How to Develop Engineering Entrepreneurship: Case Study – Florida Atlantic University

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ABSTRACT

In this paper we present non-traditional, radical university arrangements that we implemented in the College of Engineering and Computer Science at FAU in order to develop engineering entrepreneurship. In the present state of the economy, research funding has been drastically reduced – these are chances for universities. However, universities can only effectively become incubators of entrepreneurship and innovation if they themselves practice entrepreneurship. This "re-conceptualization" involves non-traditional, often radical university arrangements. In this paper, we describe our entrepreneurial, research, and innovation strategy in the College of Engineering and Computer Science at Florida Atlantic University, which we implemented during the last several years. The backbone of our new concept is the NSF-sponsored Industry/University Cooperative Research Center for Advanced Knowledge Enablement with 28 industry members, a more than 25 applied research projects. The university has created Research Park at university premises with more than 40 high-tech companies and an incubator with 27 start-up companies. As part of our strategy, we established various kinds of collaborations with these companies. We also have a strong Industry Advisory Board with 25 industry executives who advice the Center's researchers in selecting and managing the industry projects. Finally, we created joined industry/university laboratories, in which our faculty and students work jointly with industry scientists and engineers in creating innovative systems and products. In the paper, we also present several research projects and its applied results in the area of multimedia, big data, and health informatics.

Keywords: entrepreneurial university, industry/university cooperative research center.

1. INTRODUCTION

What is an entrepreneurial university, and how does it address the world's biggest problems? For different people the term "entrepreneurial university" has different meaning ([1], [2]). Here are a few characteristics that we believe define an entrepreneurial university:

- An entrepreneurial university encourages partnerships between academics, and entrepreneurs with the objective to produce results, which will have impact and resolve some important problems.
- An entrepreneurial university values both innovation and execution. With the demise of the great corporate research labs and the limitations of the growth of government research institutes, research universities are becoming primary sources of societal innovations. ([1], [2], [3]).
- An entrepreneurial university encourages multidisciplinary teams that leverage the unique strengths of the entire institution.

- An entrepreneurial university connects the academic world with the outside world, because complex problems cannot be solved without interaction with the environments in which they occur.

Another definition, found in [3], refers to "Entrepreneurship University as an exciting concept which defines those universities providing opportunities, practices, cultures, and environments to actively encouraging and embracing student and graduate entrepreneurship." In the same article, Gibb proposes three alternative organization models for the Entrepreneurial University: (i) The optimum fully integrated model, (ii) The Intermediate: university-led model, and (iii) The external support model: stakeholder driven. In this paper, we present our strategy that we implemented in the Department of Computer & Electrical Engineering and Computer Science in creating an entrepreneurial university. We can summarize our strategy through the following steps that we implemented in the last four years:

(1) We established NSF-funded Industry/University Cooperative Research Center (I/UCRC) for Advanced Knowledge Enablement (jointly with Florida International University of Miami).

(2) We established collaboration with high-tech companies in the FAU Research Park

(3) We initiated a number of applied research projects with industries in South Florida

(4) We created industry/university laboratories in our College

(5) We created and offered a number of innovative, "hot" and applied courses taught by both our faculty and experts from local industry.

We discuss all these activities in the paper. We also present an overview of successful industry projects and their results.

The National Science Foundation is looking to establish foreign sites of the I/UCRCs. At this time, there is no foreign sites in South or Latin America. Therefore, this paper provides the model that can be implemented at one or more universities in South and Latin America., Our I/UCRC is looking for academic partners in South and Latin America universities, who can implement this model and join our Center.

2. NSF Industry/University Cooperative Research Center at FAU

In 2009, Florida Atlantic University received a five-year grant from the National Science Foundation (NSF) to create the site of the Center for Advanced Knowledge Enablement (CAKE) as an Industry/University Cooperative Research Center (I/UCRC) that will provide a framework for interaction between university faculty and students and industry in the critically important areas of information technology, communication, and computing. There are only 15 NSF-supported centers in these areas in the United States. Our Center operates as a site of the Florida International University Center.

