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TITLE: Test Bed Development for Detection and Diagnosis of Prostate Cancer via Internet and Wireless Communication Networks

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14. ABSTRACT
In our research and training program (HBCU Undergraduate Collaborative Summer Training), we address detection and diagnosis of prostate cancer in two technology and application aspects, (a) remote detection and diagnosis through Internet and wireless networks and (b) computer-aided detection and diagnosis. With remote detection and diagnosis, we will provide prostate cancer screenings to men in rural regions and developing countries. With computer-aided detection and diagnosis, we will develop techniques to reduce the costs of telepathology for prostate cancer detection and diagnosis, both in terms of transmission costs and online reading costs. Thus with remote and computer-aided prostate cancer detection and diagnosis, it will have the advantage of higher penetration ofmenforcancerscreening

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Table of Contents

Test Bed Development for Detection and Diagnosis of Prostate Cancer via Internet and Wireless Communication Networks
- HBCU Undergraduate Collaborative Summer Training

1. Introduction

1.1 PC-REU Research Objectives

Prostate cancer research experiences for undergraduates (PC-REU) are conducted under a HBCU Undergraduate Collaborative Summer Training program. The HBCU institute is Jackson State University and the research and training host institute is Stevens Institute of Technology.

Prostate cancer is the most commonly diagnosed cancer in men and is the second leading cause of cancer deaths in men. Early detection offers the best chance at long-term survival. However, in rural areas or developing countries where pathologists or physicians who specialize in diagnosing prostate cancer are scarce, men have difficulties in accessing prostate cancer screenings and, therefore, incur a greater risk. Broadband access (high-speed Internet) is becoming available in more and more locations in the U.S. and it is thus desirable to take advantage of the broadband technology to improve health care for all Americans, including prostate cancer screenings for all American men. With the explosive development of information technologies (Internet, multimedia delivery, data mining), telecommunications infrastructures (wireline, wireless, satellite networks), and information processing techniques (imaging processing, automated detection and decision making), significant advances in telehealth technologies and applications, including telepathology and imaging techniques for early prostate cancer detection, are on the horizon.

In our research and training program PC-REU, we address detection and diagnosis of prostate cancer in two technology and application aspects, (a) remote detection and diagnosis through Internet and wireless networks and (b) computer-aided detection and diagnosis. With remote detection and diagnosis, we will provide prostate cancer screenings to men in rural regions and developing countries. With computer-aided detection and diagnosis, we will develop techniques to reduce the costs of telepathology for prostate cancer detection and diagnosis, both in terms of transmission costs and online reading costs. Thus with remote and computer-aided prostate cancer detection and diagnosis, it will have the advantage of higher penetration of men for cancer screening.

1.2 PC-REU Team 2005 and Projects

The following table summarizes the team of this year's training team and related projects.

PC-REU Team 2005 and Projects

<table>
<tr><td colspan="3">PI/program director: Dr. Yu-Dong Yao (Stevens Institute of Technology)</td></tr>
<tr><td colspan="3">HBCU faculty academic advisor: Dr. Robin Liu (Jackson State University)</td></tr>
<tr><td>Student</td><td>Mentor</td><td>Project</td></tr>
<tr><td> 
Ahmadullah Faizi</td><td rowspan="3">Dr. Hong Man</td><td>C++ to Java interactions teleconferencing white board for remote detection and diagnosis of prostate cancer</td></tr>
<tr><td> 
Husseina Ozigi-Otaru</td><td rowspan="2">Image processing techniques as applied to detection and diagnosis of prostate cancer</td></tr>
<tr><td> 
Hassana Ozigi-Otaru</td></tr>
</table>

 Ryan White	Dr. Yang Meng	Detection and tracking algorithms
 Coney Dorsey		
 Christopher Scott	Dr. Yu-Dong Yao	Comblocks modules for test bed development for detection and diagnosis of prostate cancer via wireless communication networks
 Busola Olagbegi		Medical imaging as applied to detection and diagnosis of prostate cancer

