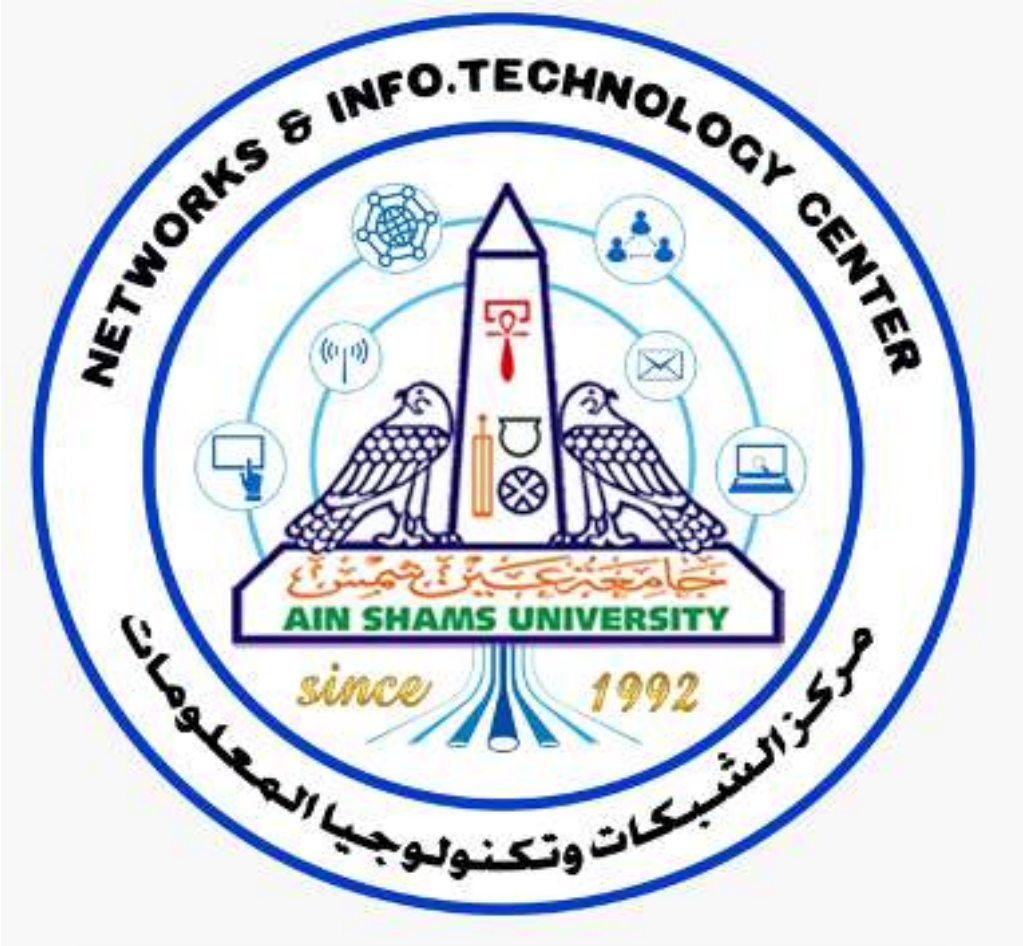
Mona Maghraby

# بسم اللّه الرحمن الرحيم

## مركز الشبكات وتكنولوجيا المعلومات

## قسم التوثيق الإلكتروني



Mona Maghraby

# جامعة عين شمس

## التوثيق الإلكتروني والميكروفيلم

## قسم

نقسم باللّه العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات


# DEVELOPMENT OF A UNIFIED CONTROL ALGORITHM FOR DEMAND RESPONSE BASED HOME ENERGY MANAGEMENT SYSTM

By

**Momen Samy El-Agamy**

A Thesis Submitted to the

Faculty of Engineering at Cairo University

in Partial Fulfillment of the

Requirements for the Degree of

**MASTER OF SCIENCE**

in

**Electrical Power and Machines Engineering**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

GIZA, EGYPT

2018

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## Title of thesis:

**DEVELOPMENT OF A UNIFIED CONTROL ALGORITHM FOR DEMAND SIDE BASED HOME ENERGY MANAGEMENT SYSTEM**


## Key Words:

Smart Grid, Home Energy Management Systems (HEMS), Demand Request Event, Appliances Load Profile, Appliances Scheduling, Load shift.



## Summary:

This thesis presents the various control methodologies of home energy management systems (HEMS) in previous literature as part of demand response programs in smart grid systems, this is done by categorizing the HEMS various techniques and clarifying the differences between them. In addition, modeling and simulating each category have been implemented in MATLAB/Simulink environment to evaluate each algorithm based on a suggested residential load profile. A new unified control algorithm is proposed and adopted to show its advantages over the preceding types of HEMS algorithms. Appliances load models have been developed using the MATLAB/Simulink environment that will assist in evaluating each algorithm and comparing their results.

# Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Date:
Signature:

# ACKNOWLEDGEMENTS

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# Nomenclature

| | |
|---|---|
| HEMS: | Home Energy Management System |
| DR: | Demand Response |
| WH: | Water Heater |
| AC: | Air Conditioning |
| CD: | Clothes Dryer |
| EV: | Electric Vehicle |

# ABSTRACT

The recent energy efficiency and conservation programs has created an unprecedented demand for home energy management systems (HEMS) in residential sector to reduce electricity consumption and hence conserve electric bills.

In this thesis, a proposed unified control algorithm is presented that targets to manage the home appliances' hourly power operation in a daily basis. The proposed algorithm is generic in the sense of getting the ability to achieve three different objectives for the electricity generation and distribution utility/customer dual benefits. Range of constraints such as load priority, customer preferences, demand response limit signal (utility request) and utility tariffs' pricing are taken into consideration. The ultimate goal of this algorithm is not only to curtail or control the appliance load power but also to shift it to better pricing period based on different tariff rates. The results reflect the effectiveness of the proposed algorithm that extends the previous results in literature by considering wider range of limitations applied on HEMS simultaneously.

In this context, firstly the main objectives of the demand response principle and its role in the energy conservation procedures are discussed as a one of the major mechanisms in the demand side management approach. Then, the general definition, goals and methodologies of HEMS are given. Moreover, the technical strategies developed and different algorithms in the literature are also presented.

The development of the load profile used in this thesis is presented to test the effects of each algorithm, the results of each algorithm is discussed showing their drawbacks. The proposed unified control algorithm is then implemented on the same load profile to show the difference and its paybacks over the traditional algorithms. Test results are presented and discussed with the help of illustrative figures and curves.