Electrical Devices Identification through Power Consumption using Machine Learning Techniques

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Abstract **— This research discusses a way to identify electrical devices in real time using intelligent techniques through data analysis. The electrical device identification process is initiated by collecting information related to power consumption of electrical appliances which are used in domestic life. In this the main attention is paid to identify an electrical device quickly with a higher accuracy. And the main objective behind the research is to provide a way to calculate power consumption of electrical devices separately with an intelligent approach with less human involvement. A prototype data acquisition system was implemented to extract parameters such as active power, reactive power, phase shift, root mean square voltage and current from the appliances connected to it. The analysis is done using neural networks, support vector machines, k-means, mean-shift and silhouette classifiers. The purpose of this study is to select the best classifier which produces the optimum results in detecting and identifying electrical appliances in real time from their electric parameters. In the selection of the classifiers for the research, basically the supervised and unsupervised learning criteria were taken into consideration. The selected classifier is used to determine a power consumption pattern (signature) for different electric appliances.**

Keywords - classification, clustering, k-means, mean-shift, neural networks, silhouette, support vector machines

I. Introduction

As an intelligent approach, machine learning techniques can be used to understand the meaning of a data set in a logical way and provide useful outputs from raw data for different purposes. Machine learning approach is a statistical approach on learning more about a raw data set. When considering the existing systems in the world, there is a huge output of data which are not well analyzed. Here in this research more focus is provided to know more about power consumption of electrical devices for the purpose of identifying electrical devices in real time. The machine learning techniques provide a way of analyzing a huge data set in order to find patterns and relationships among different entities which cannot be observed without advanced analyzing techniques. The purpose of machine learning usage in this research is to identify the relationship between power consumption characteristics in order to detect electrical devices in real time. For the purpose of this identification, there are main features that are considered in this research.

Basically, the research area is about the domestic electrical devices which are used to fulfil day to day life activities in most of the houses all around the globe. Here the main features which are considered in this research are active power, reactive power, phase shift root mean square voltage and current. The variation of these features is different from one electrical device to another electrical device. The main reason for not choosing one parameter or two is that there is a possibility of the features being very similar or very close. In this case in machine learning there is a concept to determine the number of features that must be used to classify data. Here if the number of features used is very high, there is a possibility of the prediction from the algorithm fit too much to the data. In this case when the data is fitting too much to the existing data, the nature the algorithm behaves for a new data set will be very much depending on the previous data set. Therefore, the predictions can be wrong if the present data set is not following the pattern of the previous data set very close. In addition, choosing features very less also makes the algorithms not fitting the data set really well. The reason is the algorithm does not have enough facts to provide a meaningful relationship among data. Here the algorithms are called to be under fit to the data set.

The main factor that has to be considered is choosing reasonable number of features for making the prediction. In this case, initially the research was done to understand how much parameters might need to do a better prediction. The number of factors needed might be changed depending on the number of electrical devices subjected to the research. The number of features selected may be enough to detect a couple of devices using one or two features, but when it comes for detecting more electrical devices, the predictions will be accurate if there is satisfactory number of features to support the analysis.

There are two main stages in a machine learning analysis. They are training an algorithm for a dataset and testing an algorithm for a dataset. If and only if these two stages are successful, the predictions from the algorithm will be successful. In fact, an accuracy of 100% cannot be achieved in a prediction process, but the main target is to achieve detection for a satisfactory level of prediction. In this research the final outputs showed an accuracy of 95% - 98% in the detection of electrical devices in real time.

The main difference between this research and the existing researches is that, in this research it is being deeply analyzed how to detect an electrical device very accurately. How the system must be adapted to detecting electrical devices with the course of time when devices shows functionality differ from its original form of functioning.

***In this research, a few supervised and unsupervised learning methods are compared with a constant data set and a better classifier is chosen for the data clustering and prediction. In considering power consumption patterns, neural networks and support vector machines were used as supervised learning methods to classify data and predict patterns. Basically, the real time electrical device identification is done by comparing the power consumption features of each device with the other devices and clustering the data sets in the training period and predicting the electrical device connected to the system with a new data set.

Here the main variables considered in this research are active power, reactive power, phase shift, root mean square voltage and current. The data collection is done covering all the modes of operations and all the statuses of each electrical device in order to get a fully understanding about the behavior of their functionality. The purpose is to train the system to identify the electrical device in any moment of their cycle of functioning. The challenging factor that was seen in the research is to understand and collect data for the complete cycle containing all the statuses acquired by the electrical device. In the realization of the actions of a particular device, data has to be collected covering all the scenarios as far as the performance of a particular device is considered.