2. Report Body

2.1 The Training Program

2.1.1 Training Program Overview

In the summer of 2005, we ran our first-year research training program (PC-REU) under this award/funding support. Seven undergraduate students were recruited from Jackson State University to participate in the training program. There are three mentors (Profs. H. Man, Y. Meng, and Y. D. Yao) from Stevens Institute of Technology directly advised the research. Prof. R. Liu served as HBCU faculty academic advisor. Additionally, Prof. W. Qian of Moffitt Cancer Center supported the research training program. Several graduate students also interacted with and advised the undergraduate trainees. The undergraduates participated in five projects (see subsection 2.2.2). PC-REU students also worked and interacted with other summer research students (in various programs such Scholar-REU and Technogenesis-REU).

PC-REU students together with other summer research students.

2.1.2 Training Elements

This 12-week research training program is organized and scheduled into 12 units. There are learning elements (image processing algorithm, Java programming and socket programming) and laboratory assignments (electronic components selection and testing) for each unit. There are presentations and seminars by mentors and PC-REU students. Another important element is the weekly all-hands meetings.

2.1.3 Weekly Meetings

There are weekly all-hands meetings for trainees to report work progress and plans for the following week. The following shows several photos taken at the weekly meetings. Mentors, graduate students and undergraduate trainees have extensive interactions through the weekly meetings. Students also gain experiences in presentations and professional communication. Students set up personal research web page and post their weekly reports and research documents.

Weekly report/presentation at a weekly meeting (Ahmadullah Faizi).

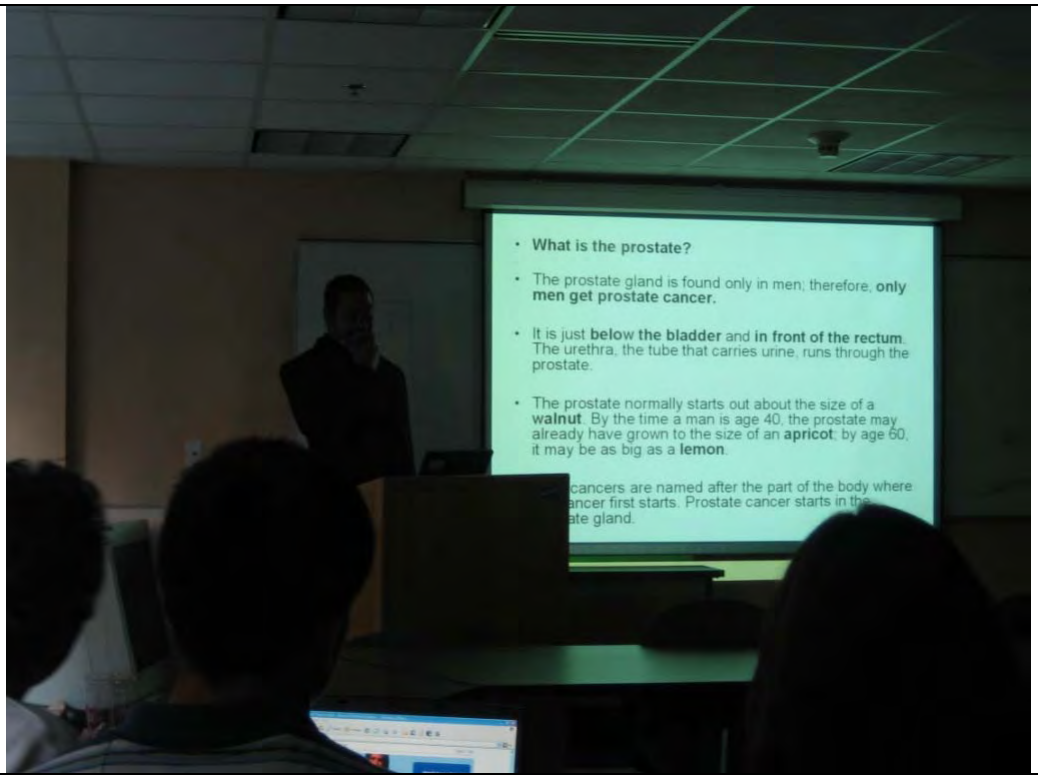
Weekly report/presentation at a weekly meeting (Ryan White).

