AC 2011-1279: COMMUNITY-BASED RESEARCH PROJECT IN WIRE-LESS COMMUNICATION

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Ronald P. Uhlig received the Bachelor of Science in Physics from the Massachusetts Institute of Technology, Cambridge, MA, USA and the Ph.D. in Physics from the University of Maryland, College Park, MD, USA. He is currently Interim Dean, School of Business and Management, National University, San Diego, California, USA. From 2005 to 2010 he was a member of the National University School of Engineering faculty, where he was Chair, Department of Computer Science and Information Systems, and Lead Faculty, Wireless Communications. During 2000-2005 he was CEO, SegWave, Inc., an educational technology company he founded, and during 1995-99 he was Vice President, Russia and Eastern Europe, Qualcomm, Inc. During 1978-1995 He held multiple positions with Northern Telecom and Bell-Northern Research. In his work both as an officer and as a civilian during 1966-1978 with the United States Army he introduced many applications in what became today's Internet. Dr. Uhlig chaired Working Group 6.5 -Email, and Technical Committee 6 Data Communications, of the International Federation for Information Processing (IFIP) and he served as both President and Secretary General of the International Council for Computer Communications (ICCC). He was elected to the International Telecommunications Academy, and, in 2000, received their Gold Medal for sustained contributions to telecommunications.

Pradip Peter Dey, National University

Dr. Pradip Peter Dey has more than 20 years of experience in Computer Science research and education. His university teaching and professional experience emphasizes mathematical modeling, information extraction, syntax and semantics of natural language, wireless apps and knowledge representation. He has done an M.S.E in Computer and Information Science and an interdisciplinary Ph.D. from University of Pennsylvania.

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Community-Based Research Project in Wireless Communication to Protect Life and Property from Wildfire

<u>Abstract</u>

In 2007, some students in the Master of Science in Wireless Communication (MSWC) program at National University observed and experienced a devastating wildfire that occurred in Southern California. This article describes how these students learned and applied their knowledge to a critical need and expressed their willingness to serve the community. The article also briefly investigates the structural relationships among the program's mission, program requirements, learning outcomes, assessment measures, and qualitative elements of the program by demonstrating students' work on a capstone project entitled "Wildfire Detection and Monitoring System." In this capstone project, students integrated hardware and software to develop an engineering product prototype to meet a pressing need. The project formal report, presentation, and prototype demonstration were evaluated by a judging panel consisting of two faculty and two professionals from the wireless industry. After careful review, the panel concluded not only that the student project was satisfactory to validate student mastery of the MSWC program, but it recommended that real world implementation of the project should be seriously considered with appropriate local governments.

Introduction

Wildfire is one of the major natural disasters that often takes place in Southern California. Every year it causes severe damage to property and loss of lives. Some of the causes of wildfires cannot be controlled. However, early detection of these wildfires can reduce the damage. According to the US Fire Administration, people living in the Wildland Urban Interface (WUI) can reduce some of these damages by taking necessary precautions if an early detection of wildfire is possible¹.

October 2007 was one of the most devastating wildfire seasons in the state of California. According to published news, 1500 homes and 500,000 acres of land were burned. Nine people died, eighty-five were injured, and one million were evacuated. Two of the largest wildfires were the Witch Fire and Harris Fire². A team of students from the MSWC program at National University started working on a project for early detection of wildfire. This project is a response to this loss of lives and property, by designing a new fire detecting system using very low cost electronics, newly developed software, and existing wireless technologies. The system is capable of detecting fire at an early stage and helping to make an accurate plan to fight the wildfires in a better way.

The "Wildfire Detection and Monitoring System" capstone project dealt with a new design and development of a fire detecting system. In this capstone project, students integrated hardware and software to develop an engineering product prototype to meet a pressing need³. They developed new software applications and used very low cost commercially available hardware

including a short-range radio channel, (Zigbee), long-range radio channel, Global System for Mobile Communications (GSM), Global Positioning System (GPS), battery (energy source), temperature sensor (thermostat: 40°C to 150°C), soldering iron (high temperature heat source), and microcontroller. This prototype system for detecting wildfires was capable of the basic functions of identifying the locations of fires and sending alert messages immediately to designated cell phones. This system can help firefighters and police officers respond quickly to an emergency call, and thus set up an effective plan to extinguish fires in an efficient way. While the system is innovative, it does not use advanced technology. What sets the system apart is the fact that the very low cost of the system and its ease of implementation make it feasible for shortterm deployment by local governments, despite very severe budget constraints.

