

Survey Paper of Energy Monitoring Systems

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1. INTRODUCTION

Energy Monitoring systems are vital technologies in all fields. The ability to know the efficiency and power usage of machines in this day and age is a highly sought after and essential tool. As energy prices increase and shortages affect more of the world, being the appliance or the system with the lowest power usage will become the goal for all. To determine this energy usage, extensive energy monitoring systems are being developed and used in all industries. In this paper we analyze various hardware and software systems based on their relevance and prevalence in the world now.

2. COMPARISON ENERGY MONITORING SYSTEMS

In this section 5 papers about energy monitoring systems are introduced and compared. Based on metrics for energy monitoring systems, we divided the sources into the following categories:

2.1 Non-invasive hardware

Non-invasive hardware is a common approach to energy monitoring hardware where the system to be monitored need not be dissected and the structure of the monitored system does not need to be known, meaning the non-invasive hardware is universal. [2] investigates a load monitoring technique for energy monitoring. The non-intrusive appliance covered in this article would be used in homes to provide information on energy consumption on major electrical appliances, although the author does note that uses in the commercial and industrial sectors are possible. The article goes into depth on how the use of this appliance in homes will aid in monitoring of the energy crisis, but fails to thoroughly investigate the reliability and accuracy of the appliance introduced in the article [1] describes and introduces the Energino, a standalone plug-load meter based on the Arduino platform. The researchers state that the driving factor behind the Energino's development was the lack of affordable and reliable energy consumption tools, which

researchers need for development of simulators. The article goes in depth on the hardware, software, and networking involved in the Energino. One of main goals described by the article is to create a easily usable device, however the article fails the recognize the learning curve that comes with understanding of the Arduino platform. [5] investigates a possible use of the Arduino platform for development of a smart plug, a non-invasive universal plug that can be used remotely to monitor energy consumption. This article also goes into detail on the devices connection to an android device for remote monitoring. However the articles does not give a prediction of when this device will be on the market and their website does not either. citejiang2007micro goes in depth on a hardware design of an energy monitoring appliance using their presented SPOT architecture. SPOT stands for, scalable power observation tool. Their design features nodes which are used to monitor a range of devices over a period of time. This article details the hardware level design and dissects each part of the design to describe its use. While the article deeply describes the hardware parts used, it only briefly covers the use of the hardware as a singular things, only describing it as a potential tool.

2.2 Software/Networking

Due to the wireless nature of non-invasive hardware for energy monitoring, networking for these systems are very important for getting the collected data to useful machines for the monitoring to occur. citelu2009online goes into detail on the process of transmission of data from non-intrusive energy monitoring devices across wireless sensor networks. The article describes also their lab experiments and test as well as their results. The article fails to recognize the challenges in designing and deploying wireless sensor networks in practice. In addition citegomez2012energino goes into detail on the software and networking involved in Energino described in the above section. The article analyzes the C/C++ programmed arduino hardware and Wiring library used to create the Energino. In addition, the articles covers the wireless network setup used and how it connects to the client used for monitoring. Lastly citeshajahan2013data covers the software and networking involved in connecting the arduino platform smart plug to a server housing an android application.

3. LIMITATIONS OF CURRENT ENERGY MONITORING SYSTEMS

Throughout the papers, two major flaws in the current field of energy monitoring are pointed out. One of the flaws,

discussed in [1], is the lack of affordable, and reliable energy consumption tools. Current reliable systems cost hundreds of dollars per appliance, which is too expensive for researchers with smaller funding. To counter this, the researchers from [1] are developing a more affordable appliance which will offer similar reliability. The other flaw, discussed in [4], is the problem of networking with all the non-invasive appliances. Due to the many different network structures, and the wireless nature of the non-invasive appliance, networking with the appliance usually results in many one-off solutions. [4], investigates a transmission protocol to combat this difficulty.

4. CONCLUSION AND FUTURE WORK

Energy monitoring systems have been important in all fields since efficiency has been a factor and energy costs have been significant. Multiple hardware, software, and networking solutions, as analyzed in this paper, have been or are being developed to increase the prevalence and ease of usage of energy monitoring systems. However there are other techniques and other hardware solutions not analyzed by this paper. In the future, effort could be focused on creating less expensive hardware, possibly with an open source mentality, as well as on how easily these hardware solutions are able to connect and transmit the data that they are collecting

5. REFERENCES

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