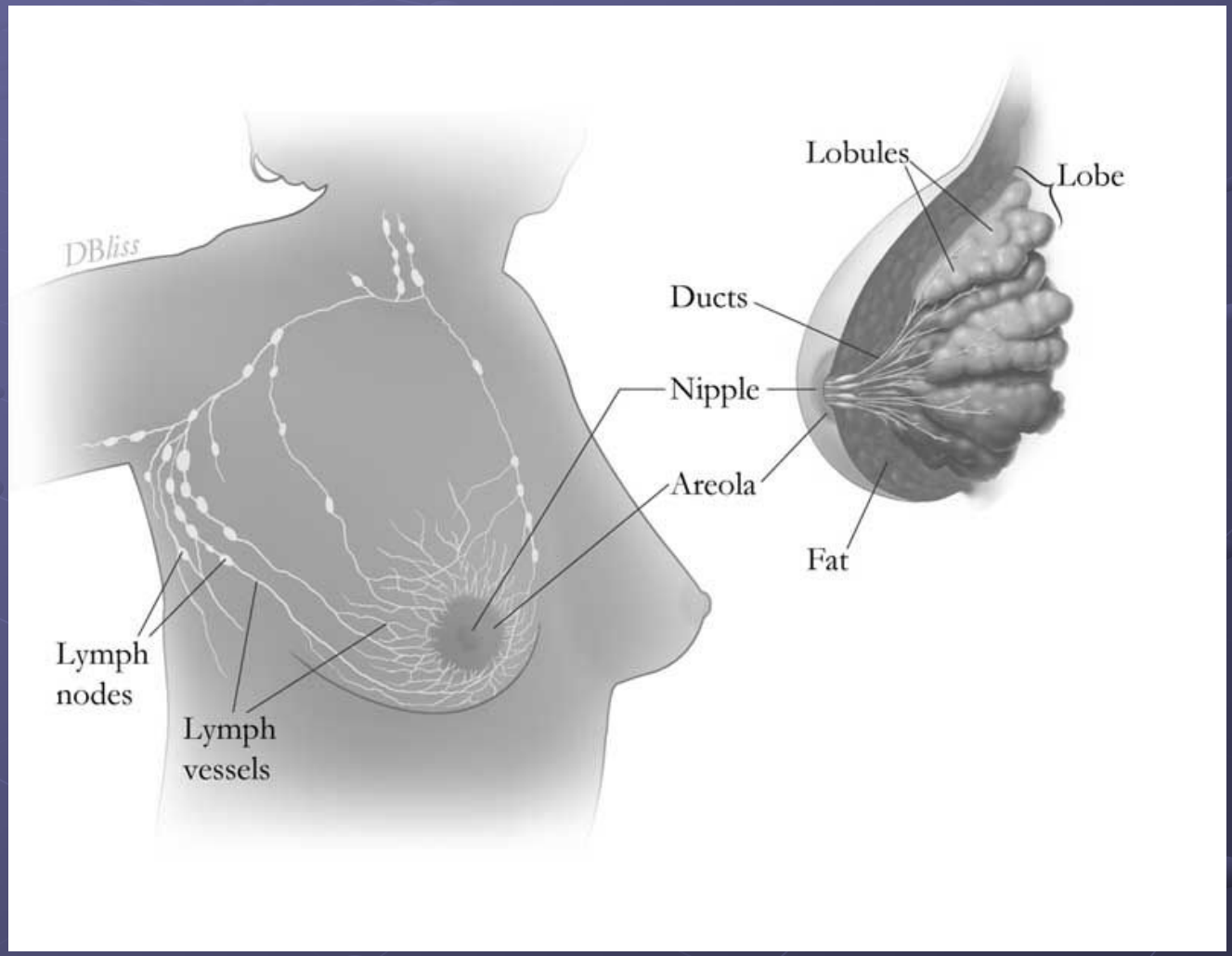
Types of Breast Cancer

- Breast Cancer *In Situ* (☺)
  - In Situ Breast Cancer is the preliminary kind in which the cancer has not spread to internal organs (good prognosis)
- Invassive (☹)
  - Invassive Breast Cancer a developed form of the disease that has already started to affect internal organs.

Ductal Carcinoma

- Tumor develops in the tubes that connect the lobular (milk producing tissues) to the nipple.
- Two types of Ductal Carcinoma
  - DCIS (Ductal Carcinoma in situ)
  - IDC (Invasive Ductal Carcinoma)
- Invasive Ductal Carcinoma Accounts for 80% of all breast cancers
- Paget's Disease