The Working System Diagram

The system consists of fire sensing units, a command and control unit, and mobile units. The fire sensing units communicate with the control unit using Radio Frequency (RF), and the control unit communicates with the mobile units using GSM. Figure-1 shows a high level diagram of this wildfire detection system⁵.



Figure-1: Wildfire Detecting System³

The overall operational method of the wildfire detection and monitoring system is as follows:

- Temperature sensor detects temperature fluctuations.
- If the ambient temperature rises above 60° C, the sensing unit alerts the control unit.

- The sensing unit encodes the detected information and transmits this encoded information using RF Transmission.
- The Control unit receives the coded detected information using a RF receiver.
- The received information is decoded, and then the information is displayed on a personal computer using HyperTerminal through RS232 Communication for which the microcontroller issues commands.
- The person at the control unit sends the information to firefighters through SMS using GSM for communications and at the same time updates all information on the website for user access.
- Mobile users open Google Maps to display the exact location of the fire.

Control command is a high-end computer located at the wildland-urban interface. Control command can receive calls/messages from multiple control units and display these units on a map. Thus it continuously monitors all fire sensors. Control command is also responsible for sending and receiving messages to and from the mobile units.

Theoretically and practically, dividing the geographical area into zones is one of the challenging steps of the entire process. In this project, zones are divided based on the electronic hardware infrastructure, assuming that a zone should contain one control unit and several fire sensors. Control units and fire sensors are linked through RF channels. A zone can be defined as a geographical area in the shape of a polygon. This definition introduces two variables – shape and area. To determine these variables and to define a zone, this project used the concepts of cellular wireless technology.

In a cellular network, a geographical area is divided into multiple cells. These cells are usually represented as hexagons. This shape is used for a cell because the radiation pattern is spherical. The concept of circular zones would appear to be the best method for a spherical radiation pattern; however, a cluster of circular zones excludes some geographical areas between the circles. Hence, to avoid this problem, hexagonal cells are considered ideal⁴. Figure-2 illustrates typical cell designs using both hexagons and circles.



Hexagonal cells

Circular cells

Figure-2: Cell System⁴

The major factor that influences the size of a cell is the range of operation of the RF transmitter and receiver. High transmitter power of the fire sensor and high receiver sensitivity of the control unit are desired. The area of a zone or cell can be increased if the transmission range can be increased. A high-end ZigBee communications channel would have a typical range of 1000 to 1200 meters.

Another issue in implementing this project was the cellular network coverage for the control units. A Wildland Urban Interface (WUI) would probably have good network coverage. However, in practice, the dense forestlands have much less network coverage. Since the control units are not moving, they can be considered as fixed wireless devices. It is easier to provide network coverage to a fixed wireless device than to a mobile device. Depending on the type of radio interfaces available, Code Division Multiple Access (CDMA), Global System for Mobile Communications (GSM), or other appropriate interfaces are installed in the control units. Third Generation (3G) networks will further strengthen this project.

The Hardware Subsystem

The hardware subsystem consists of fire sensor clients, fire alert receiver at the control unit, control command, and mobile devices. Sensor units consist of a temperature sensor, microcontroller, voltage regulator, RF transmitter, and encoder. A temperature sensor senses the heat and the microcontroller sends the sensed information through an RF transmitter to the control unit. In the sensor unit, a voltage regulator provides 5V regulated voltage to the microcontroller for its operation and an encoder encodes the sensing information for transmission to the control unit.



Figure-3: Sensor Unit³



Figure- 4: Control Unit³

The fire alert receiver at the control unit consists of a RF receiver decoder, microcontroller, voltage regulator, and a serial port. The RF receiver first receives the information from a sensor unit and then sends it to the decoder to decode the information. The decoded information is then transmitted to a personal computer through a RS232 serial port to display the alert message on the computer screen. The person at the control unit transmits the information to firefighters using a GSM Module and at the same time posts the information to their website for user access. The detail specifications and functionalities of these sensor and control units are available in the literature^{3, 5-11}.