II. Related Work

A device called smart plug is created to detect the power consumption from each device. Here in addition to the smart plug a central unit was created to process the data and record the data. This central unit is running on a raspberry pi. In most of the researches related to electrical device identification, follows with this main data acquisition system. Here the most important fact is the accuracy of the data collected for the prediction. This device is programmed with data saving and data processing capability. The central unit is receiving data from the smart plugs in a wireless format and these data are being saved and analyzed in real time. And the smart plug identifies each device with the help of the central unit using machine learning techniques and classifies data for further analysis [2][3][1]. The importance of a data acquisition device in this research is important with a higher accuracy. The accuracy of the predictions depends on the accuracy of the data readings. There are many researches done to detect electrical devices in real time and some different researches were done to optimize and predict the power consumption [4][5][6][7]. Here both these scenarios are addressed in order to provide an advanced overview on power consumption at domestic level in Sri Lanka. There are researches done to detect electrical devices in real time to collect data with better classification in the earlier stages of data acquisition to provide a solid foundation for data analysis purposes [14].

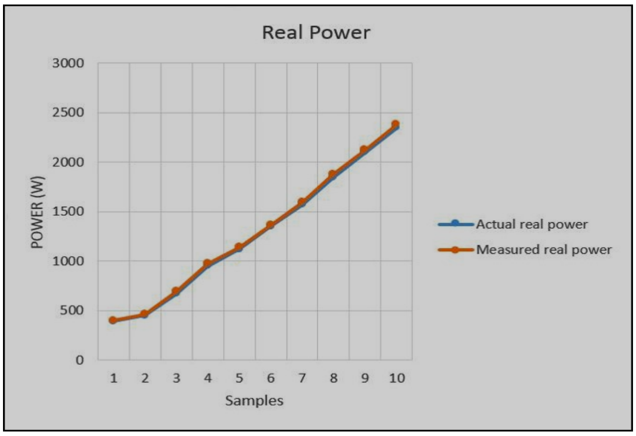

Figure 1: Accuracy of the Data Acquisition System

Later on neural networks and classification algorithms are used to detect consumption patterns and identify and cluster the electrical devices in purpose of real time device identification. In the electrical device identification domain, the related researches were more focused on extracting data from many devices and classifying them [16]. In understanding and classifying the electrical devices, there are limited numbers of features that can support the task [17]. Here the main attention was paid to the active power consumption. When it comes to devices which are consuming similar amount of power, this factor is not enough to classify the devices.

In this case more features were considered to support the classification task [20]. These features are reactive power, phase shift, root mean square voltage and current.

- Support Vector Machines.
- Artificial Neural Networks.
- K-Means Classification.
- Silhouette Classification.
- Mean-Shift Classification

In considering the machine learning algorithms used in the research, the reason for choosing a number of algorithms is that the way these algorithms converge to a result is different from each other as far as the research objective is considered. The support vector machines were not used in most of the researches done in the electrical device identification. Artificial neural networks were used to perform the clustering and identification tasks more often [9]. Support vector machine algorithm was found to be a faster algorithm which converges to the results as far as many other tests were done in classifying data [8] [18] [19]. General theory of working in support vector machines is not very complex and it enables in predicting the cluster of a new data set with the aid of an earlier trained data set.

The k-means algorithm is a very powerful self-learning algorithm [10] [15]. This algorithm needs only the input of a data set with the expected feature vector. The algorithm itself classifies the groups and provides the clustered output. This algorithm is really useful when predicting the electrical device which is providing a newer data set when it is in

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action with the data acquisition system. The Silhouette algorithm has the capability of showing graphical outputs from the clustering results [12] [13]. As far as supervision is considered, this is also an unsupervised learning method. Mean shift algorithm also functions based on the mean distance from a particular data point to the other clusters [11].

TABLE I. SAMPLE DATA SET

Active Power	Reactive Power	V_{rms}	I_{rms}	Phase Shift	Device Name
59.13	63.00	232.60	0.27	0.94	Bulb
751.33	752.00	210.82	3.57	1.00	Toaster
63.66	64.60	228.71	0.28	0.99	Fan
211.02	237.00	225.77	1.05	0.89	Blender

III. DATA ACQUISITION AND PROCESSING

The data acquisition was one of the most important parts of the research. In this case the power consumption details from each electrical device must be collected to a central point in the purpose of analyzing data. Here the smart plug device created with wireless transmission capability transmitted data to the central unit. The initial research was done to design an accurate data acquisition system to collect data. Here the data acquisition was tested to different loads and the readings were recorded. And the same loads were tested with load measuring system and the data was recorded. The data was compared and the calibration of the current and voltage measuring units were done to improve the accuracy of the data. The data collected from the data acquisition system was brought to an accuracy of 98% - 99% by doing research on data acquisition system.