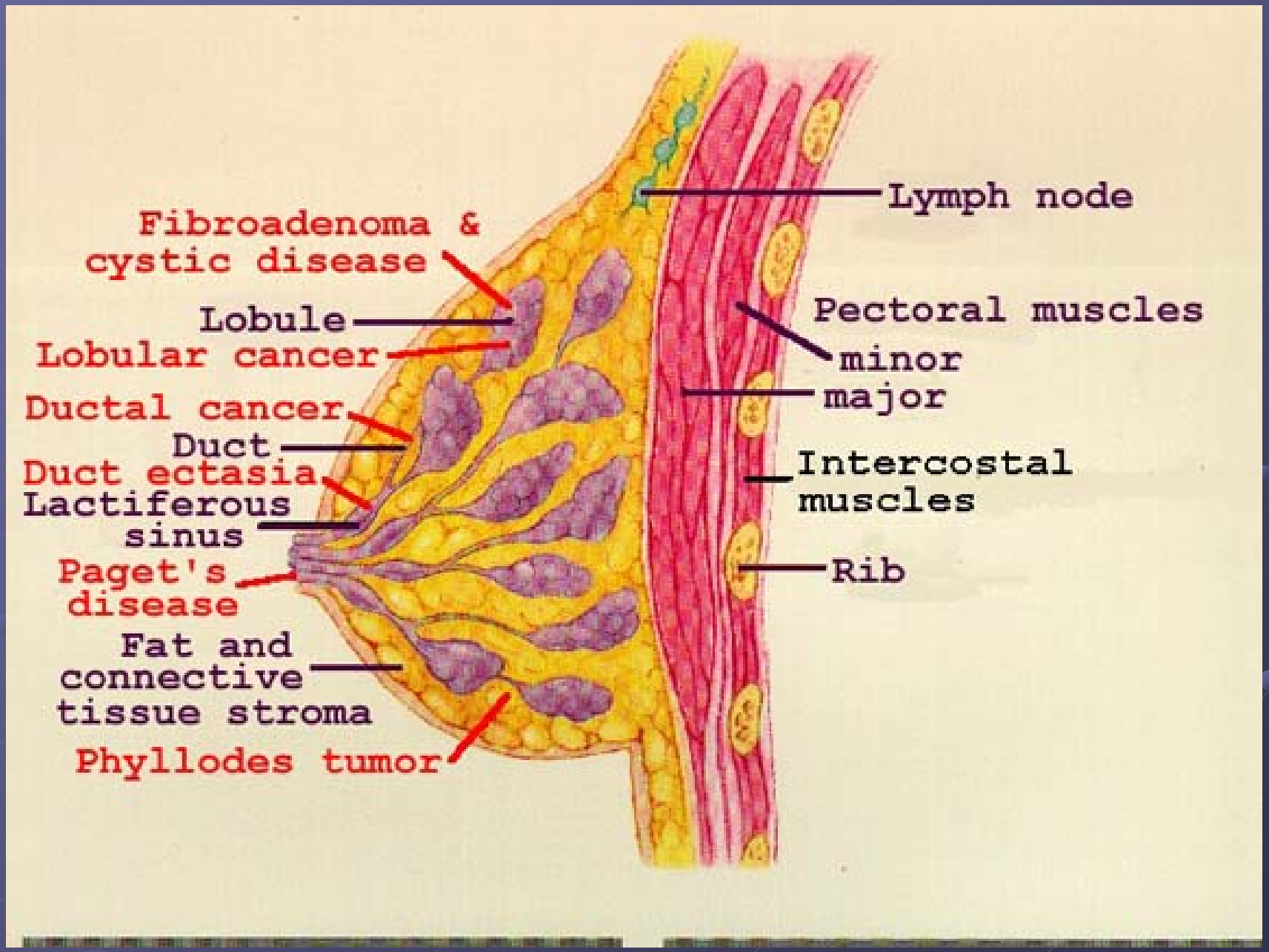
Lymph Nodes and Lymph Vessels Near the Breast



http://www.breast-cancer-treatment.org/images/Lymph-drainage-4.2.jpg

Lobular Carcinoma

- Develops in the Fatty tissue in the Breast
- LCIS (Lobular Carcinoma In Situ)
  - Peripheral Tumor that can be removed
- ILC (Invasive Lobular Carcinoma)
  - Cancer has metastisized other organs



http://www.wisc.edu/wolberg/anatomy1.jpg

Other types

- Inflamatory Breast Cancer
- Medullar Carcinoma
- Mucinous Carcinoma
- Cribiform Carcinoma
- Papillary Carcinoma
- Pheledes Syndrome

Prevention

- Diet
- Drugs
- Early Detection

Drugs Harmonal Therapy

- SERMs (Selective Estrogen-Receptor Modulators)
- Aromatase Inhibitors
- Biologic Response Modifiers

SERMs

- Bind to estrogen receptors in breast cancer cells, starving cancer cells
  - Tamoxifen (Nolvadex)
  - Evista (raloxifene)
  - Fareston (toremifene)
- Tamoxifen
  - Most commonly used Hormonal Therapy
  - Used to help men and women

Aromatase Inhibitors

- Prevent production of estrogen in adrenal glands

- Common Aromatase Inhibitors
  - Aromasin (exemestane)
  - Femara (letrozole)
  - Arimidex (anastrozole)
  - Megace (megestrol)

Biologic Response Modifiers

- Bind with certain proteins on breast cancer cells, preventing their growth
  - Herceptin (trastuzumab)

Other Hormonal Therapies

- Treat breast cancers that are dependent on estrogen for survival
  - Zoladex (goserelin acetate)
  - Faslodex (fulvestrant) <Receptor Inhibitor>