2.1.4 Seminars

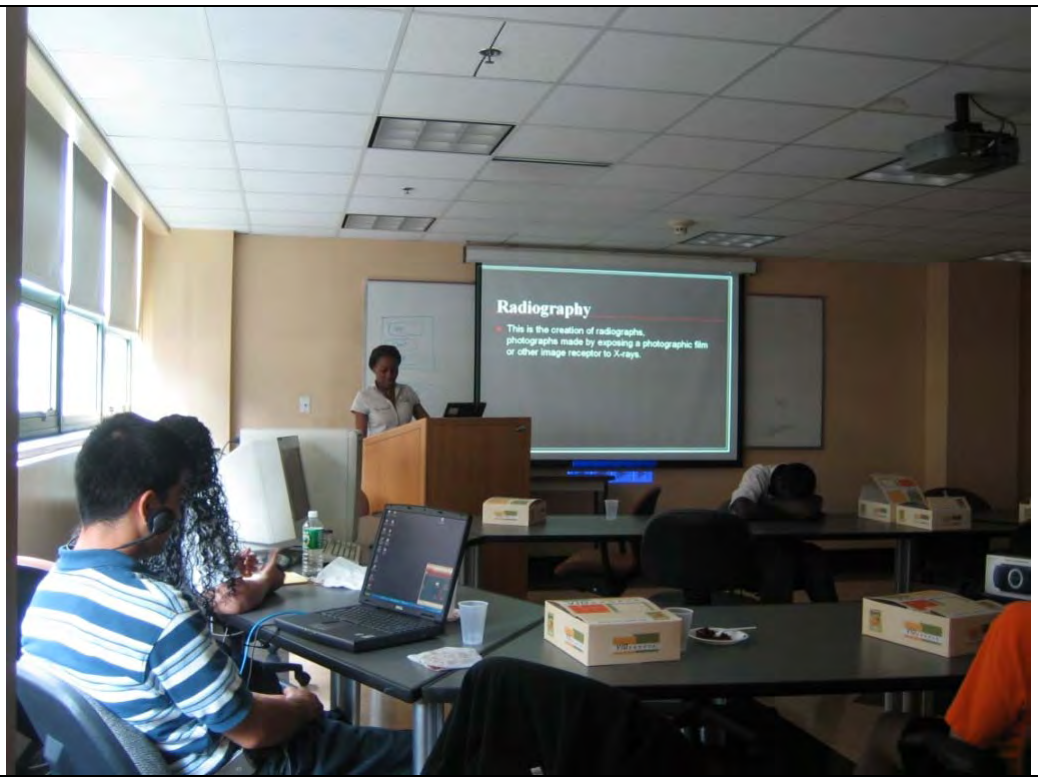
Besides weekly meetings and presentations, research mentors gave seminars addressing specific research topics. PC-REU students also gave seminars reporting research results in focused research subjects.

Prof. W. Qian gave a seminar on cancer and imaging processing.

Prof. H. Man gives a talk on X-ray.



PC-REU student Christopher Scott gave a seminar on prostate cancer.



PC-REU student Busola Olagbegi gave a seminar on radiology.

