DEPARTMENT OF
ELECTRICAL & COMPUTER ENGINEERING

UNIVERSITY OF CENTRAL FLO RIDA

EEL 4914
Senior Design I

Group 28

Integrated Renewable Power System Controller

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Sponsors:

Progress Energy (TBD)

Siemens Energy (TBD)

ABSTRACT

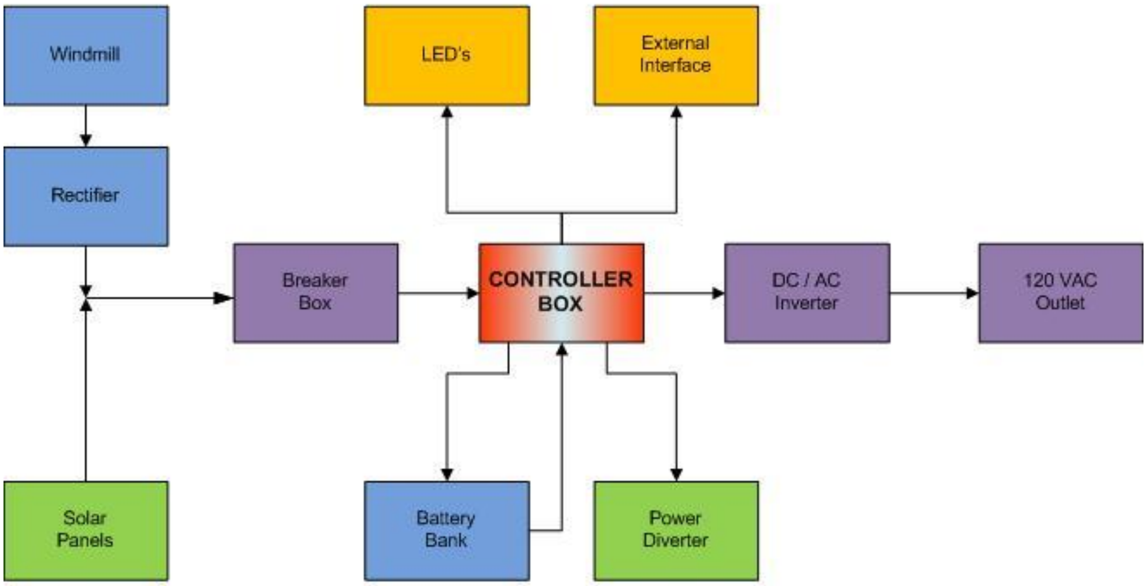
As the demand of green energy growing increasingly, solar and wind power become the main solution to the production of clean energy. However, due to the unstable and uncontrollable nature of renewable resources, relying on solar or wind source solely may not be able to produce enough power to meet the demand. The performance of a solar or wind system independently can be quite inconsistent. Therefore, integrating wind and solar power system synergistically will be necessary in the improvement of the overall charging process. Nevertheless, this is the goal of the green energy generation. In reality, it is difficult to charge a battery using both wind and solar energy at the same time. This is because the source impedance of the wind generator and the solar cell are quite different. Moreover, since wind and solar increase power system variability and uncertainty, the need for the load response increases as well. The question of how to utilize this integrated power system effectively becomes the essential problem. Our goal of this project is to design a controller that optimize both energy sources, and controls the charging system to meet the demand. The controller will be able to detect wind and solar, and calculate the threshold of the strength of these two sources. For instance, in a typical summer day in Florida, most of the daytime, there will be enough daylight for the solar system to produce acquaint amount of power for consumption. However, it is possible that a thunder storm takes place in the afternoon. The solar generation alone at this time may not be efficient, and wind and power storage may come to aid. The microprocessor-based controller detects the instantaneous variations of both wind and solar source. Then optimize the charging operation through a proper charge controller. More

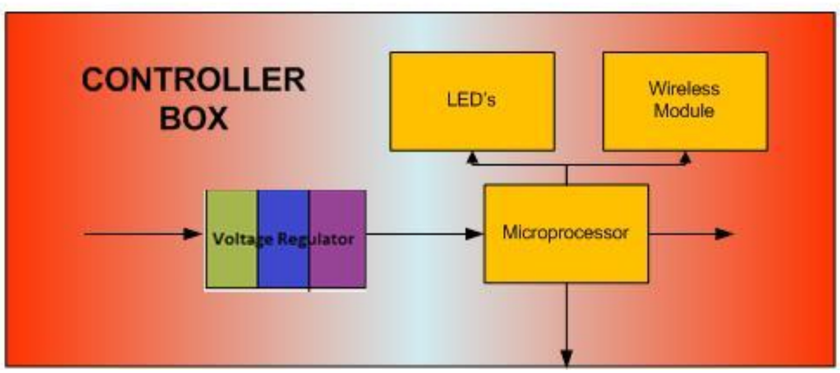
generally speaking, when both energy sources exist, the system operates in the independent charging mode. This means the wind and solar energy charge the batteries that one stores the wind power, and the other one stores the solar power respectively. If only one of the energy source exits, the system runs the integrated mode. The two batteries will be charged by either of the source at the same time. In the third mode, when both sources exit, but wind energy exceeds the threshold value, then wind energy charges wind battery independently and also charges the solar battery together with solar energy. This controller not only uses both energy sources for charging to increase the reliability and stability of the power system, but also reduce the fluctuation due to the instability of the wind energy.