Early Detection

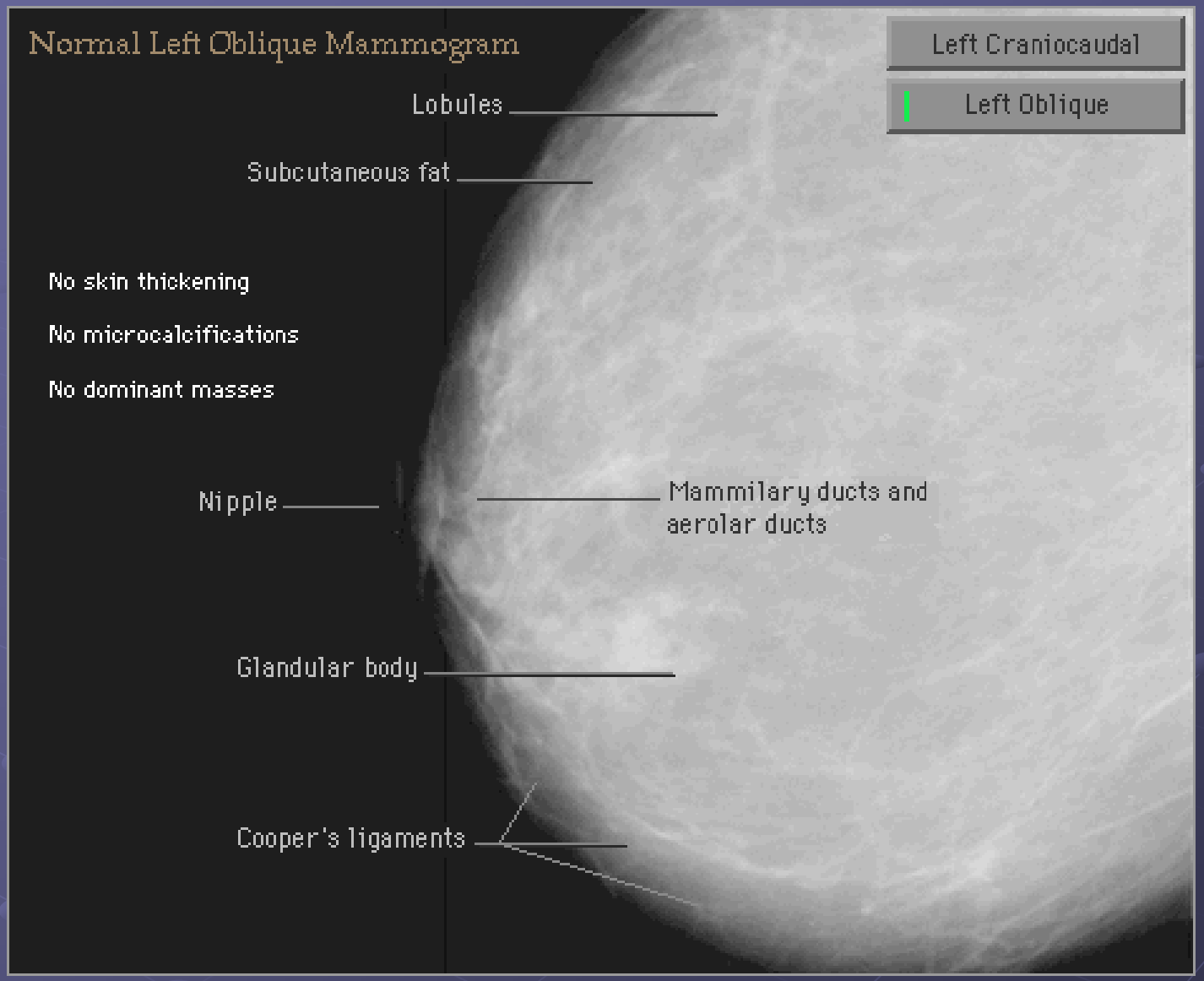
- Breast Cancer Self Test
- Mammography
- Automated Target Recognition Technology
- Applying Wavelets to Mammograms

Mammography

- Uses X-rays
- Primary Screening Method
- 1951 Leborgne first showed presence of calcification using a mammographic image
- Mammography Quality Standards Act improved quality and interpretation of images
- Low positive predictive rate

Mammogram

http://www.siumed.edu/breastcenter/images/mammogram.jpg



http://info.med.yale.edu/intmed/cardio/imaging/references/normal_mammo_ref/oblique_mammo_norm.gif

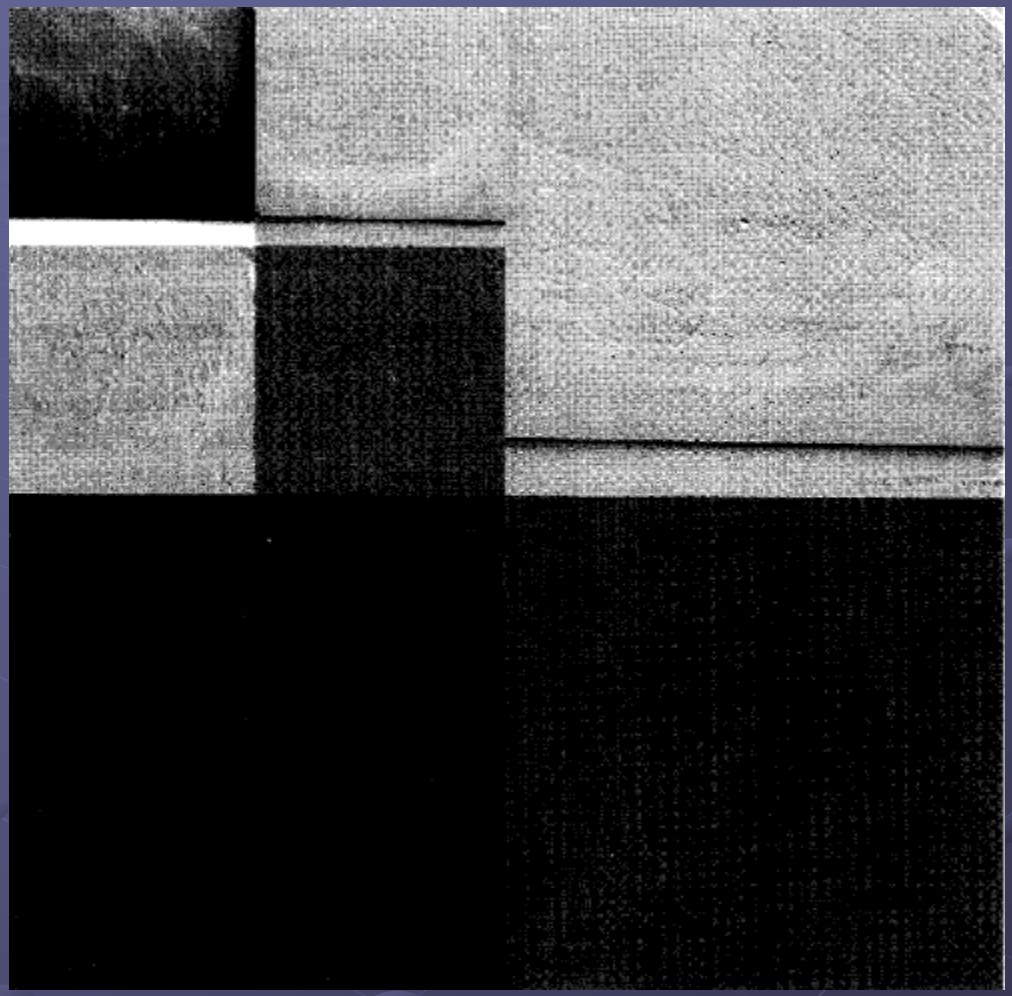
Improving the Mammogram:

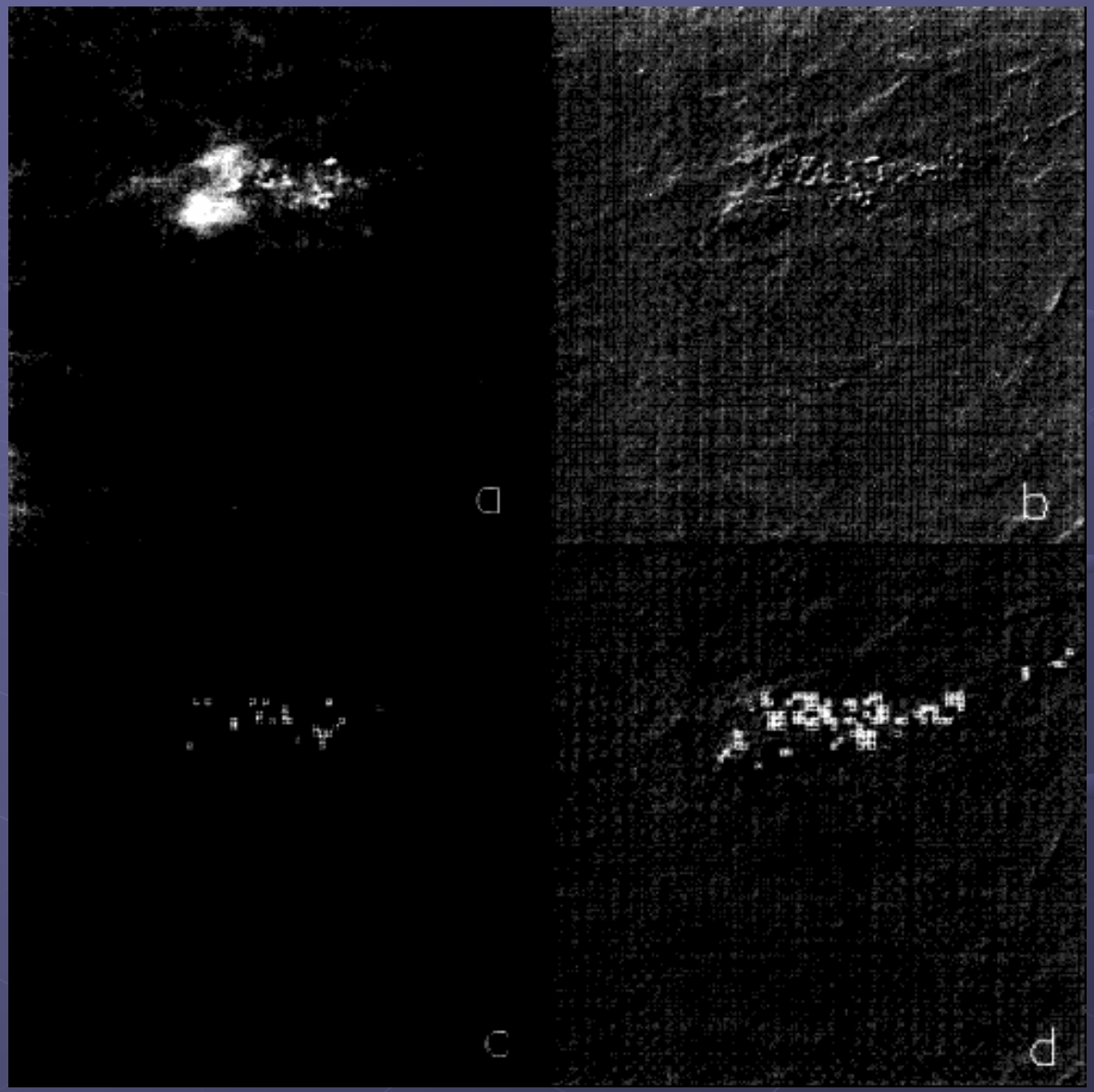
- Even well trained radiologists misdiagnose 10-20% of mammograms they review[1]

Applying Wavelets

- Improves texture of images
- Filters/Windows signals and performs Fourier Transforms
- Use of Compression Methods (Huffman)

- Computer Aided Diagnosis




a
b
c
d

Automated Target Recognition

- Image Processing Tools
  - Originally used to detect, Identify, and characterize Military targets