The Software Subsystem

The control command system is based on a Graphical User Interface (GUI) software application available through a web portal. The software subsystem makes use of the Google Maps Application Programming Interface (API) to locate the forest area and the zones. The application receives the fire alert from the control unit through a GSM network channel. This alert is

processed and posted to the respective zone on the Google Maps. Thus authorized personnel at the control command are able to monitor forest conditions, and this application is extended to the mobile units. Any mobile phone that is capable of accessing the internet can be used. Also, a text message containing details of the situation is sent to mobile users. A software application was developed to enable the control command to locate the control units on Google Maps. This application also reads the alerts received from control units and warns the person in charge of the control command. This was successfully demonstrated using a combination of C#, MySQL, and Google Maps API.

Serial port communication is used to read the messages from the control unit. This is enabled through C# via a web application created using PHP. This application has a Google Maps API plug in. The coordinates of every control unit are pinpointed on the maps that show the zones. Whenever a fire alert is received from the control unit, a graphical message is conveyed on the Maps. This information is maintained in a database server using MySQL and later published on the web portal. Any authorized 3G mobile user can access the result at the web portal.

Micro Controller Program³ at Sensors 1 & 2

<pre>// Fire Sensor and Transmitter</pre>	
#include <16F72.h>	// Microcontroller Used
#use delay (clock=20000000)	// 20MHz Crystal Oscillator
unsigned read_temperature()	// For Temperature Reading from ADC Pin
float value;	
unsigned int temp $= 0;$	
set_adc_channel(0); final = Read_ADC();	// Temperature Sensor on Channel-0 PIN_A0
temp = 5 * value * 100/256;	// Calculate the temperature
return temp;	
}	
void main()	
{	
unsigned long temp;	
setup_port_a(ALL_ANALOG);	// Enable Analog PORT
setup_adc(ADC_CLOCK_INTERNA	L); // Use Internal Clock for Analog to Digital Conversion
// Blink the LED connected to PIN C3 twic	e. This tells the startup of Microcontroller.
output high(PIN C3):	// Switch on LED connected to PIN C3
delay $ms(600)$:	// Delay
output low(PIN C3);	// Switch off LED connected to PIN C3
delay_ms(600);	// Delay
output_high(PIN_C3);	// Switch on LED connected to PIN_C3
delay_ms(600);	// Delay
output_low(PIN_C3);	// Switch off LED connected to PIN_C3
// End blink LED	
while(1)	// Infinite loop for continuous monitoring
{	······································
<pre>temp = read_temperature();</pre>	// Read the temperature

```
if(temp > 60)
                                          // If temp>60 deg, switch ON LED & send data to control unit (CU)
        {
             output_low(PIN_B4);
                                          // Make B4 low
             output_low(PIN_B3);
                                          // Low on B3 sends the data available on B4
             output_high(PIN_C3);
                                          // Switch ON the LED
             delay_ms(2000);
                                          // LED on for 2 sec (2000 msec)
        }
        else
        {
             output_high(PIN_B4);
                                          // B4=high tells CU that No fire alert at Zone1
             output_high(PIN_B3);
                                          // Send the data available on B3 (i.e. high)
             output_low(PIN_C3);
                                          // If temperature is low, switch OFF the LED
                                          // Wait for 1 sec (1000 msec)
             delay_ms(1000);
        }
    }
}
```

Micro Controller Program³ at Control Unit (CU)

// Receiver and Control Unit (CU)
#include <16F73.h> // Microcontroller Used
#use delay (clock=2000000) // 20MHz Crystal Oscillator
#use rs232 (baud=9600, xmit=PIN_C6, rcv=PIN_C7) // PIN_C6 & PIN_C7 for PC communication

void main()

