



TEXAS A&M
UNIVERSITY *at* QATAR

Electrical and Computer Engineering Program

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Functional Modeling
Monitoring The Carbon Footprint in TAMUQ

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On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work.

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1 Introduction

The objective of functional modeling for our project is to present the system and functions of our proposed design in a diagram that shows all the inputs and outputs. It is significant since we are showing our process for the project in detail, including all components and variables to show the flow of the steps until we reach the final goal. Functional modeling will benefit our project since we will take into consideration all the parts and components used and know more about each one of them, to check if it's best match our goal. This will shed light on the functionality of the project and the function of each component used to achieve the wanted results at the end. Taking into consideration different components will make our decision more precise and thus achieve better results.

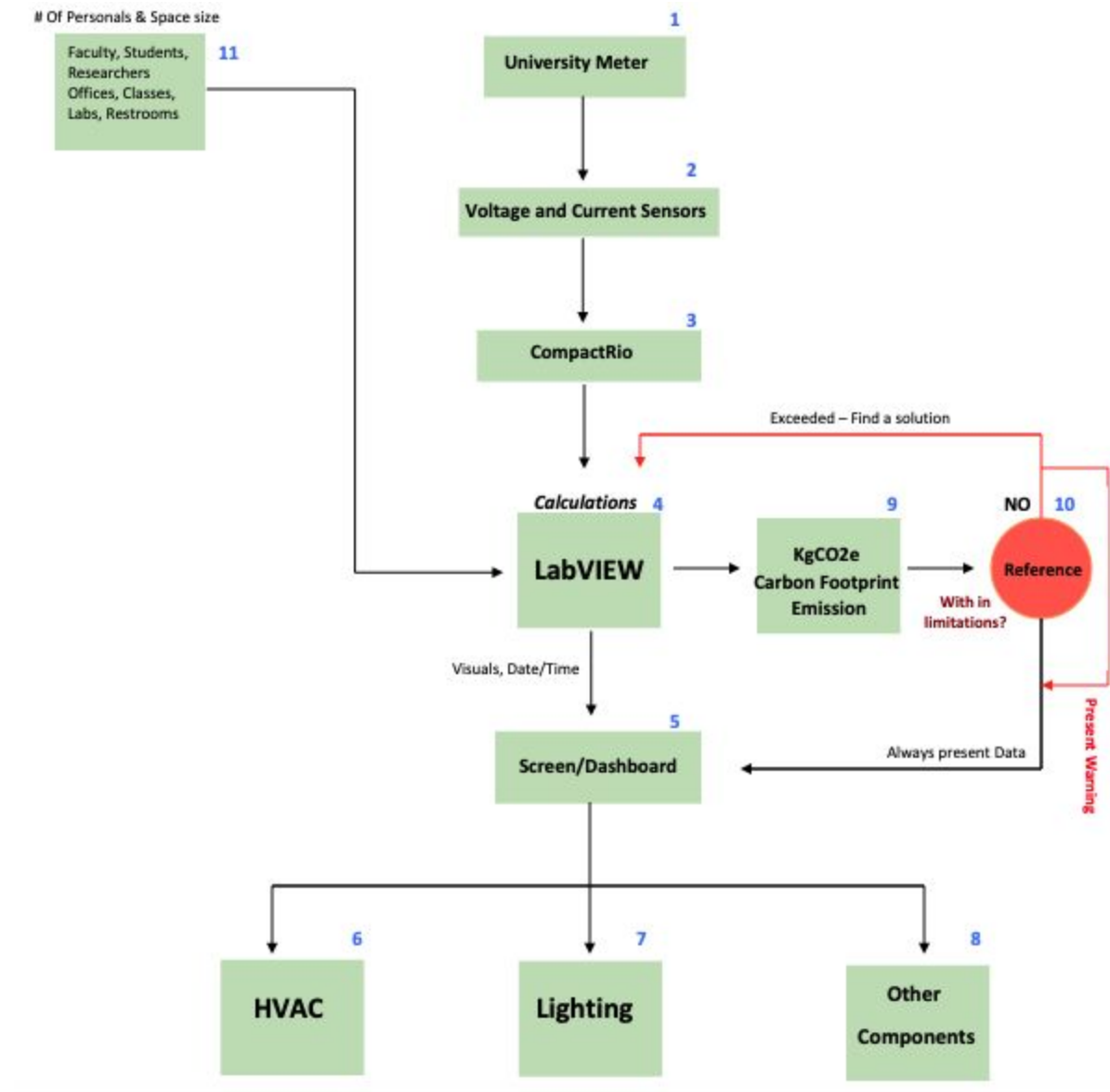
2 Upper-level functional model



Figure 1: upper level functional model

The figure above shows an upper level diagram for our proposed design. The focus for our design is to calculate the carbon footprint due to the consumption of the electricity. The input for the system is electricity consumption in Kwh and the output for the system is the amount of carbon dioxide due to the consumption in KgCOe. The input of the black box include all the data of the building including the number of students,staff,researchers and offices with all the sizes. In addition to the electricity values from the university meter that will be the main major data needed to find the carbon footprint later. For the output part, the design is expected to find the carbon footprint of TAMUQ building and present them on a screen with real time values displayed.

3 Detailed functional modeling



1-11 Number of Block

Figure 2: the detailed functional model

The detailed functional model above provide a better understanding of how the system works. Each block represents a major element that we will include in our analysis and study for the carbon footprint. The blocks are numbered from 1 to 11. In the following