The data processing was done by these acquired data. The central unit is a raspberry pi running python programme which reads data and run it through machine learning algorithms and predictions were done. Here in the training process, each device is trained to for hours to acquire data to record the whole cycle and to learn device dependent features. Initially the data is recorded and later on these data is fed in to different algorithm and clustering is done. After training each algorithm the performance was tested for a newer data set in real time.

IV. RESULTS AND DISCUSSION

In this section the way that the data was analyzed and related challenges in identifying the factors which govern the uniqueness of electrical devices will be discussed. Every electrical device possesses its own signature as far as the power consumption is considered.

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A. Electrical Device Identification

In analyzing the power consumption in domestic level, the data extraction from devices separately provides more detailed view of consumption. There are main factors that have to be considered, before creating a mathematical model to analyze data.

- Multi-Mode Functionality – The complex behavior in certain devices like fan, iron, washing machine, refrigerator possesses different modes of action. The multi-mode functionality was a complex problem addressed in the research. To identify an electrical device at all times, the system must know all the possible ways of power consumption done by the device. And also in the change of inter-modes, there are slight changes or noises. While the modes are changing still the device is drawing power from the power source, in that case for an accurate real time device detection system, there has to be a capability to detect unique signatures of theses modes in between the change of modes of operations in devices.
- Parallel usage of devices is the major fact that has to be considered in data acquisition and detection. Tapping to the main power flow and power consumption detection is only possible when there is only one electrical device in action. For multiple devices in usage, there has to be a way of quantifying the signatures of each device. In this research the approach is a hardware approach of using different units per device to collect data. The accuracy in this method is higher and the response is faster than sampling the data from overall power consumption for each device.
- External effect – The data acquisition must act in a constant manner depending on the external factors like temperature, electromagnetic interference, communication failures, etc. In the data acquisition system used in this research, the wireless data transmission was affected by the electromagnetic interference from the power consumption measurement unit, this affect the reading data in real time.
- Load variation needs to be handled based on the given scenario. In the case of training electrical devices, it was observed that the same device was subjected to real time identification in a different place; the predictions were not accurate as it was in the training facility. In this case, the device was trained again in the new place; different power characteristics in the power source. The factors are slightly different from place to another place as far as the power source is considered.

There are unique characteristics to each building depending on number of devices used, noises from the distribution line to the building, environmental temperature, etc. The research on the different venue power consumption data collection showed that there is a unique signature of the action of a particular device depending on the characteristics of the power source.

B. Supervised Learning

In the analysis, support vector machines (SVM) and artificial neural networks (ANN) are mainly used. In usage of SVM and ANN, a data set obtained from the data acquisition system was used for the training of these algorithms. In setting initialization parameters for the support vector machines, different kernels were tested and the kernel providing the accurate results was chosen. Basically there are four main kernels that were used in testing.

- Linear Kernel
- Polynomial Kernel
- RBF Kernel
- Sigmoid Kernel

The prediction accuracy with each kernel and execution time shows the best kernel which supports the real time prediction of data. In the similar way when considering the neural networks, the number of hidden layers, activation function type, output layer type, learning rate, number of iterations have been used to form the neural network for the purpose of classification.

TABLE II. ACCURACY OF CLASSIFICATION OF SVM

Kernel	Accuracy (%)	Execution (s)
Linear	95-98	0.01 - 0.03
Polynomial	94-96	0.01 - 0.04
RBF	96-99	0.01 - 0.02
Sigmoid	92-94	0.02 – 0.05

TABLE III. OVERALL ACCURACY OF CLASSIFICATION

Type	Classifier	Accuracy (%)	Execution (s)
Supervised	SVM	97	0.010
Supervised	ANN	96	13.000
Unsupervised	Mean Shift	94	0.013
Unsupervised	Silhouette	98	0.012
Unsupervised	K-Means	98	0.15

The data training was done in to all the above mentioned combinations and the prediction outputs were tested. In neural networks, the main problem was the response was not that fast. The framework used in this research provided a rapid output in all the other analysis except the neural network analysis. The accuracy was better with 100 hidden layers and with 0.001 learning rate. When considering the research data on the supervised area, the performance of support vector machines is comparatively better than that of neural networks. Both algorithms were implemented using python. The performance of the algorithms depends on the affect from the input variables for a particular scenario.