{

// Following code blinks two LEDs twice with 500 msec delay

output_high(PIN_C2);	<pre>// Switch on LED connected to PIN_C2</pre>
output_high(PIN_C3);	// Switch on LED connected to PIN_C3
delay_ms(500);	// Delay
output_low(PIN_C2);	// Switch off LED connected to PIN_C2
output_low(PIN_C3);	// Switch off LED connected to PIN_C3
delay_ms(500);	// Delay
output_high(PIN_C2);	// Switch on LED connected to PIN_C2
output_high(PIN_C3);	// Switch on LED connected to PIN_C3
delay_ms(500);	// Delay
output_low(PIN_C2);	// Switch off LED connected to PIN_C2
output_low(PIN_C3);	// Switch off LED connected to PIN_C3
// END Blink LEDs	

printf("Monitoring Fire Sensors...\r\n");

while(1)	// Infinite loop for continuous monitoring
delay_ms(1000);	// Delay 1 sec (1000 msec)

```
if(input(PIN_B3))
                                      // Check if any data available from RF receiver
     {
          if(!input(PIN_B4))
                                      // If B4 data=on then alert signal is from Zone-1 (sensor-1 sends data to B4)
          £
              printf("Fire Alert at Zone-1 \r\n");
              output_high(PIN_C2); // LED ON (high for ON, low for off)
          if(!input(PIN_B5))
                                      // Alert from Fire Sensor-2
          {
              printf("Fire Alert at Zone-2 \r\n");
              output_high(PIN_C3); // LED ON
         }
                                      // LED will be On for 1 sec (1000 msec)
    delay_ms(1000);
    output low(PIN C3):
                                      // Switch off the LED
    output_low(PIN_C2);
                                      // Switch off the LED
}
```

The prototype of this project is a web-based application. This application is able to send text message fire alert to a mobile phone. This application can be further developed with many multimedia features. These features may include a GUI and periodic text messages with ambient weather conditions.

Wildfire Detection System Design

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The objective of this new system is to detect wildfires and then help people monitor the situation remotely, all at a cost that is affordable by local governments and fire fighting agencies. The complete forest is viewed as a grid of several zones by the control command. Fire alert equipment (temperature sensors) is installed at several locations in each zone. In the case of a fire, these sensors send a fire alert over a RF link to the control unit of that zone. The control unit receives the information from the fire sensors and passes them to the control command. In this particular implementation, the control command receives the fire alert from the control unit through a GSM network link. This alert is processed and posted to the respective zone on Google Maps. Thus, authorized personnel at the control command are able to monitor the forest conditions. As noted above, this application is further extended to a mobile unit. Any mobile phone capable of accessing the internet can be used. Also, a text message containing details of the situation is sent to the mobile users.

Testing was done at the National University campus in San Diego. Two sensors were installed at two different locations; one at the Spectrum Center (Zone 1) and the other at the Aero Court campus (Zone 2). When the sensor detected a "fire" in Zone 1, an alert message was shown on the map using the Google API. If the sensor detected a "fire" in Zone 2, a similar alert message was shown on the map indicating the location of fire. The following figures illustrate the system and the test results.



Figure- 5: Working System³

Program's Mission and Structure

The mission of the MSWC program is to arm students with the tools necessary to achieve professional success in both theoretical and practical aspects of the field of wireless communication and to prepare them for lifelong learning in a field that will be in a state of continual advancement throughout their lifetimes¹⁴. This program prepares graduates for employment in research organizations, computer centers, and wireless communications businesses and enterprises. All MSWC program missions are reflected in the MSWC program outcomes, which are designed to ensure that MSWC graduates are proficient in analytical, technical, and critical thinking skills, that they have a sense of professionalism, and that they are instilled with a strong set of values essential for success in the wireless communications field.

These provide the base on which they can build through lifelong learning, which is essential in this rapidly changing field. The MSWC program is a curriculum for lifelong learning, with a focus on students who need to acquire and maintain significant scientific and technical skills.

In 2002, National University examined the critical needs of professionals in the area of wireless communications and responded by developing this unique program - the Master of Science in Wireless Communications (MSWC). This is a professional degree program that integrates communication techniques, problem solving strategies, simulation skills, and mathematical foundations with hands-on training required to solve real world problems in telecommunications. The program offers students the opportunity to learn theory and principles, using hands on activities in the field through 12 courses, and to apply their integrated knowledge in two project courses at the end of the program. All students in this program are required to take these courses in the order they are presented below.