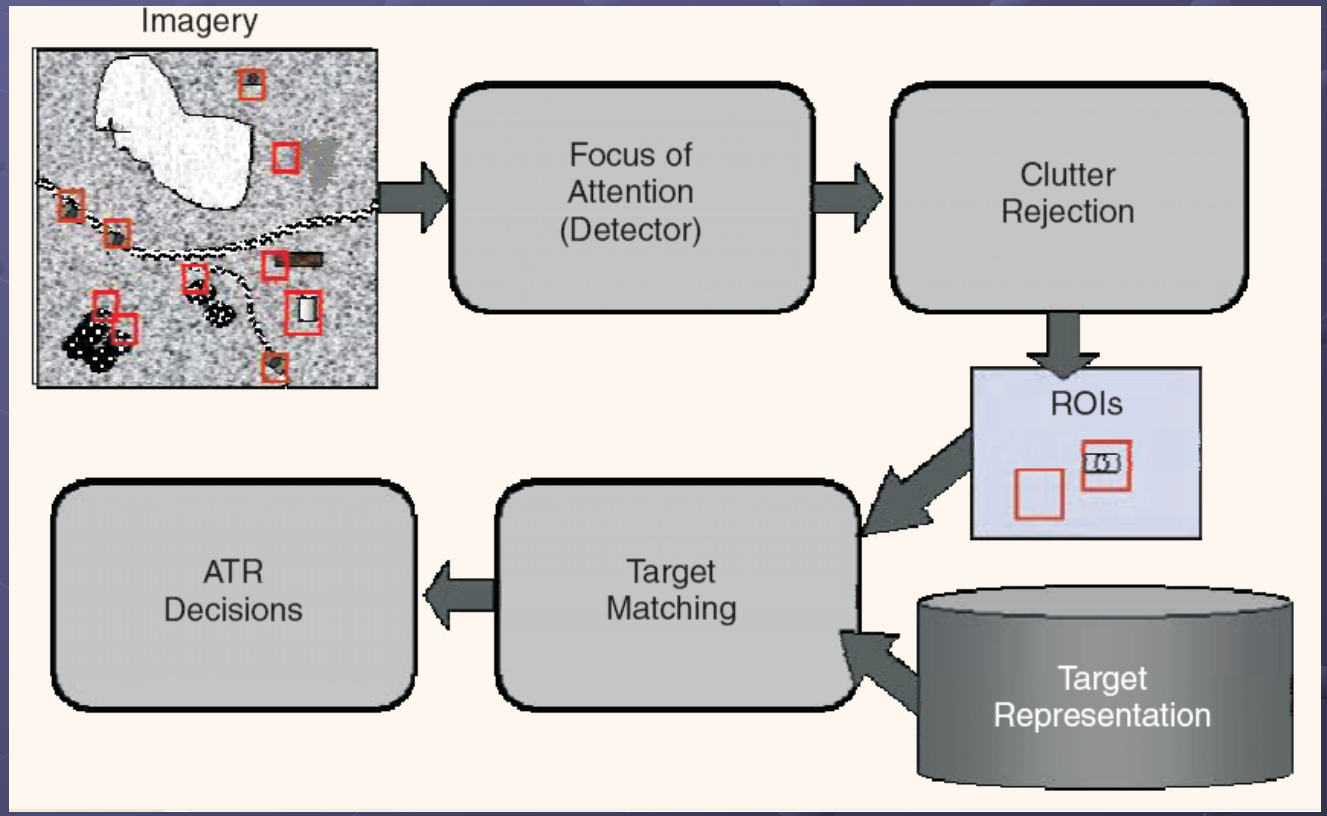


Table 1. Relationship between ATR and medical application.			
Issue	**ATR Application**	**Medical Application**	**Comments**
Gold standard	Image Truth – often derived from GPS and ground measurements	Patient history, pathology, other diagnostic tests	Incomplete understanding of missed detections
Sensing conditions	Limited control over collection conditions (weather, time of day, range to target)	Good control of environment and subject. Protocol determines sensing conditions.	Need to develop standard protocols to maximize the information derived from thermal imagery
Targets	Rigid structures and defined shapes (vehicles). Amenable to CAD modeling	Target shapes and sizes vary. Target may grow over time	Modeling the target signature is challenging
Environment	Heterogeneous background and clutter. Camouflage, target obscuration	Depth of target — target is below the surface. Complexity of surrounding tissue	Need to understand interaction between target and surrounding tissue

Table 2. Operating conditions for the ATR and medical applications.		
Class of Conditions	**ATR Application**	**Medical Application**
Sensor	Sensing modality Resolution Viewing geometry Image chain	Waveband, spatial and spectral resolution, calibration, viewing geometry, monitor/display, ambient lighting
Target	Target types, model variants, pose, articulation, obscuration	Size, depth, tumor shape, vasculation
Environment	Vegetation Season Terrain Weather Cultural features Confuser targets	Age Pre- or post-menopause Time of day, month Breast size and density Temperature: body, room, time in room Family history and genetics Medications, alcohol, tobacco

Infrared Technology

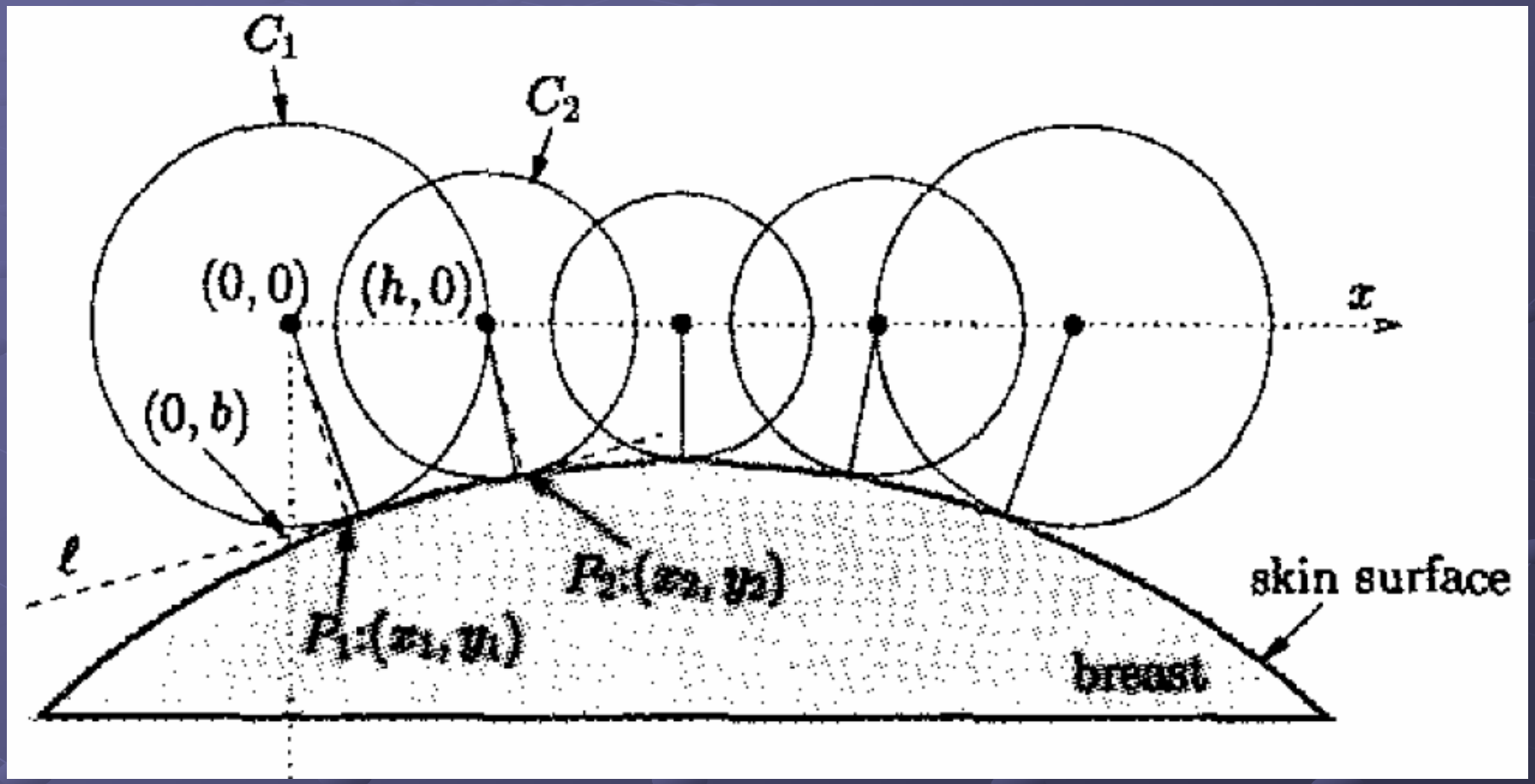
- BCDDP (Breast Cancer Detection and Demonstration Projects) 1973-1981
- Allows more pervasive detection
- Good for Earlier Detection
- Cons: Placement of tumor unknown