section we explained why we will use these components, their functionality, and specify their inputs and outputs.

3.1 University meter

The electricity is fed from 11 Kwh transformer from kahramaa and get distrunred in the building. The value of electricity is 1.2KWh. The consumption of electricity for all components in TAMUQ is collected by a specific meter which is AEM 3 PHASE 4 Wire Analog. This meter displays the overall power consumption of the building. For our project, we will be collecting the data from this specific meter. This will be the main input to our system. We will not be able to add any additional meters or switches therefore,we will only add current and voltage sensors to the university main meter.

3.2 Voltage and Current modules

Since the university only contains main meter that displays the power consumption of the building, it will be challenging to track the power consumption of different components and analyze each component separately. Therefore, we will connect two types of modules a series NI-9242 C Series Voltage Input Module and NI-9247 C Series Current Input Module[1-2]. Those modules have 3 channels which means it supports both single and three phase measurements. The modules will be connected to the meters through wires. Also the modules are safe and suitable for monitoring and transient and harmonic analysis The modules are compatible with CompactRio which is used for data acquisition collected from the modules[1-2] . we will focus mainly on the current module. it will be used to track the current changes because the change of the current represents the change in the load. The voltage module will be used to take accurate and real-time monitoring.

3.3 CompactRio

CompactRio is a real-time controller made by National Instruments for control systems.CompactRio is capable of high signal processing which makes it suitable for our proposed design. CompactRio is known to be ideal for distributed measurement, reliable monitoring, and deterministic control applications[3].It is also compatible with LabVIEW and displays real-time monitoring. CompactRio will be mainly used for data acquisition and preprocessing the data before it gets to LabView .CompactRio receives the data from current and voltage modules and amplifies the signals and then send the data to labview. It can also modulate signals that LabVIEW might not be able to identify.