Course Number & Course Name

- WCM 600 Signal Processing Theory
- WCM 601 Digital Wireless Fundamentals
- WCM 602 Wireless Principles/Standards
- WCM 604 Wireless Coding and Modulation
- WCM 605 Wireless Systems Security
- WCM 606 CDMA Wireless Systems
- WCM 607 3rd & 4th Generation Wireless
- WCM 608 Wireless Engineering Software
- WCM 609 Radio Systems Modeling
- WCM 612 Wireless Economics Topics
- WCM 611A Master's Research Project I (Prerequisites: all ten courses)
- WCM 611B Master's Research Project II (Prerequisite: WCM 611A)

WCM611 A & B Master's Research Project Class Structure

The Master's Research Project at the end of the program requires students to integrate what they have learned across the program by completing a research project in a specific area relevant to the field of wireless communications. This is a three month project. All students are required to enroll in the project classes. During the first month, students select their project partners and form small groups (two to four students per group). Each group conducts extensive research to select an appropriate project topic and submits a proposal to their faculty advisor for review and approval. All students usually meet with their advisor twice a week for four and half hours, discuss their ideas, and present their research findings. At the end of the first month each group selects a project topic, analyzes the problem, and formulates a detailed plan to reach a solution. In the second and third months, students meet their advisor once a week to discuss their research progress and results. They perform all the necessary evaluations and experiments, identify and propose meaningful results and viable solutions, and prepare a detailed formal report and associated presentation. A Master's Research Project Assessment contains the detailed criteria used in assessing both the written project report and the project presentation. Written Master's Research Project Reports in the MSWC program are required to be a minimum of 15,000 words

in length and occasionally are as long as 40,000 words. The report must be prepared by using American Psychological Association (APA) style. Every member of the team presents during the oral presentation that is normally 30 minutes in length, followed by a question-and-answer session with the evaluators and the audience. All Capstone projects are assessed by using an assessment tool (a number of questions and corresponding rubrics) developed by the Program Lead.

Program Assessment Methods

National University is well known for its teaching excellence and values. The university strives to serve the community by preparing its graduates with high standards of education and training in cutting-edge technologies. The faculty in the School of Engineering and Technology are continually engaged in exploring new types of educational programs to meet industry demands by developing new programs and preparing prospective professionals. The MSWC program is one example that prepares professionals for the wireless industry. This is a relatively new and nearly unique program. This program reflects new, evolving, and emerging technologies, socio-economic changes, the global economy, and other factors, and it is under continual review to maintain high quality and ensure appropriate content.

Program assessment is required by both institutional and accrediting agents. Assessment is needed for program evaluation, program updates, program modifications, course evaluation, course updates, course modifications, new course additions, existing course deletions, and, sometimes, program termination.

Every year the MSWC program is required to be reviewed through a process called Program Annual Review (PAR). The Program Lead is responsible for gathering program-related data and information throughout the year using both direct and indirect measures, and then analyzing these data in the PAR report. At the end of each academic year, PAR results are submitted by the Program Lead for review by the Department Chair, School Assessment Committee, School Dean, Council (Graduate/Undergraduate), and Provost. Every five years the Program Lead is also required to prepare a comprehensive report called the Five-Year Program Review. There are nine Program Learning Outcomes (PLO) in the program, and all these PLOs are assessed in multiple courses and in the Master's Research Project. Table-1 shows a Curriculum Map of the MSWC program.

PS: WCM611A&B: Ma	Master's	Required Courses										
Research Project Classes		WCM600	WCM601	WCM602	WCM604	WCM605	WCM606	WCM607	WCM608	WCM609	WCM612	WCM611 A & B
Courses and Learning Activities												
Program Learning Outcome Evaluate and apply wir networking, proto architectures, and standard the	e 1 reless ocols, ds to		1	I	D	D	D	D	D			M
Program Learning Outcome Evaluate and choose the appropriate kinds of coding	e 2 most g and	I		D	D		D	D		М		D

