FAMU- FSU College of Engineering
Department of Mechanical Engineering
Dr. Gupta, Dr. Helzer, Dr. Shih, Dr. Frank
Senior Design I: EML4551

TEAM 14

WIRELESS INFRARED MONITORING SYSTEM

RESTATED PROJECT DEFINITION REPORT

1/16/2015

Kenny Becerra	ECE	kb10j
Joseph Besler	ME	jkb11d
Michelle Hopkins	ME	meh09d
Alexander Hull	ECE	ah12r
Jonathan Jennings	ME	jwj08c
Nixon Lormand	ME	njl08c

Advisors
Dr. Hollis
Dr. Arora

SIEMENS

ABSTRACT

This project has been initiated and delegated to our Senior Design Team of Florida State University's Mechanical Engineering Program by Siemens Energy in order to investigate a more effective, simplified preventative maintenance technique incorporating the use of Infrared Technology. Siemens has expressed their interest in a conceptual design of a Wireless Infrared Monitoring System that will monitor fossil fuel power plant equipment for problematic operation. They wish for this designed system to ultimately reduce costs through replacement of existing thermocouples currently used for temperature monitoring and preventative maintenance. A conceptualized system has been designed and consists of five major subsystems: the Infrared Camera, the Pan Tilt Module, the Wireless Communication Module, the Power System, and the Mounting Structure. The Infrared Camera will survey the selected targets thoroughly, precisely, and without interfering with the equipment. The Pan Tilt Module will control the camera's position allowing it to target a wide range of equipment reducing the need for a large amount of systems. The Wireless Communication Module, consisting of a microcomputer and wireless adapter, will filter, package, and communicate the infrared data to the control room. The Power System will consist of an accurately sized solar panel, charge controller, battery, and inverter to properly power the system throughout the year making it self-sustaining. Finally, the Mounting Structure will consist of the pole, weather enclosure, and fasteners necessary to house, secure, and protect all the components from the elements. Each of these five major subsystems must be integrated correctly for each of their respective functions to contribute to the final success of the system.

This report will serve as a redefinition and expansion upon our project goal and scope based upon the progress of our work last semester and the feedback from our sponsor. First it will give an overview of what has transpired since our last deliverable, Interim Design Proposal, in early December. It will then define our goals and explain our focus entering the second phase of the project. Finally, it will detail the steps and task we have laid out for ourselves in order to complete our goals.

ACKNOWLEDGEMENT

We would like to acknowledge our sponsor, Siemens Energy Inc., for their donation and support of this project and the Senior Design program. James Sharp, specifically, has always been available for technical advising and deliverable review and has served as a great liaison. We would also like to thank Seminole Electric for taking the time to give us a tour of their facilities and educate us on the power plant equipment. We would like to thank our faculty advisors; Dr. Patrick Hollis and Dr. Rajendra Arora and the instructors of Senior Design; Dr. Nikhil Gupta, and Dr. Chiang Shih, all of whom have provided valuable feedback and advising. We would also like the thank Dr. Oscar Chuy for providing advisement on our pan-tilt and microcomputer integration. Lastly we would like to thank Dr. William Oates for loaning his infrared camera for our prototype and Dr. Clark for lending us space in his lab for testing.

TABLE OF CONTENTS

TABLE OF FIGURES

AN OVERVIEW

Before stating our goals moving forward into the second phase of the project, prototyping, it is important to state the current status of the project since the conclusion of the first phase, design. Since our Interim Design Proposal was submitted detailing our conceptual design of our Solar Powered Wireless Infrared Monitoring System in early December, our team has; had an interim design review with our sponsor, procured all major components, visited R. J. Midulla power plant site, and reformed as a team.

Our Interim Design Proposal was received well by our liaison, James Sharp. He gave several minor suggestions to our mounting structure design which was decided to be implemented this semester in our prototype and will be adjusted in our conceptual design. This report will be submitted to Siemens, as well, in order to keep them updated on our intentions for the second phase of this project.

After getting the approval from our sponsor, the purchase orders for all of our major components (solar panel, battery, charge controller, inverter, pan tilt module and accessories, and microcomputer and accessories) were placed and have been delivered.

On January 6^{th}, we traveled to Bowling Green, Florida with our liaison to participate in a plant tour of R.J. Midulla, the eventual testing and implementation site for our system. We were given a quick safety briefing before being taken on a detailed tour of the plant. We also had the opportunity to walk around with James Sharp to look at specific places we should locate our system in order to properly monitor the equipment of interest. The photos, insight, and advice we acquired during this day has shaped our project redefinition moving into this semester.