TABLE IV. ACCURACY OF CLASSIFICATION OF ANN

Activation Function	Output Layer	Learning Rate	Iterati ons	Accuracy
Rectifier	Softmax	0.1	10	10-20
Rectifier	Softmax	0.01	100	10-20
Rectifier	Softmax	0.001	1000	10-15
Rectifier	Softmax	0.0001	10000	96-98 (3)
Rectifier	Softmax	0.1	100	10-15
Rectifier	Softmax	0.01	10	10-15
Rectifier	Softmax	0.001	10000	85-95
Rectifier	Softmax	0.0001	1000	96-98 (2)
Rectifier	Softmax	0.1	1000	10-15
Rectifier	Softmax	0.01	10000	NIL
Rectifier	Softmax	0.001	10	60-70
Rectifier	Softmax	0.0001	100	96-98 (1)
Rectifier	Softmax	0.1	10000	10-15
Rectifier	Softmax	0.01	1000	10-15
Rectifier	Softmax	0.001	100	55-65
Rectifier	Softmax	0.0001	10	55-65

When considering the main parameters that are considered for device classification; active power, reactive power, Vrms, Irms and phase shift, it is clear that there is a unique signature for each electrical device. In the first place, selecting five parameters for device identification enables the avoiding a difficulty in identifying devices with similar power consumption and multiple mode of operation. By means of acquiring a data set for a longer time period, a supervised algorithm like support vector machines can be trained by providing the dataset and the matching device. Here for each state of the device a unique number is used to represent each device.

C. Unsupervised Learning

In unsupervised learning the output group is decided by the algorithm itself. The only input to the algorithm is a training data set and it clusters the inputs by itself. In this k-means, mean-shift and silhouette algorithms were used to test the data set and classify them. The k-means and silhouette algorithms provide higher accurate results than other two algorithms. The mean-shift algorithm deviates from higher accuracy, when the number of devices gets increased in the data set. Silhouette classifier works with higher accuracy and it provides graphically the nature of the classification very clearly than other methods. In the experiments, different electric devices were tested for different amounts of time and the expected prediction from each algorithm was recorded. Here the fast responses came from the SVM, silhouette and k-means algorithms. Figure 1 shows the outputs obtained from the classification from the silhouette algorithm. Here 14 different devices are shown and how these devices were classified can be seen. In addition to this algorithm the k-means algorithm was used to analyze how these devices are being classified when the five features are considered.

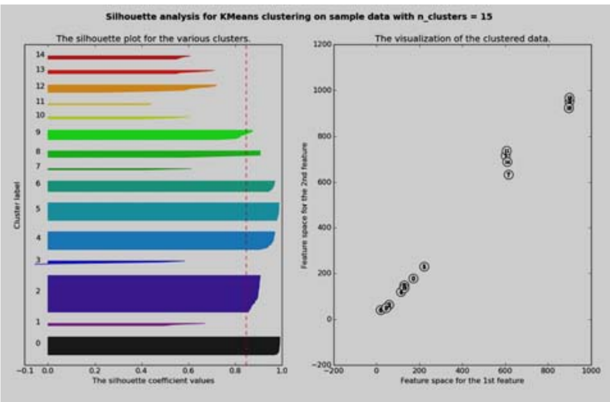

Figure 2. Classification Using Silhouette Algorithm

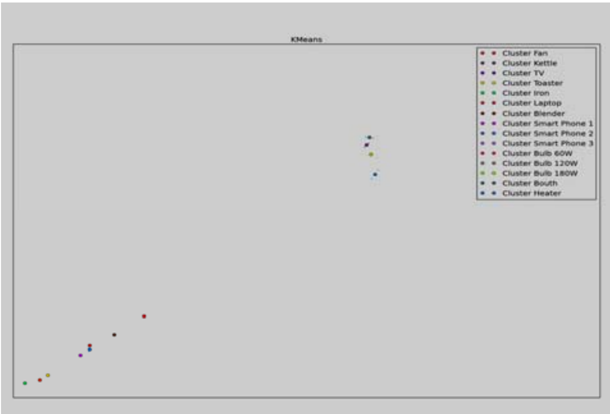

Figure 3. Classification Using K-Means Algorithm

Unsupervised algorithms were also tested by varying the initial parameters of each algorithm. But basically, the adjustment of predictions is itself carried out by these algorithms itself. In K-Means algorithms there are some parameters that has to be fed to fulfil the initial requirements of the application. By default, the initial values are not defined and the initial values have to be defined to run the algorithm.

Parameters fed in to the algorithm;

- Centroids (unique)
- Number of iterations
- Initialization method

In the algorithm implementation using python, these values were initialized before the algorithm executes.

