Microprocessor Board for Vitroceramic Control

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Abstract

This paper presents the industrial application of a microcontroller for a vitroceramic cooker. The vitroceramic surface is clustered into a matrix of cells, each one containing one heating resistor and one infrared emitter- receiver pair which detects the presence or absence of a receptacle on its cell. With this information, a microcontroller fires only those resistors arranged under the base of a receptacle. This patented vitroceramic cooker presents many advantages over traditional ones; for instance, power consumption is optimized, as only the useful ceramic surface is heated. Furthermore, when the object is removed from the surface, the heating resistors are powered off, so there is no risk for the fires being left on, which is of great interest for blind people. Acoustic signals can also be generated indicating the existence of heated resistors.

1 Introduction

Traditional vitroceramic plates only distinguishes 4 different heating zones, so receptacles should adapt to their sizes. Then, receptacles must be placed on the correct area to be properly heated, which can be difficult to achieve, specially for blind people.
The aim of this vitroceramic cooker is to replace these 4 zones with an 80 cell heat matrix. Each cell in the matrix has one resistor and one infrared emitter- receiver pair. When an object is placed on the surface on a given cell, its infrared receiver detects the light waves which bounce with the object base, enabling its companion resistor to be fired.

2 System Architecture

The vitroceramic plate is divided into 4 different zones, with 5 x 4 heating cells each. A PIC microcontroller [1] governs each of these 4 zones with a different power selector. An on-plate display shows the active cells. Figure 1 shows a prototype, which implements at full scale one plate zone.
The system is composed of the following elements: main card, control card, ceramic isolators, resistors and the vitroceramic glass.

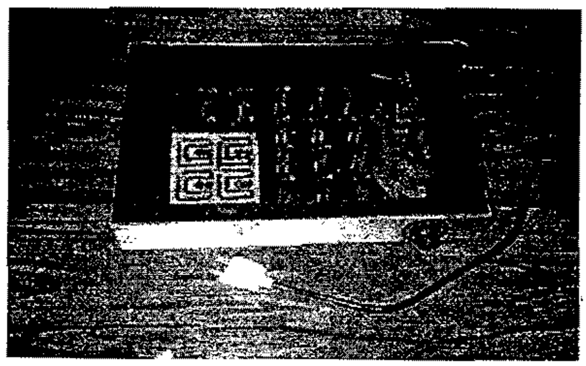

Figure 1: A photograph of the prototype

2.1 Main Card

The main card has two conducting planes. On the top side, the infrared emitter- receivers pairs are placed shielded by metallic pipes which provide electrical and thermal isolation. The top side also contains other passive components not sensible to heat. The bottom side contains the active power components (triacs). The top side of the main card can be seen in figure 2.
The ceramic isolator is mounted on the top of the main card and contains the resistors. The

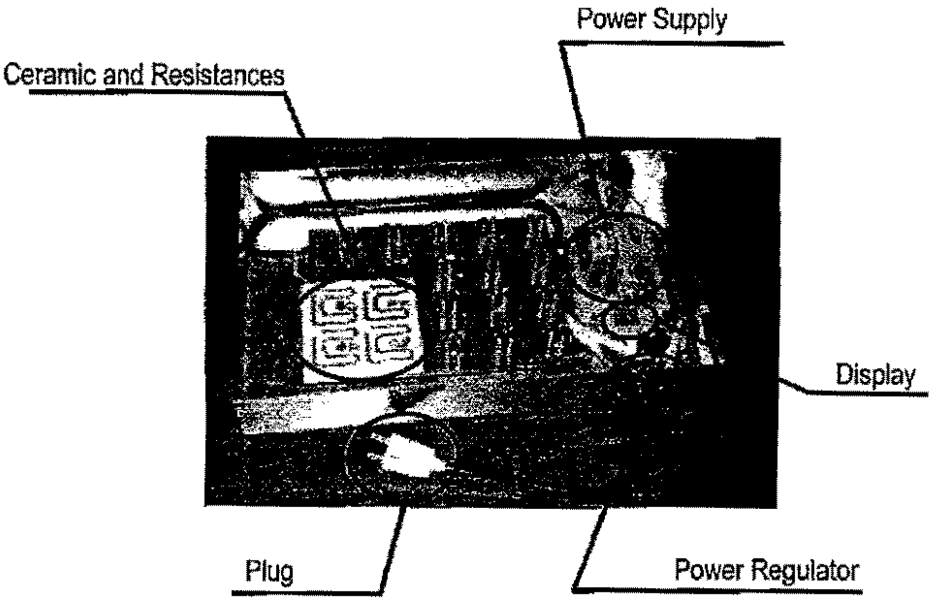

Figure 2: A photograph of the whole system

objective of the ceramic isolator is to lead heat upwards isolating the main card where the electronic devices are placed. The ceramic isolator is provided with two drills that let the optical signals from the sensors pass through.
Resistors are placed on the ceramic isolator in a cavity and are connected to the power card by two female pins, so extraction is easy without removing the ceramic isolator plate. Those pins are surrounded by the ceramic material and welded to wires connected to the power side of the main card.
The vitroceramic glass is mounted on the ceramic isolator plate. It lets heat as well as the infrared beams pass through, so that infrared beams are reflected inside the cooker only if a receptacle is placed on the hob.

2.2 Control Card

The control card is very simple and it only contains one PIC16F84 microcontroller and 2 buffers, one devoted to trigger the resistors and the other in charge of the display. Input signals from infared sensors are read through external connectors to be output in the display.
The control card has been designed in SMD technology to save area and cost. It has a credit-card size and it is connected to the main card by means of a slot in order to be easily removed for maintenance and repairing. Figure 3 shows a photograph of the control card.