2.1.4 Mentor Involvement

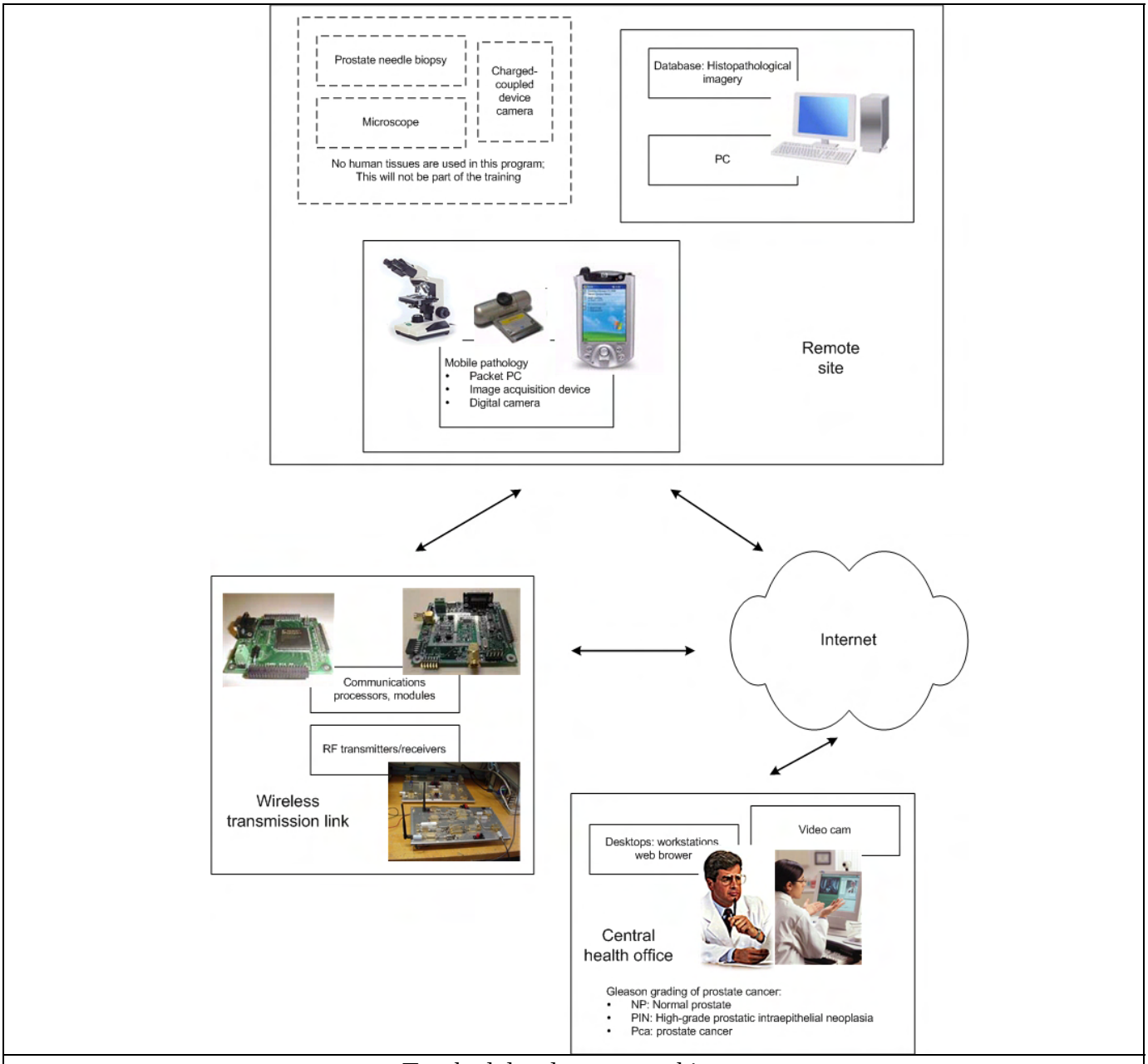
Faculty members (Dr. Yu-Dong Yao, Dr. Hong Man, and Dr. Yan Meng) interacted with students frequently. A number of graduate students worked with the undergraduates in a team and contributed significantly to the training program. Faculty mentors and undergraduate trainees attend weekly all-hands meetings. Such a group setting serves an important mentoring process. Additionally, faculty mentors visit the trainees in the research laboratory at least once a week, thus ensuring individual mentorship (mentor-trainee) once a week.

PC-REU student Christopher Scott did a demonstration or Prof. Y. Yao and Prof. W. Qian.

2.2 Study and Research Areas

2.2.1 Test Bed and Development Architecure

For this training program, a test bed development architecture contains three main elements, (1) a remote site, (2) transmission links, and (3) a central health office. Details of the test bed architecture for prostate cancer detection and diagnosis through Internet and wireless networks are illustrated below.



