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Blind Source Separation of Electrical Load Profiles

Team ECE-01
Final Report

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ABSTRACT

In the existing power system, the load is predicted as a composite entity for an entire region that is supplied by one utility. Due to mandated deregulation of electric utilities, it will now be advantageous that the actual composition of the load be determined to estimate consumers' total load usage. Separating the source load into individual appliance load profiles will allow consumers to balance their total usage and create a homogeneous, predictable, and stable load. To create loads of this type, it is necessary to find a method for gathering source load data and identifying its components. Since monitoring each individual load at the local utility is not feasible because of economic as well as privacy considerations, non-intrusive monitoring at some common measuring point is the preferred method. However, this type of measurement is a combination of signals that will require a source separation technique to determine the individual load profile for each appliance. To accomplish the task of non-intrusively monitoring loads will require a suitable data acquisition system as well as a method for signal separation.

In order to provide a compact yet robust data acquisition system, our design consists of signal conditioning hardware and a data acquisition board with interfacing software. The signal conditioning hardware attenuates both voltage and current signals to reduce these signals to levels that can be accepted by an analog to digital converter. The data acquisition board captures single-phase, instantaneous values for voltage and current and collects these points simultaneously so that phase angle difference can be determined by a method based on zero crossing detection. The interfacing software provides a means to store collected data to a database for signal separation and also for computation of real and reactive power.

The principles of Independent Component Analysis (ICA) and the introduction of FastICA, a computational method that applies the statistical techniques of ICA, have been widely used in many technical areas for signal source separation. Therefore, our method of signal separation utilizes FastICA to generate separated appliance load profiles from a residential source load at the main service bus. By comparing our results from the FastICA algorithm to individually acquired appliance load profiles, we attempted to determined if ICA and the current FastICA algorithm is efficient for use in appliance load profile separation.