During the last four years, the NSF I/UCRC has proven to be a win-win situation both for our university and our industry and government partners. We have been conducting industrially relevant research, receiving additional funding for it, and benefiting from the recognition and prestige of being an NSF research center. The Center is successfully building the bridge linking academia, industry, and government in a coordinated research initiative, which this region desperately needs. The Center has 25 industry members with the total memberships of $1.8 million in CAKE membership, 2.8 million in equipment and software membership, and about $1 million in NSF funding. We have more than 20 active industry projects with 15 faculty and more than 20 graduate and undergraduate students involved in these projects. The Center's mission is to accomplish the following goals:

- To continuously evolve an understanding of the technology needs of the industry sector through direct contact with industry professionals and related corporations.
- To identify applied research themes that meet the needs of private and public sectors.
- To conduct industry-relevant research.

Our Center research agenda includes the creation of new technologies for various Web-based applications, next generation of hardware and software development techniques and tools, mobile and wireless systems and technologies, video compression and communication technologies and systems, networking and communication systems, data mining and machine learning technologies, and various interdisciplinary initiatives and applications including medical systems and healthcare informatics.

Our research is applicable to many fields, including national defence and homeland security, healthcare, biomedical science, environmental science, entertainment, finance, and technology services.

The organization of the Center is shown in Figure 1. Memberships are open to private businesses, government agencies, and others with research needs in the areas of information technology, communications, and computing. The Center provides its partners with numerous benefits, including early access to research innovations and opportunities to interact and work with university faculty, students, and industry peers. The Center is housed in the new LED-certified platinum green Engineering building (Fig. 2a), which is powered with the state-of-the-art private cloud computing system (Fig. 2b). There are total 9 research laboratories and 6 instructional laboratories, which are available for faculty, students, and industry researchers, who are involved in the Center's projects.

The Center's Industry Advisory Board (IAB), made up of representatives of all members, has the responsibility of determining the research areas and related projects in which membership fees will be invested. The IAB meets twice a year to discuss proposed projects and set research priorities for the Center. Fig. 3a shows a photo from the last year IAB meeting. The IAB makes recommendations on research projects to be carried out by the Center and the allocation of resources to these projects. Companies paying higher membership fees have priority in selecting the Center's research projects.

Our present members include large companies including Motorola Mobility powered by Google, LexisNexis, Tecore Networks, Avocent, an Emerson company, as well small and start-up companies including LastBestChance, Mobilehelp, Omega Optics, Video Semantics, and others. For detailed information refer to the Center's booklet [8].

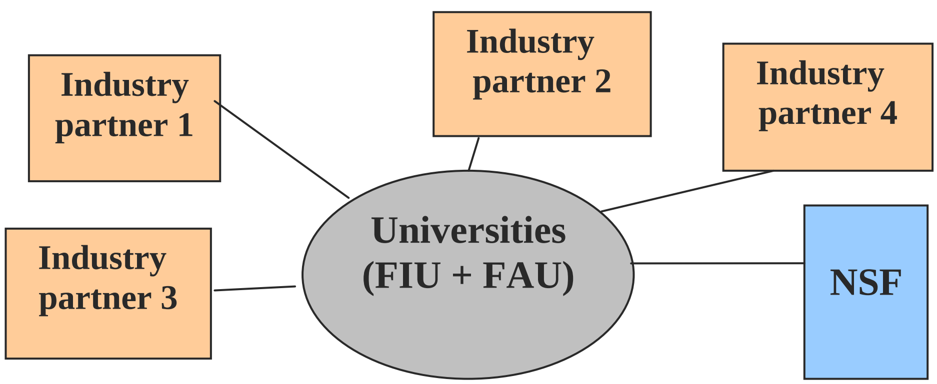

Figure 1: Organization of the Industry/University Cooperative Research Center.

3. Other Entreoreneurial Activities

One of a very important component of our entrepreneurial strategy is a very close collaboration with the Research Park, which is located on our FAU campus. FAU Research Park has 24 high-tech companies and an incubator with more than 20 start-ups. It provides 850 jobs. Our Center has collaborations with a number of companies in the Research Park, including MobileHelp, Modernizing Medicine, Pace America, and People's Trust Insurance. Figure 3b shows the aerial view of the Research Park at FAU.