TABLE V. ACCURACY OF CLASSIFICATION

Centroids	Iterations	Accuracy
2	10	95-99
4	50	95-99
6	100	95-99
8	500	95-99
10	1000	95-99

The number of iterations and the number of centroids affect the performance of the algorithm and it is analyzed in this way.

In analyzing these algorithms, the most important fact that has to be considered is the accuracy of each algorithm. Here in the training the data sets were trained without any sorting or ordering of data and the data was fed to the algorithms in the form of the data extracted from the original sources. Here in this research more than 50 different electrical devices used in domestic level were used. In analyzing all these algorithms, the most effective performances were obtained from the K-Means and SVM algorithms. In designing the system developed for real time electrical device detection, these research results were used in order to obtain successful results.

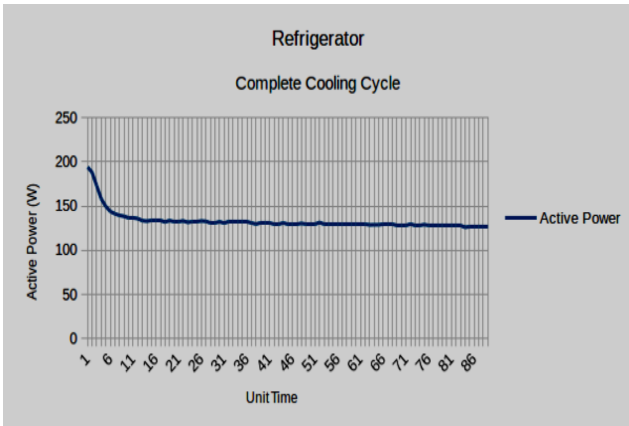

Figure 4. Multiple Modes of Operation of Fan

V. DATA SET ANALYSIS

Even though there are five parameters which can enable a clear classification, the behavior of an electric device changes depending on couple of factors. Electrical devices change the power consumption depending on the mode of its operations. The modes of operations mean there are different functions, speeds, movements, etc. Here when analyzing an electrical device for the real-time detection, the main fact is to identify all the possible power consumption patterns. Here the collection of data covering all the modes of operation was done to get a higher accuracy.

For instance, a refrigerator consumes less power when the temperature inside the device is in the expected range and when the temperature increases due to door opening, the refrigerator again starts to cool and consume more power. In order to identify a particular electric device, there has to be a data set which has a full cycle of the power consumption regarding all features; active power, reactive power, V_{rms}, I_{rms} and phase shift.

Without the knowledge of a full cycle, the prediction of a particular electric device may be limited to a certain range. In addition to this with the time electrical devices subjects to deterioration of power consumption depending on external factors like friction, mechanical disorientations and other influences the modes might be slightly different with the course of the time. In this the research data has to be updated if the application of the results is used after a considerable amount of time later. The main intention of this research was to develop a system which can detect electrical devices in real time in order to provide an automated system to calculate the power consumption data device wise and interpret these data usefully for the domestic level users.

In this case, a complete analysis was done for the purpose of covering a full cycle of operation for each electric device. For each device there is a different way of power consumption based on use inputs. Considering a fan which has three different speeds of operation, data was collected for all modes of operation.

Training electrical devices like heater, toaster needs an extensive effort, because the usage of water or the heat absorbing source should be subjected for practical scenarios.

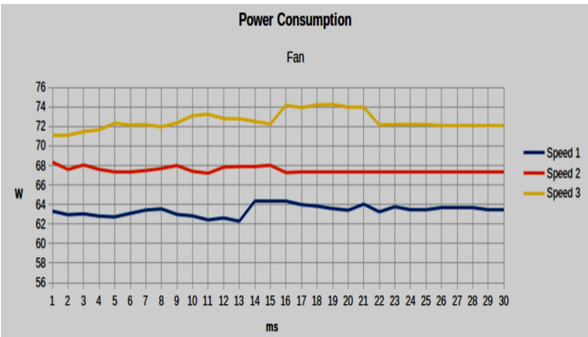

Figure 5. Active Power Consumption Cycle of Refrigerator

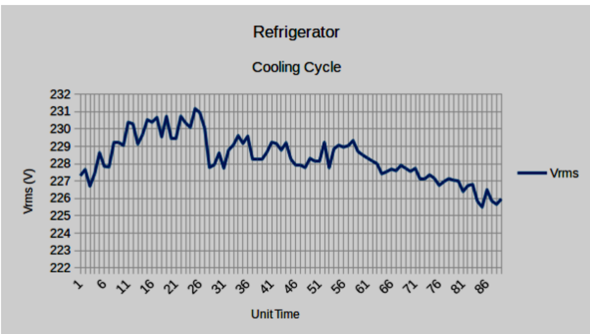

Figure 6. Root Mean Square Voltage Variation of Refrigerator

A. Test Results

From the data collected and the prediction experiments, it was clear that to identify an electrical device with a higher accuracy the modes of operations and complete functional cycle of each electrical device must be learned by the algorithm. Most of the electric devices with simple range of performance can be easily identified. But devices with complex modes of operations need to be tested and trained for the algorithm for a considerable amount of time to get accurate results. The main observations in the tests were that for each electric device there is its own way of acquiring power which can be identified as a cycle of performance.