On January 9^{th} we reformed as a team in Tallahassee Florida to gather our delivered components and plan our first team meeting to kickoff the semester. During this team meeting we decided upon our primary and secondary goal for our prototype and how we will go about achieving it.

PROJECT RE-DEFINITION

The project definition from our initial kickoff meeting still stands as our primary goal statement and objectives.

Design a proposed complete system that can monitor a wide range of equipment for problematic operation.

1. Decrease equipment interference on operating systems
2. Create cost savings through the elimination of need for numerous existing systems
3. Decrease manual work needed for preventative maintenance
4. Design a stand-alone system that does not consume any auxiliary power

CONSTRAINTS

A new constraint that we have this semester is the restricted use of the Infrared Camera in our prototype development. Due to budget constraints we elected to borrow Dr. Oates FLIR A655sc Infrared Camera in lieu of purchasing a cheaper, ill-representative camera. This allows us to be able to develop software that interfaces with a camera very similar to the one that was specified in our conceptual design. However, the use/access to the camera is very restricted and we are only allowed to power the camera with traditional sources. Due to this constraint, as well as budget, we have reformatted the way we are going to test the viability of our prototype.

PROTOTYPE GOALS

This manufacturing and testing phase of the project will focus upon a proof of concept prototype of our system. This 'prototype' will be constructed in order to demonstrate the basic function and component integration of our system Expanding upon the goal statement above, a primary and secondary goal was established for the proof of concept.

<u>Primary Goal:</u>
Wirelessly transmit infrared images of selected targets while system cycles through set positions.

<u>Secondary Goal:</u>
Develop a Graphical User Interface and alarm program to filter information received from targets and notify user when problematic situations occur.

These goals were established for the purpose of focusing our time on accomplishing the simplest form of the system's intended use. If this can be accomplished than it is confirmed that our design, at the minimum, is sound. The secondary goal has additional functions that would make the operator's job easier and could be accomplished with enough time. The secondary goal will be tackled if, and only if, our first goal is completed.

RE-SCOPE

The prototype will be constructed and tested in two separate systems; the power system and the monitoring system. Although the mounting system is an integral part of the overall system design, our budget has constrained us to only procure and test the electronic scope of this project. The subsystem schematics can be seen below in Figure 1.