Specifications

- Output voltage: 120V AC
- Windmill: 250 W, 15V DC
- PV Solar Cells Panels: 75 W, 12 V Low Voltage
- Battery Bank: (2) 12V 7AH - Sealed Lead Acid Battery
- Voltage Regulator: 15 V
- Charge time: 1 to 360 minutes
- Breaker Box: 16 A
- Power Diverter: We need 2 dump load that can dump at least 225 Watts
- DC / AC Inverter: 12VDC / 120 V AC
- STELLARIS ARM Cortex LM3S3748 Microcontroller
- MSP430 16-Bit Microcontroller
- Board: MEGA 1280 AVR Board
- LCD display: Optrex LCD display module, 20char x 4lines (5x8 dot chars), White LED backlit
- Wireless Module: 2PCS NRF24L01 + 2.4GHz Wireless Transceiver Module
- Minimal consumption of components
- Over-charge protection, low-voltage protection, reverse connection protection
- PWM CV charging function protects the batteries

HARDWARE BLOCK DIAGRAM

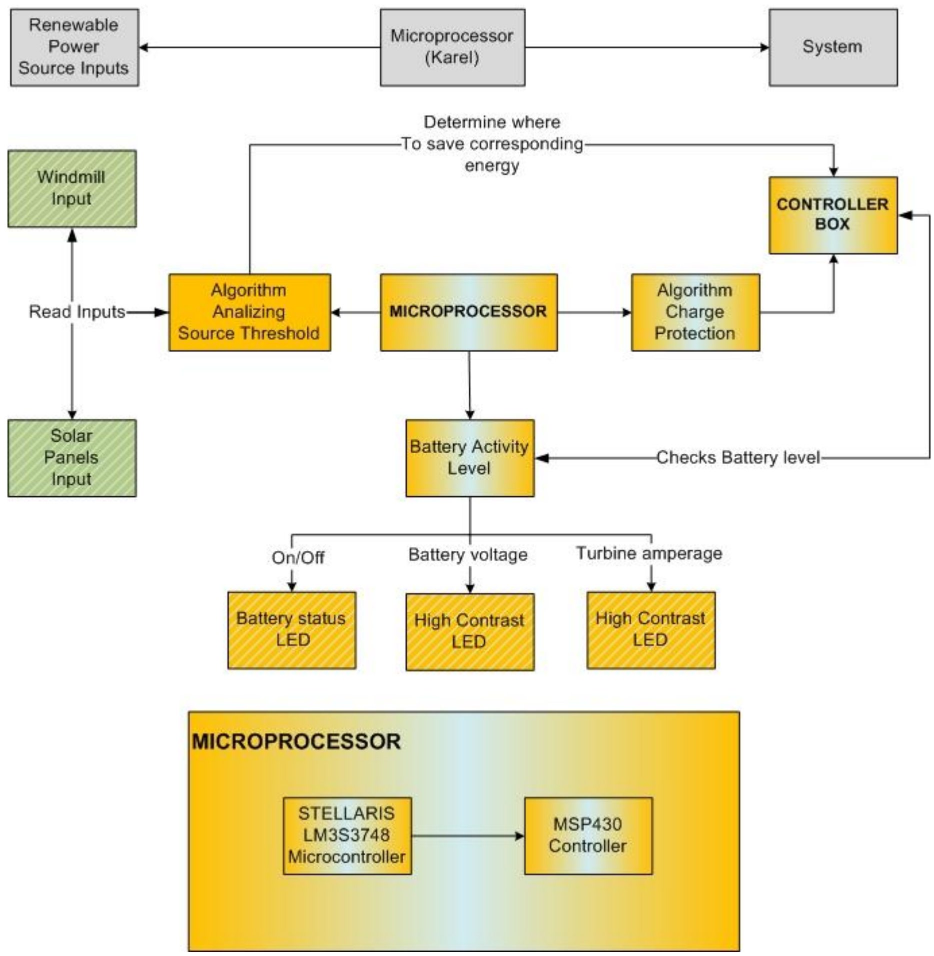




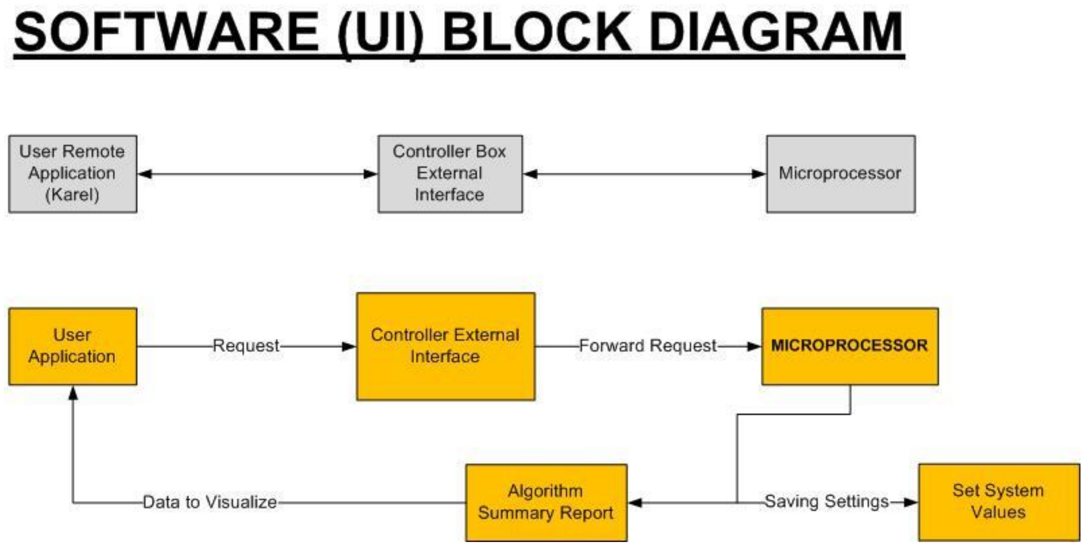
LEGENDS

DAVE WADE	JULIO LARA	KAREL RODRIGUEZ	JING ZOU

SOFTWARE BLOCK DIAGRAM



Software procedure on our controller box would be oriented to implement two 16/32 bit Microcontrollers executing dedicated algorithms, which will become the heart of the controller box and it is very important for both stability and functionality. First and main algorithm "Source Threshold" would be analyzing input sources and to determine based on the nature of the source which would be the correct battery to save harvested energy, if energy should be stored on separate batteries or if an integrated input source should fed the whole battery bank. Second algorithm "Charge Protection" would be dedicated to supervise the battery bank charge, avoiding over charge protection, over discharge protection, and reverse connection protection; this algorithm would be based on the metrics of battery level and it would trigger the appropriate signal to the Controller Box to complete the correct action. Third algorithm "Battery Activity Level" is continuously measuring battery bank status; this is a basic important feature to expand our controller box usability. Three led systems: **High Contrast LED battery voltage, High Contrast LED turbine amperage meter, and Battery status LED** would be fed from previous algorithm to present current live metrics to user as feedback.