Table-1: MSWC Curriculum Map¹³

PS: WCM611A&B: Master's	Required Courses										
Research Project Classes	WCM600	WCM601	WCM602	WCM604	WCM605	WCM606	WCM607	WCM608	WCM609	WCM612	WCM611 A & B
decoding schemes for constructing											
Program Learning Outcome 3 Build security into wireless communications systems and contrast ethical and related issues in			1		D				М		M
Program Learning Outcome 4 Plan, Integrate and implement multiple types of Second (2G) and Third Generation (3G) wireless	_		I		D				М		M
Program Learning Outcome 5 Create strategic analysis software and tools to develop wireless, networks and service plans.				D				М	M		D
Program Learning Outcome 6 Develop simulation models of the radio component of wireless systems using MATLAB, SIMULINK and	1		D	D					M		M
Program Learning Outcome 7 Evaluate and forecast economic impacts of continually advancing technologies on wireless service	_		1		D	D		D		M	D
Program Learning Outcome 8 Conduct research into a specific wireless communication topic, including finding and integrating					I	D			D		M
Program Learning Outcome 9 Demonstrate critical thinking and ability to analyze and synthesize wireless communications	I	I	D	D	D	D	D		D	М	М

Legend: I Introduced D Developed M Mastered

Project Activities and Discussions

In the Wildfire Detection and Monitoring System project, an extensive literature search was conducted by the students in order to identify the critical needs and to find a viable and cost effective solution. Students completed all their project work in three months, except for the final version of their written report, which took a little extra time to complete and get approved. During the first month, four students formed a team based on their common interests, elected a team leader, assigned each member his/her tasks and responsibilities, and collected the required materials and equipment. During the next two months, students accomplished the following: 1) design and development of different software using the appropriate tools and platforms, 2) integration of hardware and software for building a prototype, 3) testing and evaluation of the prototype, 4) collection of data and information, 5) organizing ideas and thoughts, 6) preparing for the formal 30-minute presentation, and 7) writing the first draft of the written project report.

NATIONAL UNIVERSITY

School of Engineering and Technology Master of Science in Wireless Communications

WCM 611 WRITTEN PROJECT EVALUATION FORM

REPORT TITLE: Wildfire Detection and Monitoring System										
AUTHOR(S): Student 1, Student 2, Student 3, and student 4 Date of Evaluation: January 15, 2010 Rubrics for Written Report Evaluations										
AREA	AREA OUTSTANDING GOOD FAIR POOR < \$ points									
FACTS	The student provided expert information relevant to the topic. The detail and scope of the information incorporated into the project demonstrates exceptional familiarity with the topic.	The student provided accurate information relevant to the topic. The student could have provided greater detail and scope. The detail and scope of the information incorporated into the project demonstrates considerable familiarity with the topic.	The student had some difficulty furnishing sufficient evidence. The detail and scope of the information incorporated into the project demonstrates immed familiarity with the topic.	The student failed to provide information that is accurate and relevant to the project. The detail and scope of the information incorporated into the project was insufficient.						
ANALYSIS	The student analyzed the question / problem / thesis from all relevant perspectives. Facts, key concepts and principles were presented in an orderly fashion. Inferences were logically sound and conclusions were	The student analyzed the question / problem / thesis from multiple perspectives. The student's presentation of facts, and principles was ordeny; with one erroneous inference.	The student analysis of the question / problem / thesis was limited. Some of the facts, are presented in a disorderly fashion with some erroneous inferences.	The student failed to analyze the question / problem / thesis. Presentation of facts, key concepts and principles is disorderly and there are multiple errors in reasoning.						