Test bed development architecture.

2.2.2 Projects

The following lists five projects conducted in the summer program,

(1) C++ to Java interactions teleconferencing white board for remote detection and diagnosis of prostate cancer: Remote detection and diagnosis will play a potential role in delivering a wide range of health care (including prostate cancer care), social programs and services to world living in remote and isolated communities. The goal of this project was to create teleconferencing software allowing two or more users to communicate via streaming video, voice, file transfer, text chat, and a white board. Throughout this program we attempt to improve previous years' source codes which were written for win32 in C++ and use some C standard library functions. As we went further through the project we found out using Java language more effective and powerful special in multimedia and networking than C and C++ so the decision has mad to combine C++ code with Java using JNI (Java Native Interface). In the project we wrote a whiteboard in applet to allow the User to draw pictures, shape, etc and be able to save, and clean the board by pushing buttons.

(2) Image processing techniques as applied to detection and diagnosis of prostate cancer: In this project, students were furthering research experience by investigating the techniques of image detection which can then be used to examine remote detection and diagnosis of prostrate cancer through Internet and wireless networks to provide prostrate cancer screenings to patients in remote areas. By examining the roles of telepathology and teleconsultation we hope to provide significant advances in the early detection of prostrate cancer. With the start of the program, the team decided to take a technical approach to providing a media for the teleconsultation of pathologists. We started with debugging existing programs written in previous summers. We first learned C++ then familiarizing with the Intel OpenCV under GNU Linux. We studied the CImg library which is an open source C++ tool kit for image processing and it provides simple classes to load, save, process and display images in C++. We restructured a program to load a JPEG image that when clicked on will display the intensity profiles of RGB of the corresponding image line. After which the team wrote a program to display intensity profiles of RGB on JNP files and looked at some more functions on OpenCV Image Processing.

(3) Comblocks modules for test bed development for detection and diagnosis of prostate cancer via wireless communication networks: The basic task of the comblocks was to establish connection across transmitter and receiver without any disruptions. The Comblock setup involved two platforms. On one platform it was the setup for the transmitter and the receiver setup was on the other platform. The platform setups consisted of comblocks connected to other comblocks. There were five comblocks for the transmitter and four comblocks for the receiver. The transmitter side began with comblock 5001 the LAN/IP NETWORK INTERFACE. This comblocks' main purpose was to provide high-speed network interface for data transfer and monitoring & control of comblock assemblies. This comblock was then connected to comblock 8001 the ARBITRARY WAVEFORM GENERATOR. This comblocks' main purpose was to Stores 256 MB or 1GB of binary data in DRAM. Next comblock that was connected was comblock 1002 the BPSK/QPSK/OQPSK MODULATOR. This comblock was used to modulate the signal from comblock 8001 for the next comblock, which is comblock 2001, this comblock converts the modulated signal from digital to analog. The final comblock assembled on the

transmitter side is comblock 4001 DUAL-BAND 915 MHz/2.4 GHz QUADRATURE RF MODULATOR. This comblock is the transmitter of the modulated converted signal that came through the arbitrary waveform generator from the LAN interface network comblock.

3. Key Research Accomplishments

- A telehealth and telediagnosis network architecture was defined, with applications to remote detection and diagnosis of prostate cancer
- A multimedia platform with audio, video streaming, text, and white board as applied to teleconsultation for remote detection and telediagnosis
- A comblock based wireless test bed was developed for remote detection and diagnosis of prostate cancer through a wireless network

4. Reportable Outcomes

- Developed a multimedia platform software package with audio, video streaming, text and white board applications, which is intended for communications between remote sites and a central office in a prostate cancer care network

- Developed a comblock based wireless test bed, which is a key component of a wireless test bed for the remote detection and diagnosis of prostate cancer

5. Conclusions

This training program has given undergraduate students good opportunities to understand the importance of remote detection and diagnosis of prostate cancer. It shows engineering students (electrical and computer engineering) the role of engineering and technology in health care and medical services, especially in prostate cancer care. The training program also enables the undergraduate students interact with faculty and graduate students in learning and research.

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