Table 1. Infrared results from normal, cancer, and deceased cancer patients.			
Infrared Results	Patients		
	Normal	Cancer	Deceased
Normal	72 72%	35 35%	15 12%
Abnormal	28 28%	65 65%	111 88%
$p < 0.0001$, chi-square analysis for independence			

1. A patient with an abnormal asymmetric breast infrared image.

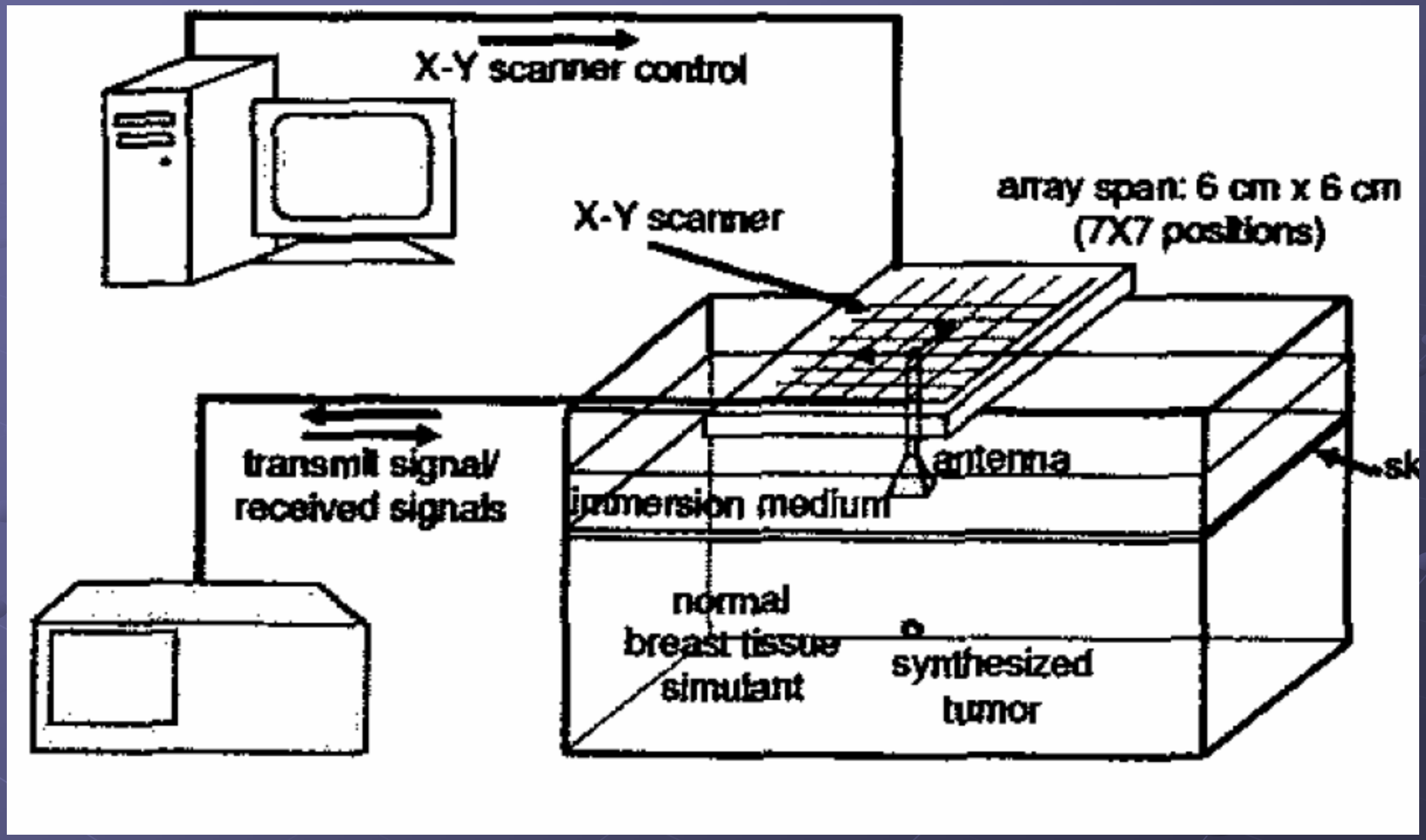
UMB Microwave Breast Cancer Detection

- Tumors have different dialectric properties than normal tissue
  - Dielectric Constant ε_r
  - Conductivity σ
- Two types of microwave imaging techniques
  - Tomography
  - Radar


C_1
C_2
$(0,0)$
$(h,0)$
x
$(0,b)$
ℓ
$P_2(x_2,y_2)$
$P_1(x_1,y_1)$
skin surface
breast