In identifying an electrical device, the main thing is to find a way of differentiating it from the other devices. The existence of a cycle helps to understand the behavior of an electric device in different phase of its complete cycle. Without understanding the full cycle, predicting or real time detection of an electrical device is not accurate. Here in the research, many devices which are used at household were tested and the cycles were plotted. It was obvious that when the data set covers more amount of the cycle the prediction results were accurate.

In the training process, initially the system is fed with sample data set containing the main parameters and the matching electrical device identity. Here there are two matrices known as the feature vector and corresponding output vector. These two vectors are being fed to the classifiers. In support vector machines and artificial neural networks, these two vectors are identified and learned. In support vector machines the kernel function is used to classify the data with reference to the data set. Here basically the sigmoid and the linear kernels were used when the support vector machines were used. Basically the python programming language was used to develop the model and do the classification task in a Raspberry Pi environment using Linux.

The figures interpret the cycle of a refrigerator when completing its cooling cycle on the basis of increasing the temperature above the threshold value to keep the device in cooled condition and stop cooling after acquiring the threshold temperature.

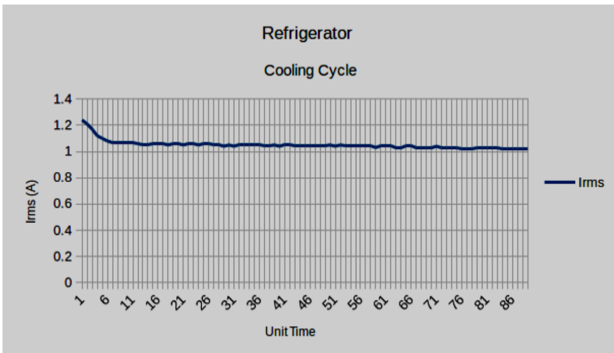

Figure 7. Reactive Power Consumption Cycle of Refrigerator

In detecting this device in any moment of its performance cycle, the system has to be trained on this complete data set. The main features active power, reactive power, phase shift, root mean square voltage and current behaves in a different way as far as test results were considered for many electrical devices. When considering an electric device like television, it does not have a well-defined cycle, the cycle changes based on the human inputs, the power consumption changes when the volume increases, decreases etc.

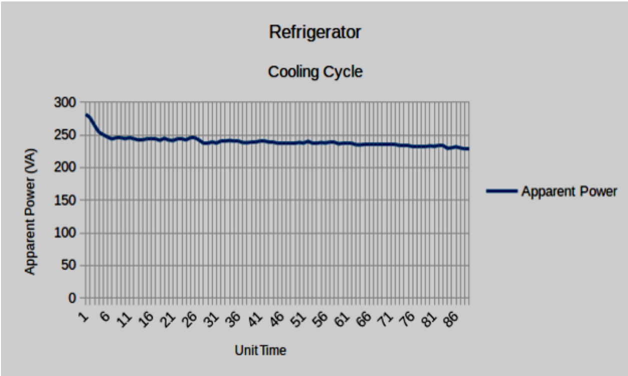

Figure 8. Root Mean Square Current Variation of Refrigerator

In the case of configuring the modes of operations like sound equalizer options, brightness, contrast and many more features, the power consumption changes. It is obvious for the fact that even when changing the channels, the power consumption is different from channel to channel when the cable televisions were tested in the research. The television is a device with a very complex behavior. The amount of power consumption by the television is changing with the channel used in the moment, the sound level, contrast level and other features supporting the visual and audio configurations in the television.

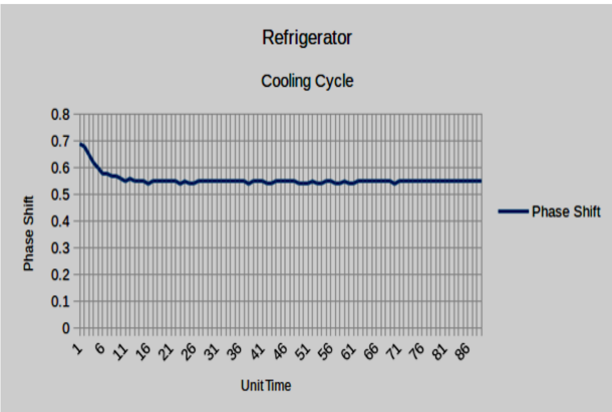

Figure 9. Phase Shift Variation of Refrigerator

Here the number of modes of operation in such a device is very complex and really hard to be understood without a data set collected for a longer time period. An electrical appliance like laptop has more complex configurations.

