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Solar Decathlon Controls

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SOLAR DECATHLON PROJECT

6. HOME AUTOMATION AND CONTROL SYSTEMS (CONTROLS TEAM)

The automation control system used in the Living Light house aims to create a simple user interface with real time feedback of energy trends. The connectivity of the user is a large focus because a well-informed tenant is more likely to become passionate about the energy conservation that the Living Light house is capable of. The system will consist of an iPad tablet, which is wirelessly linked to the housing control computer. This mobile tablet will allow the user to effortlessly control anything in the house from the thermostat to the lighting level. Energy usage by component will also be readily available, as well as an overall energy plot that will display a dollar amount of energy used. The availability of knowledge regarding energy usage and conservation should allow the system to become transparent to the user and therefore inspire a more energy conscious lifestyle.

LIGHTING SCHEME

The Living Light house utilizes a tranquil lighting scheme that involves gentle adjustments of lighting levels depending on outdoor lighting and time of day inputs. This technique aims to lower the energy consumed by harvesting natural light when it is available. The brightness of the lighting will gradually increase in the morning hours to properly let the human body adapt while conserving energy. Conversely, in the evening the lighting will dim slowly to reflect the natural loss of light. It should be noted that any light in the home can be manually controlled to supply necessary illumination at any time.

HVAC & PASSIVE VENTILATION

The HVAC control system of the Living Light house is very complex, however this burden is not passed on to the user. The control system is constantly measuring environmental data and adjusting the HVAC system accordingly in order to provide a comfortable living environment. A series of dampers within the HVAC ducting structure are all controlled and monitored by the control system. For example, during the heating season, intake air from the south façade will be used to pre-heat the system air and exhausted through the north façade by engaging a combination of dampers. The opposite is true for the cooling season where the flow of air is reversed to pre-cool the air. There are instances in this evaluation where natural ventilation is the best option of providing a comfortable living environment; we call this "Passive Ventilation." The control system will prompt the user to open all of the windows and turn off the system. The control system will further alert the user if bad weather is imminent so that they can plan accordingly. The majority of decisions are made behind the scenes to ensure that the occupant resides in a relaxed, yet controlled, atmosphere.

POWER MONITORING

The power consumption of all major appliances as well as the entire home's energy consumption is monitored using a PowerLogic E4800 Power Metering system. This system allows up to 24 distinct devices to be monitored without interfering with the components of the devices. The data taken from this metering system is relayed to the main control computer where it is available to the homeowner at any time. The iPad control interface allows the user to correlate the energy usage of the various components of the home with daily activities. The power generation of the solar panels is also monitored and is displayed as a net income of energy that is sold back to the power company. The transparency of the system will allow the user to remain informed on the energy usage of their home.

6.1 COMPONENTS OF CONTROL SYSTEM

The major components of the control system consist of the following:

- PAC (Pascal Automation Controller) – This component is the communications bridge between the system and the computer system.
- Dimmer – The function of the dimmer is simply as an output for certain commands that the system generates. For example the lighting control program is a complex set of orchestrated commands that turn lights on and off. The dimmer receives this signal and converts it into an electrical output to the light itself. If the command states that the light level is 30%, the dimmer supplies the given light with the equivalent power to produce 30% luminosity.
- General Input – In the Living Light house, the general input unit is used to gather environmental data. Instruments that transmit an electrical signal representing a calibrated value measure the temperature and humidity; the general input device acquires these signals and allows for the computer system to analyze the values.
- DMX Gateway – The gateway maps C-Bus Group Addresses and levels to a DMX-512-A interface. It permits input devices such as wall switches, DLT's, and PIR's to control lighting devices with DMX interface capability.
- Relays – A relay is a method for triggering electronic actions by means of a small input voltage (usually about 5V). Relays are used primarily as "switches" to activate certain aspects of the control system that normally operate at higher voltages and/or currents.
- PIR Sensor (Passive Infrared) – The PIR sensor is used to monitor occupancy of the home and system to conserve energy by turning off lights and other devices.
- NIRT Controller – This device is used to emulate the infrared signal from a TV remote capabilities so that it too can be controlled by the home automation system. This allows all of the functionality of the TV to be accessible from the iPad.
- Bus Coupler – This unit allows for the input of up to four 4 no-voltage devices to be recognized by the control system. Various switches can be coupled with this unit in order to provide an analog input for controls.

6.1.1 Controllers

The controller used in the Living Light house is the Pascal Automation Controller (PAC). This unit converts logic developed in the PICED software to discrete signals that control the various aspects of the home. All programming logic will be stored within the HomeGate software on the desktop PC. The PAC controller is simply a bridge of communication between the computer system and the home components.

6.1.2 User Interface

The user interface used in the Living Light house was designed to be a user-friendly environment where vital energy information could be centrally available. The homeowner will be able to see the real time rate of energy usage/generation using the iPad interface. This same controller can also access every aspect of the home's controls. The main focus of the user interface was to both inform the homeowner of certain energy trends and ensure that the system runs smoothly without constant input by the user. Simple graphics and animated sequences will allow the system to be operated by people of all technical backgrounds.

6.1.3 Instrumentation

Temperature – The temperature data is measured using thermistors throughout the home. There is a thermistor in each façade to monitor incoming and outgoing air temperature.

Humidity – The humidity is measured in each façade and at the ERV outlets using digital humidity sensors. This data is used, among other things, to determine if a state is present where condensation will occur in the façade.

Light Level – The level of light in the home is monitored to allow the lighting scheme to adjust accordingly.

Passive Infrared – The PIR sensor is utilized to detect changes in heat (human occupancy) within the home. This is important because the home's control system can assess whether or not there are people in certain areas and conserve energy accordingly.

Power – Power usage of all major appliances as well as the entire house is measured using current transducers. These sensors supply an output voltage of 1-5 V, which correlate to a current that is passing through a power line, given a known voltage. The monitoring of power usage is extremely important in our research.