Pro's For Using this Technique

- Microwave Attenuation low enough to allow imaging of the entire breast
- Low Power Pulses (avoids ionization)
- Microwave Imaging in Space Time
  - Allows 3D rendering
  - Allows Discovery of tumors <0.5 cm
- Microwaves frequency in the middle
  - High Frequency allows better resolution images
  - Low Frequency allows better penetration


X-Y scanner control
X-Y scanner
array span: 6 cm x 6 cm
(7X7 positions)
transmit signal/
received signals
antenna
immersion medium
normal
breast tissue
simulant
synthesized
tumor

Microwave Image

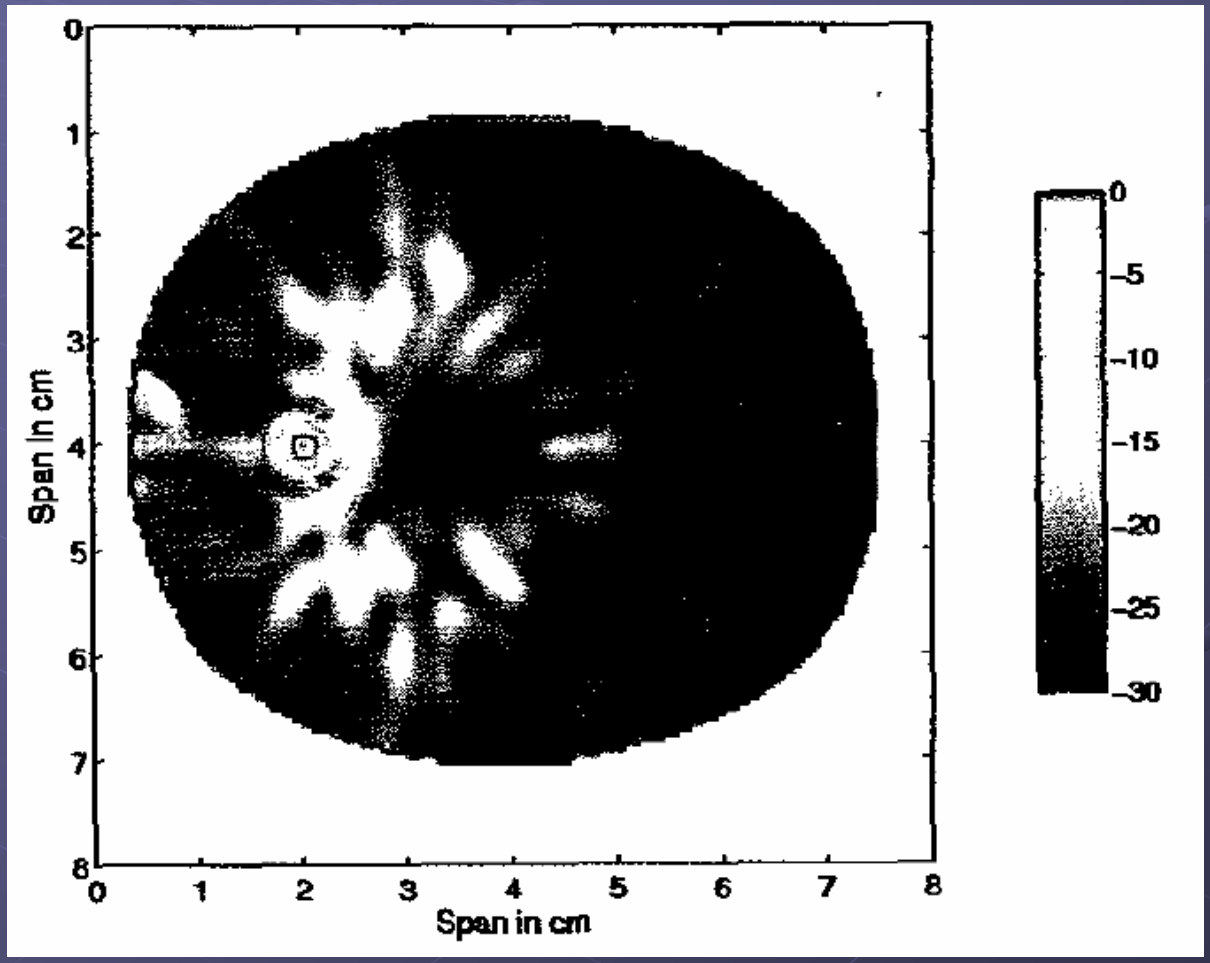
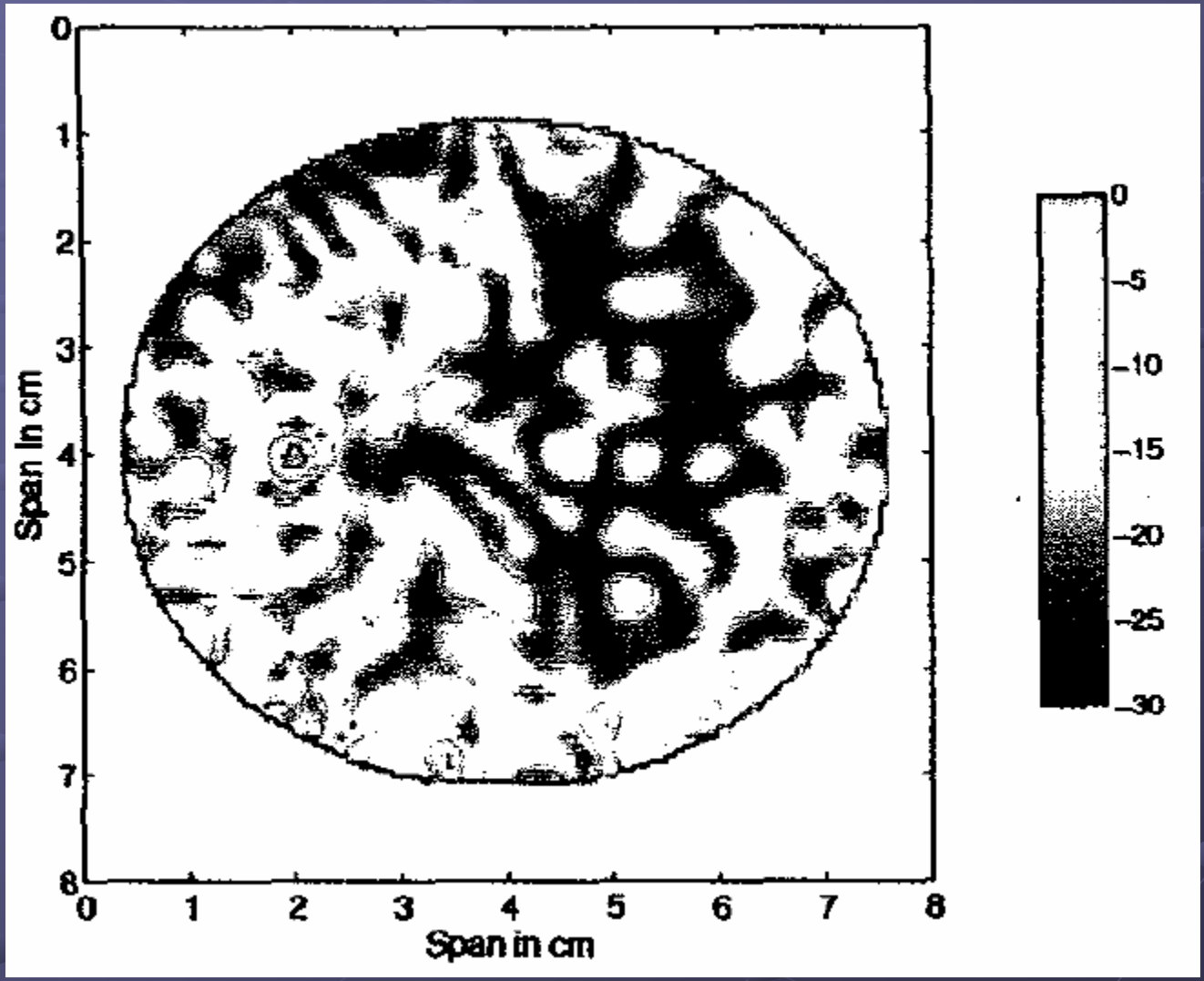
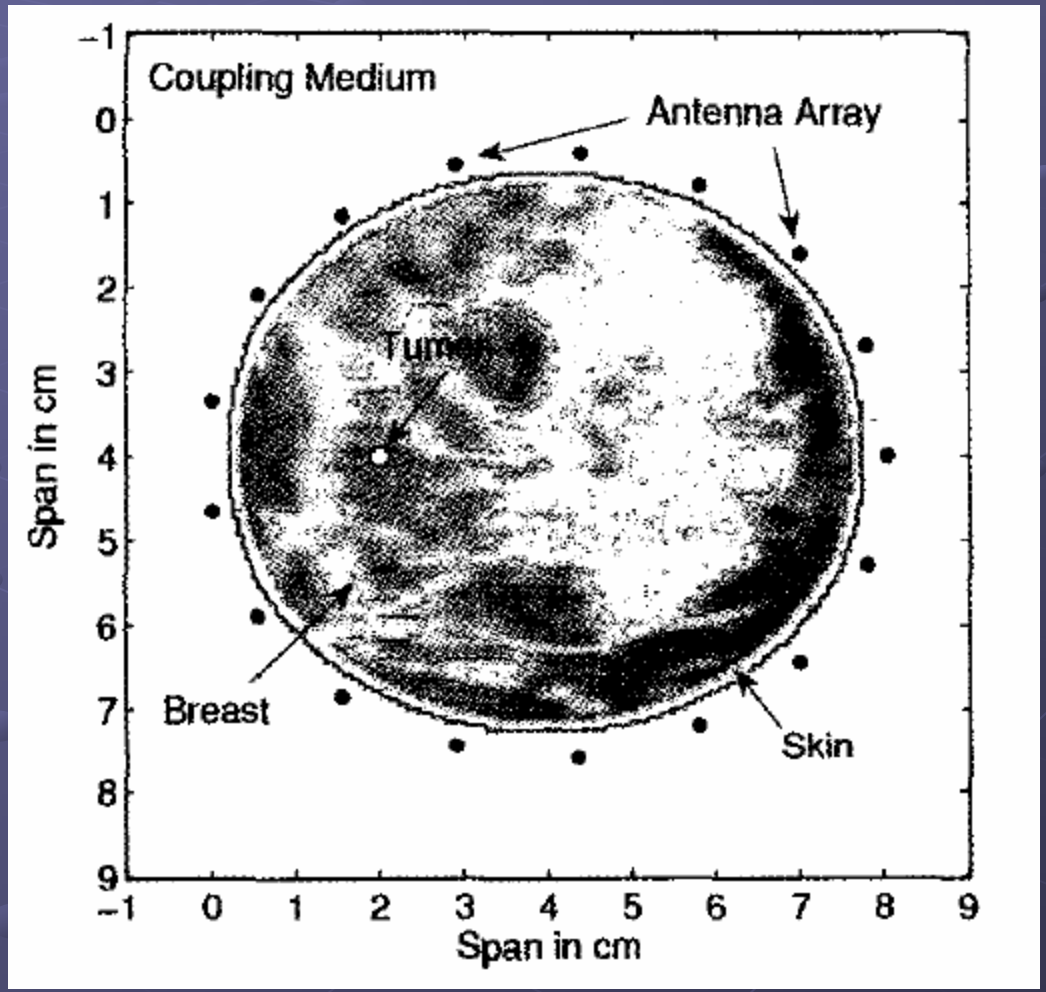


Image after Idealized Articraft Removal



Using MRI to detect Tumors



Conclusions

- Electrical Engineers can provide better solutions to detect and destroy breast cancer
- Breast Cancer has been around for a long time and recent technologies are improving prognosis

Funding for Breast Cancer Research

- American Cancer Association
  - Breast Cancer Walk
- NSF (National Science Foundation)
- Department of Defence

Questions?