In training a device like television, the amount of data needed is vast and the time period which has to be allocated for a television is considerably higher than other electrical devices. The laptop or computer behaves similar to the television

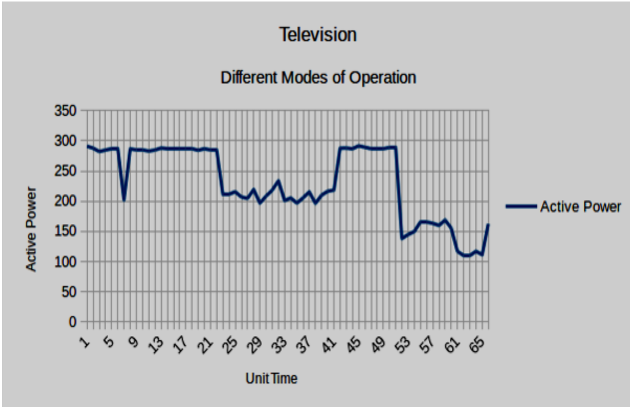

Figure 10. Active Power Variation of Television

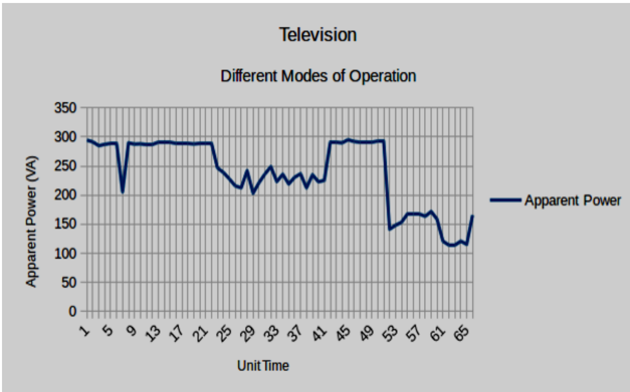

Figure 11. Apparent Power Variation of Television

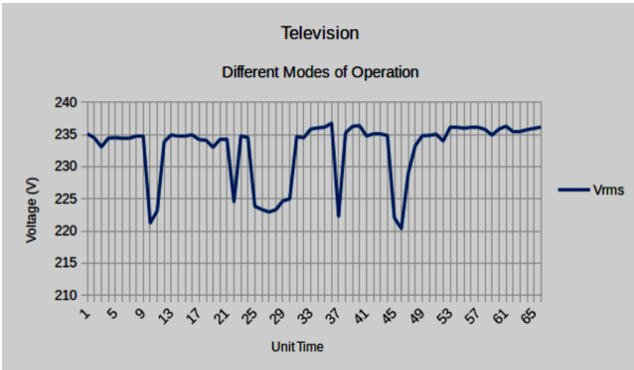

Figure 12. Vrms Variation of Television

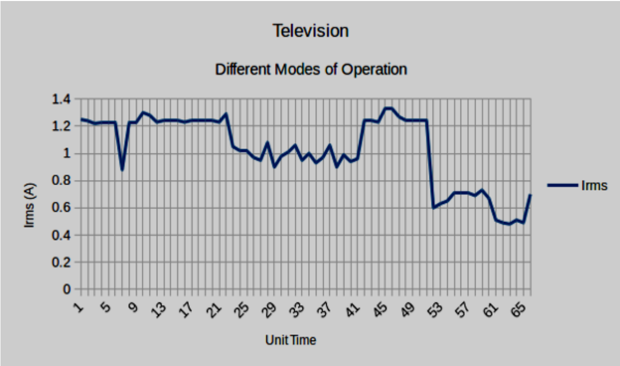

Figure 13. Irms Variation of Television

VI. CONCLUSION

By the data collected and patterns detected, it is clear that there is a unique signature for each electrical appliance and these signatures can be used to identify each device uniquely with a promising accuracy. The most important fact in the research was collecting data in an accurate way. In this case the initial research was done to design an accurate data acquisition system which can provide data with higher accuracy. In considering the features collected in the data acquisition system, in order improve the prediction accuracy the involvement of more features will improve fast convergence in the prediction algorithms. In this case the factors like peak active and reactive power consumption, peak V_{rms} and I_{rms} values are important. The need of higher number of features spring up when the number of devices subjected to test are fallen into similar behavior categories as far as power consumption is considered. This can be seen in the devices of serving the same purpose. In training two irons in this system, it was observed that if the ratings are similar, the power consumption is also similar, but considering all the main features, it can be classified, but if the current feature set is not capable of doing such classification, the fact is the training has to be done for a longer time and also the number of features involving the classification must be increased. The implementation of real time electrical device identification system provides the ability to filter power consumption data from overall consumption data. In these researches the cycle of functionality of complex behaving devices were not discussed. But in this research more attention was paid to understand an electrical device more like a living object than a machine. In this research aspect, the cycle of performance, effect of noises and detecting the accuracy of the data acquisition system are considered to obtain more accurate results. The fact is in optimizing cost and saving power the most important thing is to collect details on the ways power consumption happens and how much each device consumes power. When there is enough data to know how the power consumption happened in considering each electrical device, the ability to predict ways to optimize power consumption, save energy and identify wasting events can be done through a thorough analysis. In addition to that there is an advantage of the implementation of the real time device detection system in considering the life-span of electrical devices. When an electrical device shows the sign of behavior abnormal to the normal functionality, by means of the data collected in the history and comparing these data with the data receiving in the current state, predictions and analysis can be done to understand what has happened to the system or to detect any power overflow or leak in the system. This is an extra advantage of the research implementation in real world scenarios. In addition to that, each device has its way of functioning based on human involvement. It provides different modes of operation of devices. Each electrical device possesses its own cycle of power consumption. In detecting an electrical device with a higher accuracy, the understanding of all forms of power consumption is important for an accurate identification to detect a device at any time. Training of an electrical device for a longer time period with changing the modes of operations was done to record the all possible ways of power consumption. And also the transition period of a particular device transferring from one mode to another mode is a complex area of study.