3.4 Labview

Labview is a system-design platform and development environment for a visual programming language. It was developed by National Instruments in 1986, it is written in C and C++ code[4]. Labview has many functionalities which are Data acquisition, instrument control, test automation, analysis and signal processing, industrial control, embedded system design[4]. Labview was chosen as the software used for our project because of many reasons. In LabVIEW, we can monitor the energy consumption in real-time which is very important to obtain accurate results. In LabVIEW we will have different inputs that we considered, first we have to insert the data that we collected from the university which is the total number of students, staff, and researchers. In addition to the total number of classes, labs, and offices in the building to find and compare the average consumption. We will input the equations used to calculate the carbon footprint and add the necessary conversion factors that are specific for Qatar to obtain accurate results. From CompactRIO we will get real-time values of the energy consumption in kWh and using LabVIEW to plug in the equations we need for the conversion from energy consumption in kWh to carbon footprint in KgCo_{2e}, so we will obtain the real-time values of carbon footprint simultaneously and presented on a screen. Using LabVIEW we can build the connections we need by adding voltage and current sensors in the software to take the values from CompactRio this will help us find the carbon footprint. Thus the output from the LabVIEW would be the real-time values of carbon footprint in KgCo_{2e}. Labview is important for our project since it has all the functions that we need to build our system and equations and provide one of the most important factors in our design which is real-time monitoring.

3.5 Data Dashboard using LabView

The goal of this project is not just to quantify the carbon footprint, we also want to reduce the emissions by setting a reference values based on the different inputs for labview. If the reference values are exceeded we want to suggest a solution and display the data and warnings through a dashboard .Through LabVIEW we can use a data dashboard and display it using a laptop. In addition to the real-time carbon footprint emission that is calculated using LabVIEW. On the screen,. Also, the screen will contain subsections of HVAC, Lightning, and other components and how to conserve energy in each component. The Graphs will contain real-time values of each component and how much energy it is consuming. If any of these components contribute to the increase of energy, a notification of that specific component will be identified and viewed on the screen. The screen is more convenient for the public and easy-to-read.

3.6 HVAC

By intuition we know that air conditioning system is one of the components that consumes high electricity . Since the air conditioning system consists of heating and cooling stages, with depth analysis and study of the system we might be able to find a way to reduce the energy either by modifying the system itself or the operation of the system. For example by changing the temperature by one to two degrees and see the impact on carbon footprint . The type of air conditioning system used in TAMUQ building is Carrier and York. Using the information provided in the data sheet we can estimate how much power can be saved and reduction in carbon footprint.

3.7 Lighting

Based on the information provided office of building operation most of the lighting used in the building are not LED light. We will analyze and compare the energy consumption by the current tube lights and how much energy will be saved if LED lights are used instead.

3.8 Other components

Other component includes the equipment used in the research and teaching labs. For these components, we don't have the capability to control or modify the operation of the labs. The values of these components will be embedded with the total power consumption but will not be considered in the solution part where we try to minimize the consumption of electricity.

3.9 Number of people and offices

Some important input parameters that we need to consider for our system includes the number of faculty, staff, temporary staff, researchers, and students. In addition to the number of offices, labs, computer labs, lecture halls, lecture rooms, and restrooms. Each area in the building is used daily by Texas A&M personals. So taking the total amount of personnel in the building in addition to the different areas, we can section to where the most energy is consumed. This information will be an input to LabVIEW.

4 Analysis and evaluation of assignment

From the functional modeling analysis we were able to set the major and right path of our project to reach our desired goal which is to monitor and measure the carbon footprint in TAMUQ building. From the findings we found, it was clear to us which components are essential for our design such as CompactRio for acquisition, and Labview for computation and real time monitoring, also voltage and current sensors that will show us the values of current and voltage to be able to find the power. We defined the inputs and output of our design and set the flow of the project using the necessary components and approaches. The benefits and outcomes of this assignment for our project is that it will help us set a clear image of our project system and functionality. This clear path will make us know what's missing in our project and what do we need to add to achieve the wanted results. functional modeling helped us to assess the major steps in our project and choose our components carefully to reach our desired goal. Also we were able to identify some challenges that might occur throughout the project such as seeking permission from the proper authorities since the data we inquire are confidential and adding the modules to the meters without the interference with the operation of the building. Another major challenge finding an analysis method and accuracy for results since our project is dynamic and the data changing all the time. Some data might not be available or not reachable so we might need to make some assumptions close to the real values.

5 References

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