SYNTHESIS	The student combined ideas in novel ways around an imaginative central concept to create a novel, impactuil, coherent essay/solution. In addition, the student piaced the topic in a new context and/or made important new connections to other events, people, piaces and things.	The student brought together ideas around a central concect to create a meaningful, coherent essayisolution. In addition, the student placed the topic in an appropriate context and/or made relevant connections to other events, people, places and things.	The student brought together ideas around a central concept. however, sufficient context is lacking. The essayisolution contains satisfactory factual and conceptual content, but is presented in a disjointed, "grocery list" fashion.	The student has failed to construct a coherent essay/solution built around an identifiable organizing theme or concept.
RESEARCH	The student has used a wide variety of informative and relevant accroonate professional sources, and integrated them seamlessly into the body of the project. Conclusions are verified or verifiability has been incorporated	The student has used a sufficient number of informative and relevant appropriate primary professional sources. Conclusions are logical	The student has provided sources but had difficulty integrating them Conclusions are incomplete, questionable, or difficult to discern.	The student has failed to provide sufficient relevant sources for this assignment and/or failed to adequately incorporate putside sources into the body of the project. Conclusions are missing, irrelevant or unacceptable
VOCABULARY, MECHANICS & SENTENCE STRUCTURE	The student has combined the effective use of subject-specific terminology with extensive vocabulary and variety of expression. The student consistently uses correct grammar, syntax, spelling, punctuation, and capitalization.	The student has demonstrated good use of vocabulary and variety of expression The student has an average of fewer than 3 errors per page in grammar, syntax, spelling, punctuation, and capitalization	The student has demonstrated limited vocabulary or variety of expression. The student has an average of 3 or 4 errors per page in grammar, syntax, spelling, punctuation, and capitalization.	The student has utilized a vocabulary with little or no range and/or no variety in expression. The student has an average of more than 4 errors per page in grammar, syntax, spelling, punctuation, and capitalization.

FORM The report follows APA format. The student has organized ide into coherent paragraphs w smooth transitions. T assignment h good structur and unity.	The report follows APA format. Transitions are sometimes as awkward, and/or the assignment does not the aways hold together.	The report deviates from APA format in a number of areas. There is weakness in one of the following oriteria: organized paragraphs or smooth transitions.	The report does not follow APA format. The student has not demonstrated an understanding of paragraph structure, transitions, or unity. Student has not adhered to NU Capstone/Master s Research Project guidelines
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	AREA	SCORE (out of 10 points)					
	Panel Member	FT1	PT1	ЕЛ	EJ2	Avg.	
1.	FACTS	9	10	9	10	9.5	
2.	ANALYSIS	8	8	8	9	8.25	
3.	SYNTHESIS	8	9	9	8	8.5	
4.	RESEARCH	10	9	8	9	9	
5.	VOCABULARY, MECHANICS, ETC.	8	7	8	7	7.0	
6.	FORM	9	8	8	9	8.5	
7.	TOTAL SCORE (Maximum - 60 points)	52	51	50	52	52.25	
8.	Average	85.43	296				

In the light of your professional experience, does the report show mastery of the topic at a Master's level for the following facets?

- Sufficient original work (for a 2-month project): These idea and work are considered original.
- Accurate representation of basic technical concepts: Technical concepts used in this work are accurate and appropriate.
- Intelligent discussion of results (rather than just mentioning them): Results and discussions are acceptable and meaningful.
- Adequate depth and variety of analysis: Data analysis and interpretation are accurate.
- Other Comments (add additional pages if needed): Overall quality of this work is considered to be good. This proposed system has great impacts on citizen life and property. This is a viable solution to real world critical problems. Students in the program learned theories and principles and gained valuable practical knowledge and team experience from this project class. This project combined advanced knowledge about cutting edge technologies used in the fields of wireless communications, computational science, electronics, and engineering. Selection and use of hardware and existing software, writing additional computer programs using different platforms, meeting both industry needs and degree requirements are very challenging tasks. But students in this project faced all these challenges and made valuable contribution which is expected to be helpful for fighting wildfires in better ways.

FT1: FT Faculty 1, Professor, National University

PT1: NU PT Faculty and FT Qualcomm Sr. Engineering and Production Manager

EJ1: External Judge 1, Sr. Member of Technical Staff, Olympus Communications

EJ2: External Judge 2, Research Engineer, Broadcom

PS: Both External Judges have no prior relationships with the Program and National University

In October 22, 2010, a formal presentation was made by all team members followed by a successful demonstration. All comments received from both Internal and External Judges from the Presentation and Demonstration Sessions were found to be good and positive. The average score received on this Project Presentation was above 85% and passed.

Figure-6: Summary of Panel Reports¹⁴

At the end of the third month, students submitted their project report to the Faculty Judging Panel for review and made a formal presentation followed by a successful demonstration. After observation of this project presentation and careful review of the written report, each Panel Member submitted their evaluation reports to the MSWC Program Lead Faculty. Figure-6 displays the summary of evaluations using the corresponding rubrics and comments received on the written report of the Wildfire Detection and Monitoring System project.