Second component of the software module would be an external user application which will grant the user privileges to interact with our controller settings and to obtain current data. The user application will run on a different portable device granting the commodity of our integrated controller use. This application will be connected to our controller box external interface which will forward all requests to Microprocessor, once both sides are linked and security is validated to avoid unwilling requests, then the following actions can be executed:

1. Summary report: User will experience a simple nicely designed interface showing current metrics from our system such as battery charge level, current power source in use and how much voltage/current is passing through. Also, warning message will be displayed if system is experienced some sort of malfunctioning.
2. System Settings: User will be able to set limited settings to system, expanding the flexibility and adaptability. Settings that could endanger the whole system and trigger a dangerous reaction will not be provided.

Individual Blocks Description

Block / Task	Responsible (s)	Level of Complexity from 1-10	Status
Windmill	Julio	5	To Be Acquire
Rectifier	Julio	6	Research
Battery Bank	Julio	3	To Be Acquire
Solar Panels	Dave	5	To Be Acquire
Power Diverter	Dave	8	Research
Breaker Box	Jing	3	To Be Acquire
DC/AC Inverter	Jing / Dave	8	Research
120 VAC Outlet	Jing	3	To Be Acquire
LEDs	Karel	3	To Be Acquire
Microprocessor	Karel	9	To Be Acquire / Research
Wireless Module	Karel / Julio	8	To Be Acquire / Research
Voltage Regulator	Jing / Dave / Julio	10	Research
Algorithm Analizing Source Threshold	Karel	6	Research
Algorithm Charge Protection	Karel	6	Research
Battery Activity Level	Karel	6	Research
User Application	Karel	6	Research
Algorithme Summary Report	Karel	6	Research
Set Systems Values	Karel	6	Research
Controller External Interface	Karel / Julio / Dave	6	Research