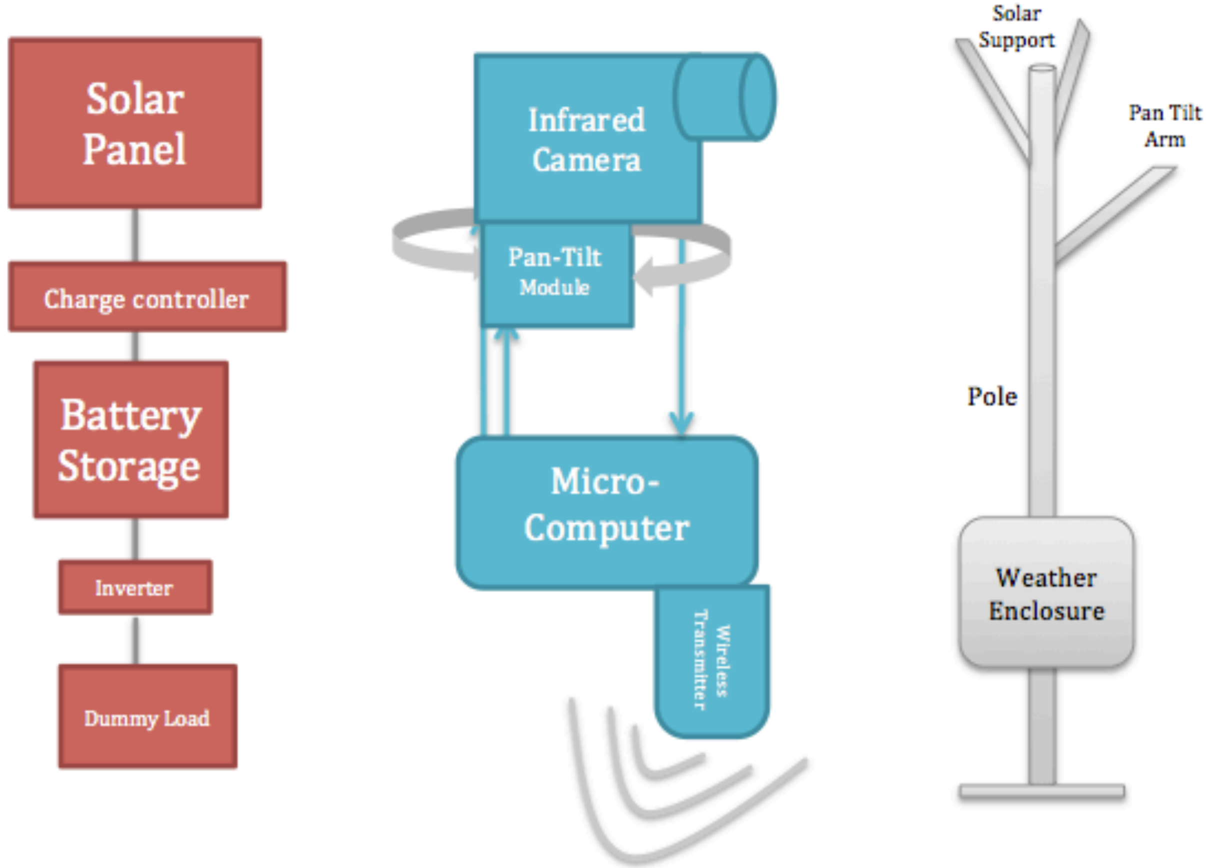

Figure 1. Subsystem: power system, monitoring system, mounting system.

The power system will consist of the solar panel, the charger controller, the battery, the inverter, and a dummy load. It will all be constructed in a circuit to be tested. The dummy load will simulate the load of our monitoring system. We will test the charge and discharge of the batteries over the course of 3 days to ensure that our power system is producing the amount of power intended.

The monitoring system will consist of the infrared camera, the pan tilt module, the microcomputer, and the wireless communication module. It will be constructed and tested throughout the process of our software development geared to our primary goal stated above. It is crucial that these components are treated with great care as they make up the bulk of our system's value. This is why they will be tested separate from the power system and in the safety of a lab.

PROJECT PLAN

PROJECT SCHEDULE

In order to accomplish our restated scope and goal statement, a detailed schedule has been created consisting of important tasks and milestones. The Gantt chart can be seen on the following page in Figure 2. The schedule from the first phase of the project has been minimized with a focus on the second phase details. The next four months are broken up into 5 summary tasks; Procurement, Second Phase Project Definition, Prototype Development, Final Assembly, and Project Finalization. Over the month of December, as mentioned in the Overview, we completed Procurement. With the submission of this report, our first staff meeting, and the update of our website, the Second Phase Project Definition will conclude on February 5th. Our largest and most difficult task will be Prototype Development, which will be a total of 66 days during which the construction and testing of our three prototype subsystems will take place. We plan to conclude our subsystem development and pre-testing within the first week of March where we can then commence final assembly of the system. ‘Refinement’ has been built into both this phase and the Prototype Development phase because it is realized that iteration is a large part of developing and testing. Finally we hope to conclude our prototype testing with our Operation Manual Report submitted on April 3rd. This will leave us almost the entire month of April to prepare for final presentations and write our Final Report.

RESOURCE ALLOCATION

Kenny Becerra, the Electrical Engineering Lead, will be responsible for the development and testing of the power system. Alex Hull, our Programming chair, will be the lead of the software development of the monitoring system. Nixon Lormand and Joseph Besler will support Alex with the development and testing of the monitoring system as well. Jonathan Jennings, our Prototype Chair, is responsible for the construction and testing of the mounting system. He is also responsible for the final assembly of the system. The project manager, Michelle Hopkins, is in charge of all reports and deliverables as well as overseeing and providing support when needed on all of the above efforts.