Figure 2: (a) Engineering building, in which the NSF I/UCRC is housed. (b) Cloud computing system is used in several Center's projects.

We also created several joint industry/university research laboratories. These labs differentiate from traditional labs, where typically students and faculty work on research projects. These new labs also include researchers from industry, who are members of the Center, and who actively participate on joint projects with our researchers and students. We started several years ago with Motorola lab, and followed with additional joint labs with Tecore Networks, ProntoProgress, LastBestChance, and Mobile System laboratory.

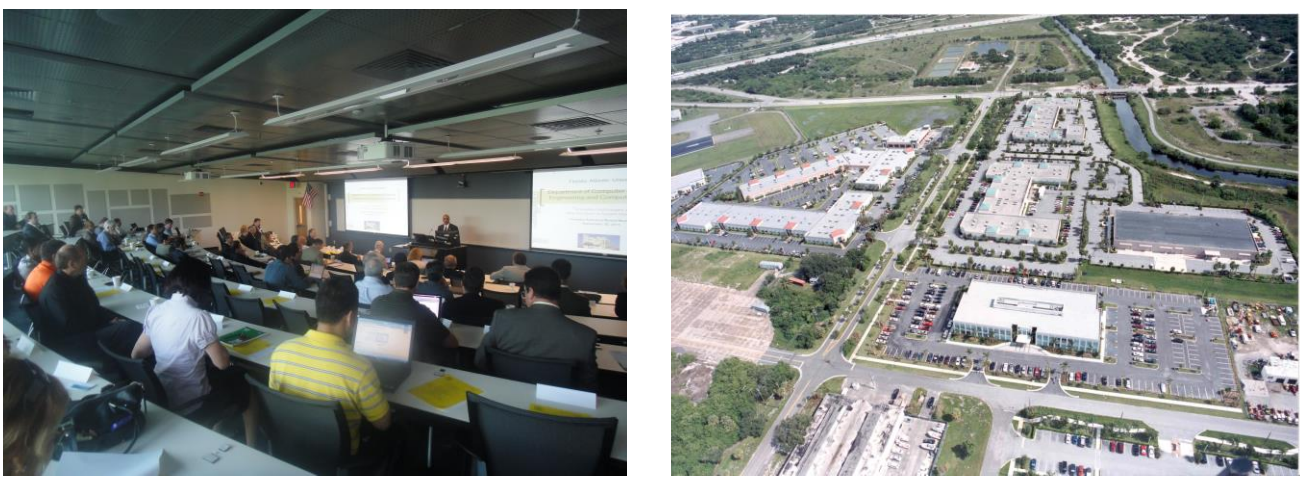

Figure 3: (a) Industry Advisory Board Meeting of the I/UCRC for Advanced Knowledge Enablement, (b) Research Park at FAU.

We also created and offered a number of innovative, "hot" and applied courses taught by both our faculty and experts from local industry. These courses attracted a large number of undergraduate and graduate students, and they were a great source to attract and identify the best students for the Center's research projects. The recent courses included Mobile System Development (both for iOS and Android), Cloud Computing, Data Intensive Computing, Advanced Internet Programming, Social Networks and Big Data Analytics, Emerging Multimedia Technologies, and Data Mining and Machine Learning.

4. OVERVIEW OF INDUSTRY PROJECTS

4.1 CLOUD COMPUTING SERVICES WITH 3-D VISULAIZATION FOR CLIMATE DATA ON DEMAND

This study has been result of the collaboration between FIU and FAU I/UCRCs and the Center for Hybrid Multicore Productivity Research (CHMPR) at University of Maryland Baltimore County. In this project we have developed the capability to deliver a decade of 3-D gridded arrays of animated visualizations of spectral IR satellite radiance data from instruments on the Aqua satellite, which was launched in 2002 (Figure 4). These animations render in 3-D the vertical structure of a decade of global and regional temperature trends occurring at the surface and lower troposphere.