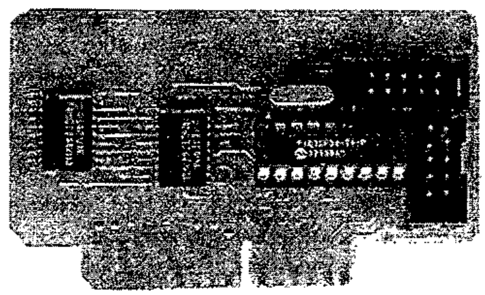

Figure 3: A photograph of the control card

3 System Control

Each area is controlled by one control card containing one PIC16F84 Microchip microcontroller. This solution allows a simple and economic control with a reduced size (18 pins). This PIC has an in-built 1K flash memory where the program is stored, one watchdog and sleep mode for power saving. Input signals scheduling appears in figure 4.
Microcontroller inputs are:

- Power regulation signals.
- One active-low signals (0.35 ms duration) coming from a zero-crossing detector of the power line.
- Signals coming from the optical receivers.

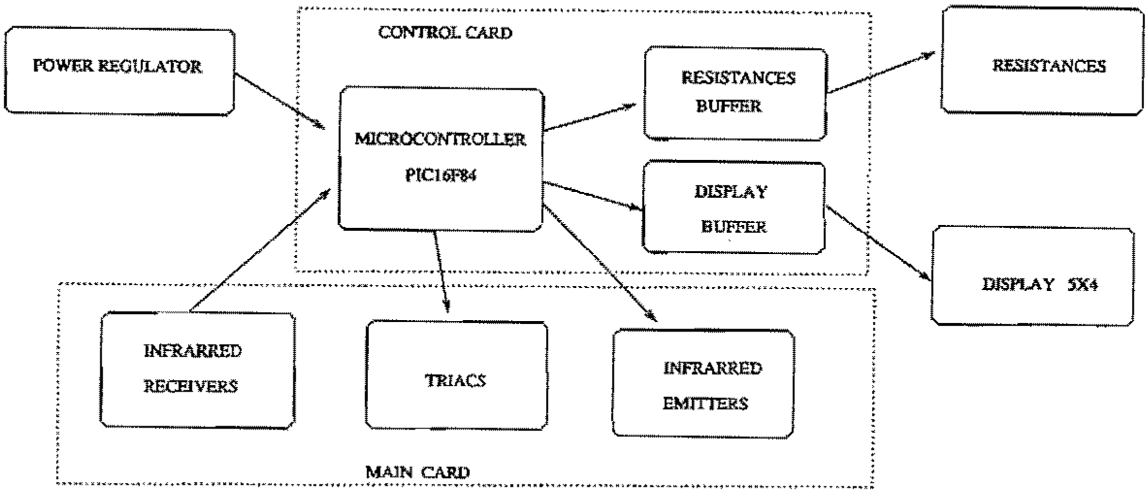

Figure 4: System control scheme

Power regulation might be mechanically or digitally done. In this prototype a mechanical selector has been chosen, providing up to 8 different power levels. One zero-crossing detector allows the microcontroller to perform a conventional phase-angle power control. To simplify the interface, the controller excites 5 emitters in a row at the same time and waits for the corresponding receiver outputs. In this way, 4 receivers share the same controller input line.
To reduce interferences, the receiver signals are digitally filtered with a 38 KHz center frequency (which is the frequency of the sinusoidal signals that drive the infrared emitters).

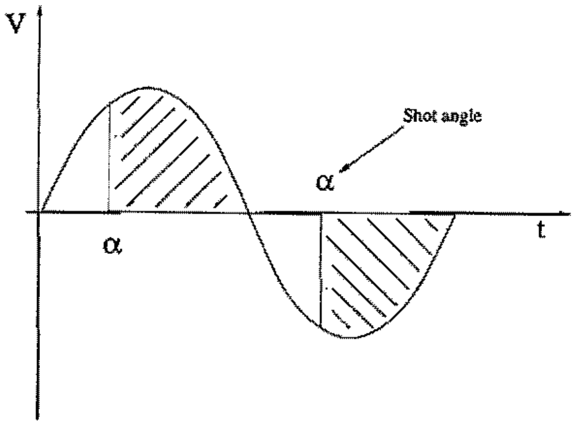

Figure 5: Power regulation

4 Power Regulation

A classical phase angle power regulation is carried out (figure 5) by means of triacs. The shot angle can be software selected.
When purely resistive elements are connected, the control system influence on the voltage grid (electrical noise) is minimal. The main noticeable effect is acoustic noise produced by the resistors and the mechanical efforts due to temperature changes. However, when the glass is placed, this acoustic noise is negligible. Nevertheless, other optimal control strategies can be selected with a different software programming. For instance, the power could be delivered in trains of complete voltage cycles.

5 Conclusions

This paper presents an intelligent vitroceramic cooker that switch on/off a matrix of 80 resistors depending on the presence or absence of objects on its surface. A prototype has been designed in order to show its feasibility. The new vitroceramic cooker is no larger than conventional ones, and its foreseen cost is no more than a 10 and easy management, making it suitable for all customers, specially for handicapped people, such as blind people.

Acknowledgements

This prototype has been financially supported by Hnos. Valé, who are the patent [2] owners.

References

[1] *"PIC16/17 Microcontroller Data Book"*, Microchip, 1998.

[2] Spanish Patent: P96-00676