Conclusions

The Wildfire Detection and Monitoring System is not only a technological achievement, but it is a responsible attempt to detect wildfires quickly and efficiently. There are several activities going on across the world to detect and fight wildfires. This Wildfire Detection and Monitoring System is capable of detecting wildfires at an early stage, alert people, and help firefighters make a better fire extinguishing plan. This system combines the knowledge of electrical engineering, wireless communication, and computer science. It is expected that this Wildfire Detection and Monitoring System will help detect wildfires quickly, thus reduce property damage, save lives, and protect forest resources. This work was prototyped and tested with two sensors deployed at two different locations. The system detected fires, identified locations and sent SMS to mobile phones. Deployment of this system in the wildlands needs help and collaboration from different organizations including government, private companies and donors, because this system requires good network coverage and continuous power supply in the deep forest. It is clear that the infrastructure and initial setup of this system requires an investment. However, the investment is feasible for financially strapped local governments. The cost of all equipment used by students was a few hundred dollars, not millions or even thousands of dollars. And the system is simple enough that the cost of setting it up is not high. The only possible drawback could be the lack of adequate cell phone coverage. We believe that the outcome of this effort is a viable solution for detecting and thus helping in controlling wildfires.

This student project, the Wildfire Detection and Monitoring System, met the program's requirements and fulfilled the program's mission. The reports received from the Faculty Judging Panel clearly indicate the appropriateness of graduate level work, student's learning, and contributions. The reports further validate the appropriateness of the academic rigor, research quality, and graduates' awareness and social responsibility.

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References

- U.S. Fire Administration (2001, December), Wildland Fires: A Historical Perspective, Topica Fire Research Series I(3), http://www.usfa.dhs.gov/downloads/pdf/tfrs/v1i3.pdf, Retrieved September 1, 2010.
- Absolute Astronomy (2007, October), October 2007 California wildfires, http://www.absoluteastronomy.com/topics/October_2007_California_wildfires, Retrieved September 5, 2010.
- V. Dharanalakota, S. Reddy, F. Maradona, and V. Gona (2010, January), Wildfire Detection and Monitoring System, Master's Project Report in the area of Wireless Communications, National University, San Diego, CA, (www.nu.edu).
- 4. T. Rappaport (2001), Wireless Communications: Principles and Practice 2nd ed., Prentice Hall, New Jersey.

- Cytron Technologies(n.d.), Temperature Control System using LM35, http://www.cytron.com.my/attachment/Details%20Description/PR11%20v4.pdf, Retrieved October 05, 2009.
- Microchip (2007, February), PIC16F72 Data Sheet, http://ww1.microchip.com/downloads/en/DeviceDoc/39597C.pdf, Retrieved September 21, 2009. and Microchip (2003, April), PIC16F73 Data Sheet, http://ww1.microchip.com/downloads/en/DeviceDoc/30325b.pdf, Retrieved September 21, 2009.
- Holtek Semiconductor Inc. (2010), HT12A/HT12E -- 2¹² Series of Encoders http://www.holtek.com.tw/English/docum/consumer/2_12e.htm , Retrieved September 17, 2009
- 8. RF Solutions. (2001, June), 433MHz Narrow Band Radio Transmitter & Receivers, http://www.rfsolutions.co.uk/acatalog/DS337_2.pdf, Retrievd September 21, 2009
- Holtek Semiconductor Inc. (2010), HT12D/HT12F -- 2¹² Series of Decoders, http://www.holtek.com.tw/english/docum/consumer/2_12d.htm. Retrieved September 17, 2009
- 10. Texas Instruments (2010), MAX 232, http://focus.ti.com/docs/prod/folders/print/max232.html, Retrieved October 06, 2009
- 11. ATMEL (n.d.), AT89 Series Hardware Description http://www.atmel.com/dyn/resources/prod_documents/doc0499.pdf, Retrieved September 20, 2010.
- 12. General Catalog, MSWC Program, School of Engineering and Technology, National University, San Diego, CA (www.nu.edu)
- 13. MSWC Assessments Data, Accountability Management System, National University (2009), https://www.taskstream.com/pub/, Retrieved November 06, 2009
- 14. M. Amin (2009), MSWC Judging Panel Reports, School of Engineering and Technology, National University, CA