Application Potential for Developments in Microwave Oven Systems

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ABSTRACT*: Microwave oven system is an indispensable electric appliance in modern kitchen that heats, bakes or cooks the food by exposing it with electromagnetic radiation. This paper discusses the application potential for development of electric oven systems for enhanced functionality and more user friendliness.*

Keywords *– Cooking appliances, embedded systems, microwave ovens, programmable ovens, smart ovens*

I. INTRODUCTION

The practical uses of electromagnetic energy at microwave and radio frequencies have been exclusively used for communication and broadcasting applications since last one century. During the past half century, microwave energy is being used to interact with materials for some end benefits like heating and baking of the foods. The increasing disposable incomes, improving lifestyles, emergence of double income families, busy schedules, and a rising number of working women have generated the massive market for microwave ovens.

Microwave heating is the transfer of electromagnetic energy to thermal energy. Molecules such as water with positive and negative charges behave as dipole magnets and respond to the rapidly changing field caused by alternations in the cavity of the microwave oven. This causes friction and thus generates the heat. The microwave energy is delivered directly to the material through molecular interaction with the electromagnetic field.

Microwaves lie in the electromagnetic spectrum between infrared waves and radio waves. They have wavelengths between 0.01 and 1 meter, and operate in a frequency range between 0.3 and 30 GHz. Beyond the value 30 GHz, the microwave frequency range overlaps with the radio frequency range [1].

The microwave oven has a history of more than five decades. The first microwave oven was introduced by Tappan in 1955, but the widespread use of domestic microwave ovens occurred during the 1970s and 1980s. Since the first domestic microwave oven was released for household use in 1965, microwave ovens have become widely used as multifunctional cooking equipment without fire for warming, baking, boiling, steaming, etc. The global market for microwave ovens is projected to reach 72.5 million units by the year 2015 [2].

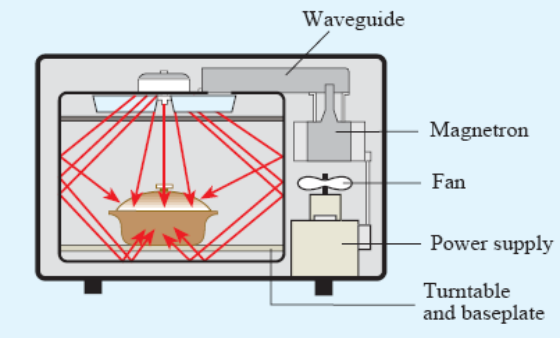

Figure 1: Microwave Oven System
(Source: Electronic)

The design of oven had undergone many transformations form mechanical to automatic electric toaster with color sensors. In the modern toasting systems, the user can specify required temperature and a toasting time. In order to make the system more user friendly, temperature values are directly associated with the recipe, instead of selecting the temperatures manually. The commercially available domestic electric microwave ovens allow users to set time and or temperature as per the instructions and guidelines provided by the manufacturers. In some cases, the recipes are pre-defined and user needs not to set the temperature or time. Figure 1 shows the basic components of a microwave oven system.

This paper discusses about the potential for development of electric oven system for enhanced functionality and more user friendliness.

II. PAST CONTRIBUTIONS

Application of microwave energy for materials processing is emerging as a novel and innovative technology with many advantages over conventional processing, such as reduction in

processing cycle time resulting into substantial energy and cost savings, providing finer microstructures leading to improved mechanical properties, and eco friendliness. The microwave energy is highly versatile in its application to numerous diverse fields such as communication, chemical reactions, rubber vulcanization, drying, food processing and medical related fields [3]. A microwave oven can save a substantial amount of the electrical energy when used to cook food, approximating the saving of energy up to 63% [4].

The microwave has got unexpected success in last 50 years. Author made some predictions about what will happen in the next 50 years relative to microwave power applications. His major predictions reported to be about development of new magnetrons, solid-state sources and broadening of scope of microwave power applications [5]. The overview upon the prospects of microwave processing has been identified and reported. The attempt has been made to study the heating behavior of materials in the electric and magnetic fields at microwave frequencies for industrial applications [6]. The physics of microwave oven has been described to give basic understanding of the concept. The presented study deals with the generation of microwaves in the oven and includes the operation of the magnetrons, waveguides and standing waves in resonant cavities. Also the basic issues like, absorption of microwaves by foods, dielectric relaxation of water, penetration depths of electromagnetic waves in matter and, in considering the possible chemical changes during the microwave heating, multi-photon ionization or dissociation are presented [7]. The principle of microwave activation, various types of Microwave Reactor and its characteristics are illustrated [8].

Tsai C. et al proposed the new effective circuit design for a touch panel microwave ovens to reduce the standby power consumption thereby reducing the heat developed due to low consumption of electricity [9]. Chang Y. et al presented the use of microwave radiation to process cereal-based products [10]. The microcontroller based electric cooker/oven with temperature and time control for the developing countries has been reported [11]. Author inferred that the unregulated hot plate element cooks faster than microcontroller based electric oven. Author also stated that the oven/cooker is the efficient energy conservator.

Rahman M. et al proposed the microcontroller based natural gas oven system designed to reduce the large amount of natural gas using IR sensor and solenoid valve [12]. The application note on toaster oven control system using MC9S08QD2 microcontroller describes the microcontroller based oven system [13]. Different techniques in circuit design, intelligent software control, and reliable mechanical structure are illustrated in the application note to show how to achieve a product design with protection features for handling faults in extreme conditions [14].