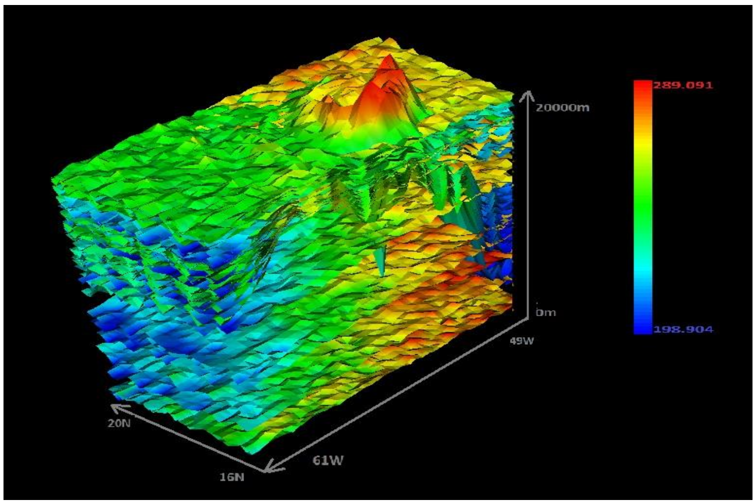

Figure 4: The 3-D gridded arrays of animated visualizations of spectral IR satellite radiance data provide atmospheric temperature layers up to 20,000 meters (6,619 feet).

The CHMPR center developed the gridding algorithm, which was applied to provide the CAKE Center with 3-D temperature profiles that specify the thermal structure around hurricanes in order to improve their landfall prediction. The joint team has implemented a distributed cloud computing Web-based service, called SOAR that incorporates this visualization capability as a public service available on an advanced IBM-based server cluster. The system provides researchers with the ability to select regional and temporal periods and automatically transform IR orbital satellite data into spherical grid arrays of 3-D temperature profiles for viewing the continuous changing thermal structure of the atmosphere. This project has been published in the NSF Compendium of Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers, 2014 [2].

4.2 AUTOMATIC ASSET MANAGEMENT IN DATA CENTERS

A data center is a facility that hosts computer systems, servers, power supplies, storage systems, and other related computing equipment, referred to as assets. The size and number of these data centers are continuously increasing to accommodate the need and demand for web based applications and services. Assets are mounted in racks and a typical rack can accommodate up to 42 assets depending on the asset size. Large data centers have thousands of racks and keeping track of these large numbers of assets manually makes it very tedious and highly prone to errors. Human errors continue to be the greatest cause of unplanned downtime in data centers. Solutions that minimize human input in asset management will lead to higher productivity and reduced downtimes.

Portable devices such as tablets and mobile phones are ideal devices to perform asset management operations in data centers. Information technology (IT) personnel can effortlessly carry these devices in data centers to conduct management operations. Such devices have become computationally powerful and are equipped with cameras and other sensors. Cameras on these devices provide a unique opportunity to simplify asset monitoring in a data center. Cameras on mobile devices can be used to visually recognize the assets in a rack and provide real-time information about the operating health of the assets. With a camera based solution, IT personnel have to just point the camera at a rack and select the device to monitor. Any mismatch between the asset identified in the rack and the asset that was expected is immediately flagged. Another advantage of this solution is to be able to immediately identify problematic assets using real-time operational data from the assets without having to explicitly and manually logging into the asset management system.

We developed a solution for asset identification using image descriptors. A database with descriptors of asset images was built for every distinct asset in the data center. Assets to be identified are captured using the camera on the mobile device. The device then extracts and transmits the image descriptors to the server for matching and asset information retrieval. Speeded Up Robust Features (SURF) is widely used in image matching problems. We developed an optimized version of SURF to improve matching accuracy and reduce computational complexity of feature extraction as well as matching. The system diagram of the solution is shown in Figure 5. Information theoretic approaches were used in complexity reduction methods. The results show that the proposed methods reduce complexity of asset matching by 67% when compared to the matching process using unmodified image feature descriptors. Figure 6 shows various query images of the assets used in the project.

This research performed has potential for a broad impact on data center management. The image matching technology has applications in a broad range of applications where robust matching of visual information is essential. One company has conducted a thorough evaluation and integrated this technology in a data center management product line. Industry partner, who was involved in this project is Avocent, and Emerson company.