ID	Task Name	Duration	Start	Finish	Resource Names
1	**Team Formation**	**4 days**	**Mon 9/8/14**	**Fri 9/12/14**	
5	**First Phase Project Definition**	**26 days**	**Mon 9/15/14**	**Fri 10/10/14**	
16	**Preliminary Design**	**25 days**	**Mon 10/6/14**	**Fri 10/31/14**	
31	**Detailed Design & Analysis**	**37 days**	**Mon 11/3/14**	**Wed 12/10/1**	
51	**Procurement**	**31 days**	**Fri 12/5/14**	**Mon 1/5/15**	
52	Prototype Design Freeze	0 days	Fri 12/5/14	Fri 12/5/14	
53	Major Purchase Orders Complete	0 days	Fri 12/12/14	Fri 12/12/14	Joseph Besler
54	Component Lead Time	21 days	Mon 12/15/14	Sun 1/4/15	
55	Major Components Received	0 days	Mon 1/5/15	Mon 1/5/15	
56	**Second Phase Project Definition**	**30 days**	**Tue 1/6/15**	**Thu 2/5/15**	
57	Site Visit	0 days	Tue 1/6/15	Tue 1/6/15	TEam
58	Team Reformation	0 days	Thu 1/8/15	Thu 1/8/15	TEam
59	Restated Scope Report Due	0 days	Fri 1/16/15	Fri 1/16/15	Michelle Hopkins
60	Progress Presentation	0 days	Thu 1/22/15	Thu 1/22/15	Joseph Besler,Alex Hull,Jonathan Jennings
61	Staff Meeting 5	0 days	Thu 1/29/15	Thu 1/29/15	TEam
62	Website Update Due	0 days	Thu 2/5/15	Thu 2/5/15	Alex Hull
63	**Prototype Development**	**66 days**	**Mon 1/19/15**	**Thu 3/26/15**	
64	**Power System Development**	**26 days**	**Mon 1/19/15**	**Fri 2/13/15**	
65	Component Load Testing	7 days	Mon 1/19/15	Sun 1/25/15	Kenny Becerra
66	Power Circuit Assembly	5 days	Mon 1/26/15	Fri 1/30/15	Kenny Becerra
67	Power System Testing	5 days	Sat 1/31/15	Wed 2/4/15	Kenny Becerra
68	Analysis & Refinement	10 days	Wed 2/4/15	Fri 2/13/15	Kenny Becerra
69	Midterm Presentation I	0 days	Thu 2/19/15	Thu 2/19/15	Kenny Becerra,Joseph Besler,Michelle Hopkins
70	Team Evaluation Due	0 days	Fri 2/20/15	Fri 2/20/15	Individual
71	Staff Meeting 6	0 days	Thu 2/26/15	Thu 2/26/15	TEam
72	**Monitoring System Development**	**47 days**	**Mon 1/19/15**	**Fri 3/6/15**	
73	Camera Programming	20 days	Mon 1/19/15	Sat 2/7/15	Joseph Besler
74	Pan Tilt Programming	20 days	Fri 1/23/15	Wed 2/11/15	Nixon Lormand
75	Wireless Communication Programming	20 days	Sat 1/31/15	Thu 2/19/15	Alex Hull
76	Monitoring Circuit Assembly & Testing	7 days	Fri 2/20/15	Thu 2/26/15	Alex Hull,Joseph Besler,Nixon Lormand
77	Refinement	7 days	Sat 2/28/15	Fri 3/6/15	Alex Hull,Joseph Besler,Nixon Lormand
78	Midterm Presentation II	0 days	Thu 3/19/15	Thu 3/19/15	Alex Hull,Nixon Lormand,Jonathan Jennings
79	Team Evaluation 2 Due	0 days	Fri 3/20/15	Fri 3/20/15	Individual
80	Staff Meeting 7	0 days	Thu 3/26/15	Thu 3/26/15	TEam
81	**Final Assembly**	**14 days**	**Mon 3/23/15**	**Sun 4/5/15**	
82	Full System Assembly	7 days	Mon 3/23/15	Sun 3/29/15	Jonathan Jennings
83	Testing & Refinement	7 days	Mon 3/30/15	Sun 4/5/15	Jonathan Jennings
84	Prototype Complete	0 days	Sun 3/29/15	Sun 3/29/15	Jonathan Jennings
85	Operation Manual Report	0 days	Fri 4/3/15	Fri 4/3/15	Michelle Hopkins
86	**Project Finalization**	**14 days**	**Thu 4/9/15**	**Fri 4/24/15**	
87	Walk Through Presentation	0 days	Thu 4/9/15	Thu 4/9/15	TEam
88	Final Project Report Due	0 days	Fri 4/10/15	Fri 4/10/15	Michelle Hopkins
89	Open House Final Presentations	0 days	Thu 4/16/15	Thu 4/16/15	TEam
90	Final Team Evaluation Report	0 days	Fri 4/17/15	Fri 4/17/15	Individual
91	Final Staff Meeting	0 days	Thu 4/23/15	Thu 4/23/15	TEam
92	Final Report to SEI	0 days	Fri 4/24/15	Fri 4/24/15	Michelle Hopkins

