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Data Monitoring and Visualization for Portable Household Appliances

Introduction

People often lose track of their kitchen inventory which can lead to disorganization and inefficient planning of grocery shopping as well as unnecessary stress in households. Monitoring and informing individuals requires an efficient and responsive data collection and visualization system. The most common practice is having a real-time monitoring system via a smart devices and displaying only required values so as not to overwhelm the user. Data visualization helps in connecting the data directly with ones' brains so that it can be understood effectively [1]. This paper summarizes the commercially available solutions that provide data visualization for portable household appliances, explains the advances in the technology and defines the implementation that would produce the most appealing and informative representation.

Commercially Available Solutions

Bud Light is a brand under the company Anheuser-Busch that has produced Bud-E Fridge in partnership with Buzz Connect and Linq IQ [2]. The device sends data to a smartphone application which informs the users of the number of Bud Light cans and bottles remaining as well as the time required for the optimal serving temperature to be reached. The device holds up to 78 beers and is currently marketed at 299 USD which includes the fridge and a dedicated smartphone application [3].

LG Electronics produces a smart fridge equipped with a HomeChat application that lets people receive real-time food status updates from their refrigerators directly on their smartphones. The device also provides added data visualization by providing information on what items are reaching their expiration dates. Users can also request recipes based on the ingredients they already have. No pricing information is available [4].

There is a visualization library available called Data-Driven Documents (D3) which produces various forms of graphs and data visuals given an input data [5]. It provides an extensive set of tools and algorithms for manipulating and visualizing data. The software is free however has licensing requirements.

Technology in Data Monitoring and Visualization

Raw data from the microcontroller is infeasible to understand or evaluate, and some of that data is not required. The data needs to be processed before it can be used for visualizing. Most commercial solutions have their own tailor made algorithms for processing the data however the base concept is the same [1]. The most common way of processing and storing this data is using a local database loaded into memory. This would allow very rapid reads and writes to and from the database [6]. It would also enable

real-time monitoring. Processing of the data can be done in parallel using multiple threads which would increase efficiency. All of the processing is usually done on the smartphone instead of the portable household appliances to take advantage of the greater processing power. A very common algorithm used for data processing is called Data Abstraction [7]. It allows summarizing and reducing large amounts of data by grouping them into intervals or patterns. This allows faster processing with lesser required data storage space.

Once the data is processed, it can then be visualized using various techniques and algorithms. The most common way of handling data is by binding it to a Data Object Model (DOM) that would enable quick access to various sets of data [8]. This model clusters related data together and allows them to share common attributes. Once the data is bounded to a DOM, various data-driven transformations can be applied to it which would enable generating a wide variety of visualizations. Since the data is bounded to a DOM, the representation for the data can be quickly switched from one form to another without requiring to reprocess the data [7]. A well-known algorithm, Spatial Layout, produces the logic and mechanism for positioning a data element in a spatial substrate [9]. This allows generation of visuals such as scatter plots, bar graphs, stacked graphs, various sorts of maps and theme river graphs.

Implementation of Data Monitoring and Visualization

Smartphones have been determined to be the most popular and effective source of data monitoring [10]. Hence designing a custom smartphone application would prove to be the most effective in visualizing and monitoring data. The data will be received from the portable household appliances via a defined communication protocol and stored locally on the smartphone. The data will then be inputted through various processing algorithms to convert the raw data into its processed form which can be used for visualization. Subsequently, visualization techniques would be used to cluster and organize the data and allow creation of various forms of visualization. Algorithms would then be utilized to produce varied visuals based off the type of data displayed. Various forms of visuals will be created so as to cover all possible information required to monitor and notify the user. Line graphs, bar graphs and theme river graphs would be the most effective ways of displaying changes in quantities over time. These representations can be used for both real-time and long-term monitoring.

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