In this the transition period the power consumption pattern changes and these transitions has to be identified well by training for a longer period switching between different modes. In the practical applications the training of different electrical device is really important in order to collect data to understand all the possible ways of power consumed by a particular electrical device. For devices like mobile phones, heater, fan, iron, oven and single or limited mode machines have a higher accuracy in detected by the system. For the complex mode operation devices like computer, laptop, radio and similar devices, the training is the most important thing to be done for a longer period. When considering a device like laptop the configurations are very complex, but the fact is, if the charging of the device is calculated, the device is only charging and the power is consumed later the training is not very complex. But when charging and working simultaneously, the configurations are very complex and it takes a longer training period to understand the device completely. In further reference, after a very thorough training process the programme executed by the device can be predicted. In this research the main focus was only to read the power consumption patterns. The time period is important because when the devices are used for a longer period for the experiment, the capability of covering all the forms of actions and states taken by the device can be identified. Basically every electric device possesses its own unique signature. In addition to that the consistent performance is not always observed in every electrical device. Because with the course of time there can be some irregularities which causes the devices to function deviating from the original way of functioning. In understanding these factors, longer the training period, the accuracy of the results is always better. In addition to this the user profiling is also a possible output from this research. The research data presented in this paper is regarding the electrical devices which were mostly used in Sri Lanka. The profiling task is same for a different country. The only change is the change that has to be done in the data acquisition system for acquiring data in different voltage levels. In user profiling, the deep idea is to personalize the environment depending on the human behavior. The speed of the fan used in the morning and the speed of the fan used in the evening can be different. And also depending on the portion of the house, there exists a pattern of usage of vivid electrical devices.

By real time electrical device identification, the device activation time and the corresponding power consumption patterns can be recorded and by using these records, the prediction of human actions and modes of operation of electrical devices can be predicted. The real world applications and end results of this research is massive so that a large amount of data can be collected when considering domestic environment in order identify the needs of the human beings and the needs of a particular community. In the training process, the most vital task is to train the device meeting different scenarios. For instance, a refrigerator was tested for different amount of food storage and changing the number of times foods are being taken from the refrigerator in detecting every possible way of power consumption. More the experiment is done on different scenarios the accuracy of the results is higher. Depending on the external factors the inner system functionalities can be changed. The possibility of recognizing power consumption based on patterns or signatures for electrical appliances would be vital for intelligent power electronic systems for optimizing their power consumption as well as to detect and monitor connected services. In considering the smart concept, the centralization of large amount of data regarding power consumption can lead to identify power consumption patterns. In considering the smart concept, the centralization of large amount of data regarding power consumption can lead to identify power consumption patterns. Identifying power consumption patterns can provide details to personalize devices, home automation, power demand prediction and provide information on time periods on which repairs should be done in order to minimize the effect on a particular community

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