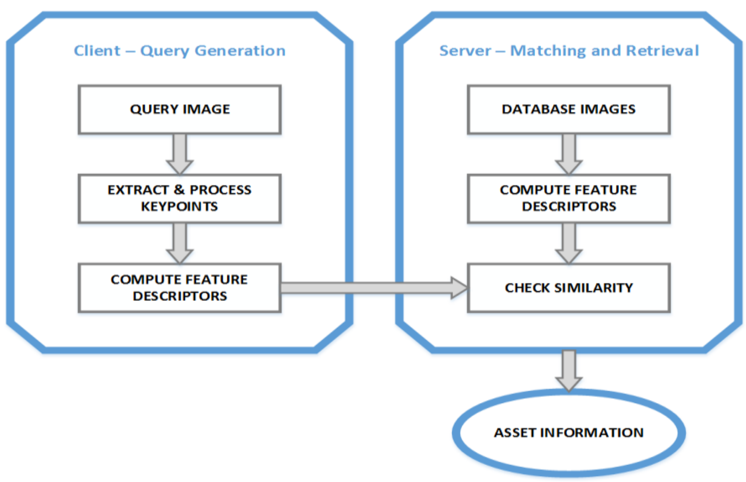

Figure 5: System diagram of the proposed solution.

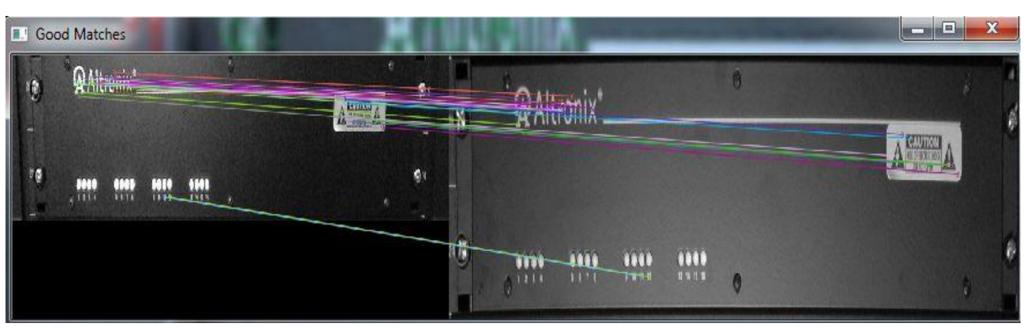

Figure 6: Matched output with lines indicating the matches from

the query image to the image in the database

4.3 SYSTEM FOR REDUCING PATENT RE-ADMISSION

Hospital readmission is one of the indicators for the quality of care. Hospital readmission rate has direction relation with the financial burden on the patients and the government/private medical care organizations such as Medicare, Medicaid and Insurance companies. There is enough evidence that almost 70% of the readmissions are related to four diseases which are Congestive Heart Failure, Diabetes, Chronic Obstructive Pulmonary Disease (COPD) and Syncope. Deploying technologies to avoid such readmission could not only improve the quality of patient care but also help offload a great deal of mounting financial burden. It is important to note that one of the biggest pie of the healthcare expenses in USA are related to "Hospitalization". FAU's NSF I/ICRC for Advanced Knowledge Enablement in partnership with Soren Technology developed a system for reducing hospital readmissions. The technology solution is developed by integrating several concepts such as telemedicine, patient care coordination and developing a decision support system for identifying a patient with high risk of re-admission based on data-mining and statistical analysis engine. The current system focuses on the readmission issues related to COPD. The process flow is shown in Figure 7.

A study reported in 2009 indicates that 19.6% of Medicare fee-for-service beneficiaries who had been discharged from a hospital were readmitted to the hospital within 30 days, 34.0% within 90 days, and more than half (56.1%) within one year of discharge. Also, the Medicare Payment Advisory Commission (MedPAC) found that 17.6% of hospital admissions resulted in readmissions within 30 days of discharge, 11.3% within 15 days, and 6.2% within 7 days. MedPAC also reported that readmissions within 30 days accounted for $15 billion of Medicare spending. More recently, according to the Institute for Healthcare Improvement, of the 5 million U.S. hospital readmissions, approximately 76 percent are preventable, at an annual cost of about $25 billion. Medicare is the payer for about half of these readmissions. The proposed system is a valuable tool in contributing the reduction in hospital re-admission. The company, which was involved in the project, was Soren Technology.