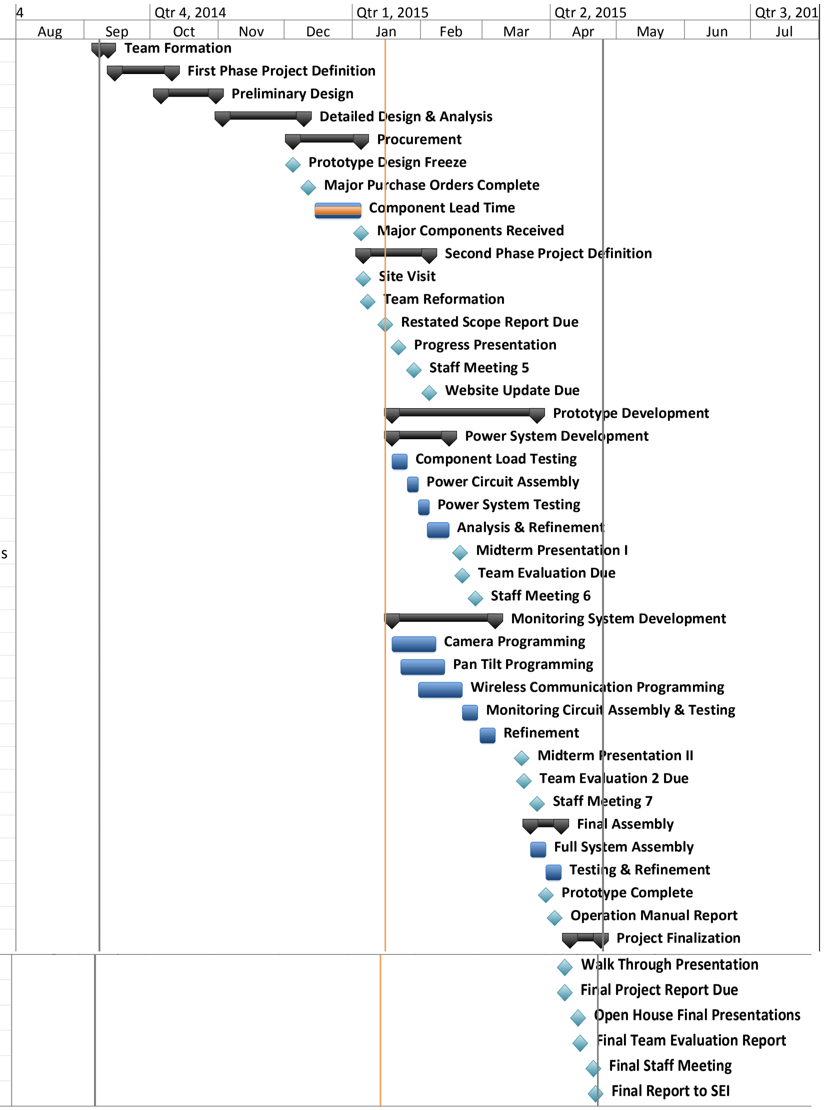

Figure 2. Project Gantt Chart.

CONCLUSION

In conclusion, our goal this semester is to produce a proof of concept prototype with the simplified function of transmitting infrared images of monitored targets. We will develop and test our prototype in two subsystems; the power system and the monitoring system. The two subsystems, once completed, will then be assembled together to demonstrate the arrangement of our final design. We plan to be able to deliver our sponsor a final design report and operation manual along with functioning system software and hardware at the conclusion of this semester.

BIOGRAPHY

Michelle Hopkins - Project Manager

Michelle is a senior in Mechanical Engineering completing her final year as a Co-op with Siemens Energy. She specialized in, and is currently working on, Thermal Systems. She is currently a founding brother of the FSU Chapter of Theta Tau. Michelle plans to accept a full offer from Siemens Energy at the conclusion of the spring semester.

Nixon Lormand - Mechanical Engineering Lead

Nixon is a senior in Mechanical Engineering completing his final year. He specializes in mechatronics and robotics. Nixon is a member of ASME, NSBE, and Theta Tau and runs a blog about a robotics project he is a part of. He also does robotics research for Dr. Moore at the National High Magnetic Field Laboratory.

Kenny Becerra - Electrical Engineering Lead

Kenny is a senior and is double majoring in Computer and Electrical Engineering. He is an active member of SHPE and IEEE. He specializes in programming and embedded system software. Currently, he has an offer from PG&E as an IT Developer. He is interested in going back for his Masters in Computer Engineering after spending some time in industry.

Joseph Besler - Procurement Chair

Joseph is a senior in Mechanical Engineering and specialized in Dynamics. He is the secretary for SAE and interned for US Patent and Trademark Office. Joseph hopes to begin his engineering career in spring by getting a full time offer.

Alexander Hull- Programming Chair

Alex is a senior in Computer Engineering. He has interned at National Institute of Standards and Technology as well as worked under Dr. Edward Jones on programming an automated grading program. Alex plans on attending graduate school for Artificial Intelligence after finishing his undergraduate degree.

Jonathan Jennings - Prototype Chair

Jonathan is a senior in Mechanical Engineering and specializes in mechanical design/simulation. He is a founding brother and current President of the FSU Chapter of Theta Tau. He has previously interned at the National High Magnetic Field Laboratory in their Research and Development Department. He would like to pursue a career in Automotive or Marine Design.