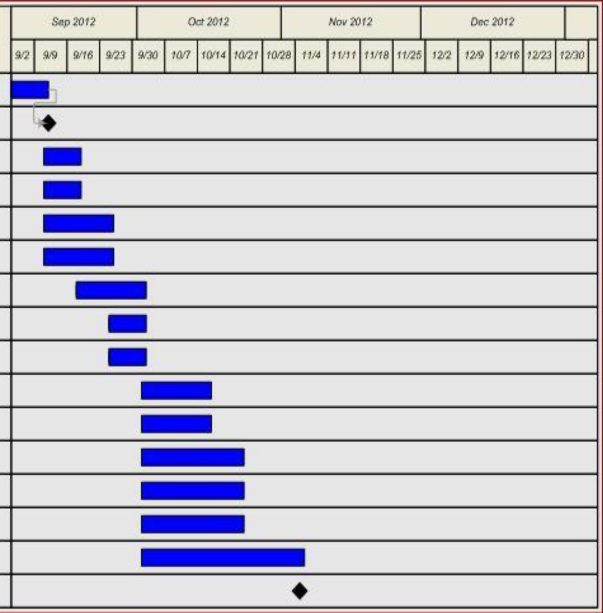
Budget

Item	Price	Location
Windmill 12V 250W	$184-$240	Alibaba.com
Solar Panel 12V 75W	$63-$100	Alibaba.com
Wire	$20-$35	Skycraft
Resistors	$5-$10	Skycraft
Capacitors	$5-$10	Skycraft
Breaker Box	$30-$50	Skycraft
Transistors	$5-$10	Skycraft
16-bit Microprocessor	$2-$4	AvNet
LEDs	$5-$10	Skycraft
WIFI module	$15-$30	Techship
12V 7AH Battery x2	$25-$35	Shopping.google
Circuit Board	$30-$40	4PCB

MILESTONES

FALL 2012 MILESTONE (TENTATIVE)

ID	Task Name	Start	Finish	Duration
1	Initial Documentation Preparation	9/4/2012	9/11/2012	6d
2	Turn in Initial Documentation	9/12/2012	9/12/2012	0d
3	Send Proposal to Sponsors	9/11/2012	9/18/2012	6d
4	Research on Windmill and Solar Panel	9/11/2012	9/18/2012	6d
5	Research on Voltage Regulator	9/11/2012	9/25/2012	11d
6	Research on Microcontroller and WiFi	9/11/2012	9/25/2012	11d
7	Research on Battery Charger	9/18/2012	10/2/2012	11d
8	Research on Power Diverter	9/25/2012	10/2/2012	6d
9	Research on DC / AC Inverter	9/25/2012	10/2/2012	6d
10	Project Documentation: Windmill	10/2/2012	10/16/2012	11d
11	Project Documentation: Solar Panel	10/2/2012	10/16/2012	11d
12	Project Documentation: Voltage Regulator	10/2/2012	10/23/2012	16d
13	Project Documentation: Battery Charger and Power Diverter	10/2/2012	10/23/2012	16d
14	Project Documentation: DC/AC Inverter and output voltage	10/2/2012	10/23/2012	16d
15	Project Documentation: Computing Components, display and Wifi	10/2/2012	11/5/2012	25d
16	Project Documentation: Review	11/5/2012	11/5/2012	0d



SPRING '12 MILESTONE (TENTATIVE)

ID	Task Name	Start	Finish	Duration
1	Purchase External Componets	1/1/2013	1/15/2013	11d
2	Build Voltage Regulator Cicuit	1/1/2013	1/22/2013	16d
3	Build Charger and Power Diverter Circuit	1/1/2013	1/22/2013	16d
4	Build Microcontroller code	1/1/2013	1/22/2013	16d
5	Connect LCD and Wifi	1/23/2013	2/6/2013	11d
6	Build DC/AC Inverter Circuit	1/23/2013	2/7/2013	12d
7	Create Critical Design PP Presentation	2/7/2013	3/7/2013	21d
8	Assemble Circuit for Testing	2/8/2013	2/15/2013	6d
9	Lab Testing	2/15/2013	3/1/2013	11d
10	Final Assmablation	3/1/2013	3/15/2013	11d
11	Final Testing	3/15/2013	3/22/2013	6d
12	Review Final Documentation	3/22/2013	3/29/2013	6d
13	Create Final PP Presentation	3/22/2013	3/29/2013	6d
14	Turn in Project For Academic Rating	4/15/2013	4/15/2013	0d