III.LIMITATIONS OF CONVENTIONAL MICROWAVE SYSTEMS

Although significant progress in microwave oven has been achieved, there are still quite a large number of open issues relating to the specialization and performance enhancement of existing microwave technologies and new technological solutions for tomorrow. There are significant limitations in versatility, user friendliness and functionality of the domestic microwave ovens and further progress is needed to extend the range of functionalities and accuracy. This fact intensifies the demand for development of smart microwave oven systems.

The commercially available microwave ovens limit in functionality and user friendliness.

Following are the major disadvantages of existing microwave ovens:

1) Less user friendly
2) No suggestions about ingredients of recipe
3) No guideline provides about selection of quantity depending upon number of persons
4) Non-programmable

IV. SCOPE FOR DEVELOPMENT OF SMARTER OVEN SYSTEMS

In the commercially available microwave oven systems, few numbers of recipes are pre-defined in the form of touch-screen menus. Consequently, the user gets limited choice for recipe selection, despite making heavy investment in microwave ovens. Moreover, the existing oven systems do not suggest the quantity of ingredients based upon the number of persons. The programmable microwave oven systems can be developed that will allow users to grow the list of recipes.

The review of the literature reveals that there is an intense need for development of the microcontroller based smart microwave oven system that is more versatile and gives more return on investment. The development of smart over systems can be carried out with following objectives:

1. Development of a microcontroller based Electric Oven with Recipe, time and temperature control

2. Development of a code for microcontroller in C programming language
3. Development of oven controller with high grade accuracy

During the study of various reports of investigators pertaining to the issues of microwave ovens, the recommendations observed to be in the following areas:

1) Need to develop a more user friendly microwave oven system
2) Need to develop a more versatile microwave oven system
3) Need to develop a microwave oven system that gives more return on investment

The embedded system is an extremely live area. The recent technology in the development and utilization of embedded systems in the every segment of human life are certainly bringing benefits. There are strong incentives to reduce costs while increasing the speed, functionality, accuracy and flexibility of the product. Despite the obvious advantages like, ease of operation, time saving, the microwave ovens can be improved to fit everybody's cooking need. Among the few disadvantages, although significant advancements have been made with newer software, the coding process itself tends to be slower. Therefore, lack of automatic program generation is the major disadvantage.

V. CONCLUSION

Despite the obvious advantages like, ease of operation and time saving, the microwave ovens can be improved to fit everybody's cooking need. There are strong incentives to reduce costs while increasing the speed, functionality, accuracy and flexibility of the microwave systems.

The embedded system is an extremely live area. The recent technology in the development and utilization of embedded systems in the every segment of human life are certainly bringing benefits.

REFERENCES

[1] Gaba M. and Dhingra N., (2011), "Microwave Chemistry: General Features and Applications", Indian Journal of Pharmaceutical Education and Research, Vol. 45, Issue 2, pp. 175-183.

[2] Research Cell, (2012), "Microwave Ovens", TV Veopar Journal, Annual Issue, ADI Media publication, pp. 77-80.

[3] Agrawal D., (2010), "Latest global developments in microwave materials processing", Materials Research Innovations, Vol. 14, No. 1,pp.3-8.

[4] McConnell D., (1974), "Energy Consumption : A Comparison between the Microwave Oven and the Conventional Electric Range", Journal of Microwave Power, Vol. 9, No. 4, pp. 341-347.

[5] Osepchuk J., (2002), "Microwave Power Applications", IEEE Transactions on Microwave Theory and Techniques, Vol. 50, No. 3, pp. 975-985.

[6] Das S., Mukhopadhyay A., Datta S., Basu D., (2009), "Prospects of Microwave Processing : An Overview", Bulletin of Material Science, Indian Academy of Sciences, Vol. 32, No. 1, pp. 1-13.

[7] Vollmer M., (2004), "Physics of the Microwave Oven", Physics Education, Vol. 39, No. 1, pp. 74-81.

[8] Surati M., Jauhari S., Desai K., (2012), "A Brief Review: Microwave Assisted Organic Reaction", Archives of Applied Science Research, Vol. 4, No. 1, pp. 645-661.

[9] Tsai C., Bai Y., Lin M., Jhang R., (2013), "Reduce the Standby Power Consumption of a Microwave Oven", IEEE Transactions on Consumer Electronics, Vol. 59, No. 1, pp. 54-61.

[10] Chang Y., Steel C., Clerici M., (2011), "Use of Microwave Radiation to Process Cereal-Based Products", Chapter 23, Advances in Induction and Microwave Heating of Mineral and Organic Materials, InTech Pub., pp. 531-552.

[11] David M., Kwoopnaan V., Ademola B., Audu W., (2013), "A Microcontroller Based Electric Cooker/Oven with Temperature and Time Control for the Developing Countries", International Journal of Engineering Research and Applications, Vol. 3, Issue 3, pp.1082-1084.

[12] Rahman M., Ronee A., Islam A., Huq A., Islam R., (2012), "Microcontroller Based Smart Natural Gas Oven", International Journal of Advancements in Research & Technology, Volume 1, Issue3, pp. 1-5.

[13] Corkidi S., (2007), "Toaster Oven Control System Using MC9S08QD2, Freescale Semiconductor Inc., pp. 1-9.

[14] Lui D. and Lun T. (2012), "Design Microwave using S08PT Family", Freescale Semiconductor Inc., pp. 1-14.