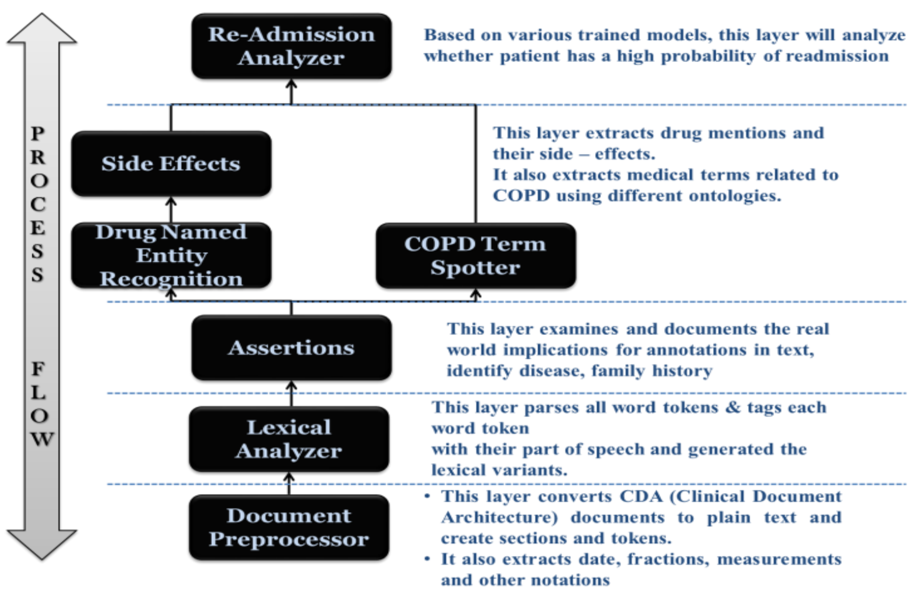

Figure 7: The process flow of the system for reducing patent re-admission.

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4.4 SMART BUILDING OPTIMIZATION SYSTEMS AND ALGORITHMS

The Engineering East building at FAU, that houses the NSF Center, is LEED Platinum certified and applies the newest green technologies to reduce its energy usage and environmental footprint (Figure 8). The building power, HVAC systems, and the server room are heavily instrumented with hundreds of sensors. In this project, we developed predictive models for energy systems and room comfort with the objective to optimize building operations. An earlier study looked at the efficiency of the solar power system, which is presently generating 7-13% of the total consumed power. We investigated the relationship between the outside environmental parameters and the generated power. A model for power generation has been developed and simulated. The results indicate a strong correlation between the sky light level and generated power – 84% correlation. The graph in Figure 9 shows the measurements of the photovoltaic power during the day, which indicates a loss in efficiency in the early afternoon. This can be explained by set of panels being in the building's shadow.

In this project, we also used data mining techniques to identify the relationships between room comfort level (defined as temperature, CO2, and humidity), HVAC parameters (defined as air inflow temperature, room volume, and occupancy), and external parameters (defined as sun exposure, outside temperature, light, barometric pressure, and participation). We derived the most relevant parameters for predicting room comfort as well as associations between a desired comfort level and controllable or environmental metrics. Using machine learning techniques, we developed models for the power consumed in the building by HVAC systems. The model includes a number of parameters such as room parameters, outside environment (such as light level, participation, temperature, and humidity), and time, date and estimated building occupancy. The predictive models for energy usage are applied for optimizing the building's energy and occupant comfort. Industries involved in these project include ILS Technology and Aware Technology.

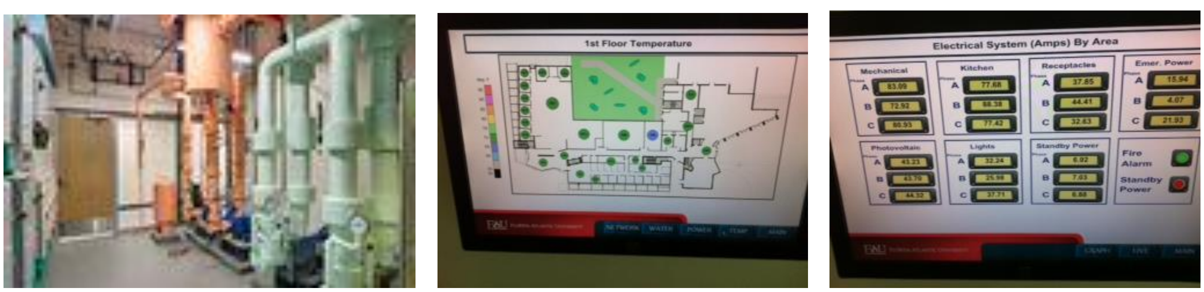

Figure 8: LEED Platinum certified Engineering building, where the experiments were made.

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The other industry projects, described in [8], include: Exploration and Integration of Voice Over IP Technologies with Social Media Platform, conducted for Motorola Mobility, Predictive Battery Analysis, done for Avocent, and Emerson company, Mobile Commerce Technology, performed for WiGime, Servicve Oriented Architecture for Agile Automated Tested Environment, jointly done with Adventure Technologies, a group of Campus 2020 projects, done with LastBestChance, LLC, New Technologies for Web-based Applications, performed for ProntoProgress, Developing Machine Learning Algorithms on HPCC/ECL Platform, jointly researched with LexisNexis, a group of projects in Wireless and Mobile Networks, done for Tecore Networks, Component Evaluation for Physical Phenomenon, performed for Mobile Help, and Design of Airport Electrical Systems, conducted for Hillers Electrrical Engineering.

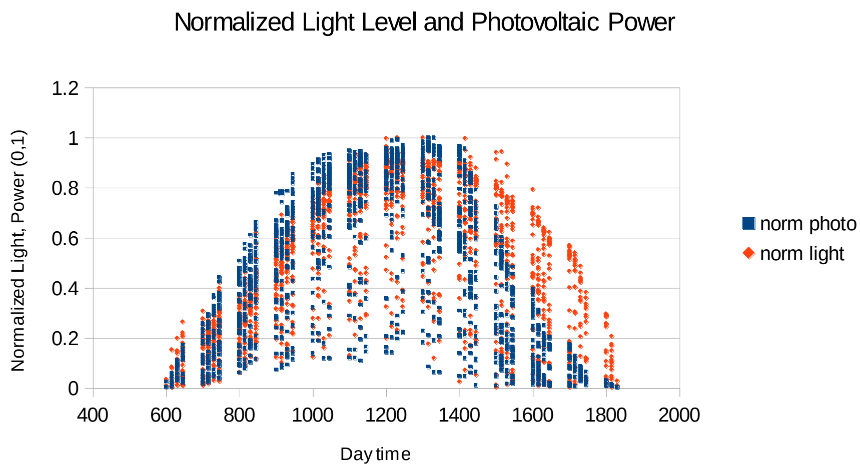

Figure 9: Photovoltaic power measurements during the day.

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5. Conclusion

In summary, research universities are increasingly critical hubs in the ecosystem of global innovation. Broad commercialization of scientific discoveries and technology breakthroughs is a rising priority of many research universities including ours. We believe that licensing of new products and services to existing companies or to university-affiliated start-up companies is an important potential source of new revenue, but it is also evaluated in the context of the university’s broader role in the local and global innovation ecosystem.

There is a very interesting initiative to create a network of entrepreneurial universities, which was explored at a workshop at MIT in March 2013. The workshop brought together experts in the field of entrepreneurship and innovation to develop a shared vision of university innovation and identify opportunities for expanding collaboration among universities.

In this paper, we presented our approach in creating an entrepreneurship university with the main focus on working closely with high-technology companies through the NSF-funded Industry/University Cooperative Research Center. We believe that we were able to build an innovative infrastructure which provides us to better connect with the needs of industry and society. After graduation, a number of our undergraduate and graduate students were hired by these industries. We still have to work to improve our "Entrepreneurship University" model by focusing on commercialization of developed technologies and creating start-up companies.

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