

# Design of Smart Dining Table using Arduino Nano and Low Induction Heating

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**Abstract** - This paper introduces the design and validation of a Smart Dining Table utilizing an Arduino Nano microcontroller and Low Induction Heating (LIH) technology to automatically keep food at its original serving temperature, solving inefficiencies in typical temperature preservation methods. The classic methods tend to involve manual input of temperature, resulting in human errors and power wastage. Conversely, this work presents a new closed-loop temperature control system through LM-series analog temperature sensors for sensing and maintaining the temperature at which food is first served without the intervention of the user. The system structure combines Arduino Nano with LM35 temperature sensors, low-power LIH coils, and a touch interface. After placing food, the LM35 sensor immediately detects its surface temperature, which is set by Arduino Nano as the target reference. The PID control algorithm constantly modulates the induction coils' output to keep the measured temperature at  $\pm 2^{\circ}\text{C}$ , minimizing variance from the original serving condition. LIH coils, which have been designed to work optimally in low frequencies, achieve 89% thermal efficiency with localized heating. Experimental tests confirmed the system to maintain food temperatures with 95% accuracy during 45-minute periods, having a 35% energy reduction compared to standard warmers. Users tested the system with a satisfaction rate of 95%, highlighting the system's smooth automation and consistency. This work makes a contribution to smart appliance design by illustrating an energy-efficient, autonomous, and low-cost solution that prioritizes user convenience. Potential uses include residential kitchens, healthcare settings, and smart restaurants. Future directions will investigate multi-sensor fusion for heterogeneous food loads and edge-computing optimization.

**Keywords** - Smart Dining Table, Low Induction Heating (LIH), Arduino Nano, Closed-Loop Temperature Control, PID Control Algorithm.

## I. INTRODUCTION

The demand for smart home appliances that enhance user convenience while minimizing energy consumption has grown significantly in recent years [1].

Traditional food warming systems, such as electric hotplates or centralized warmers, often lack precision, require manual temperature input, and waste energy through continuous high-power operation [2]. This paper addresses these limitations by proposing a Smart Dining Table that autonomously maintains food at its initial serving

temperature using an Arduino Nano microcontroller, LM35 temperature sensors, and Low Induction Heating (LIH) technology.

The system's innovation lies in its closed-loop control mechanism, which eliminates user intervention by detecting the food's initial temperature and dynamically adjusting heat output to preserve it. T

his approach aligns with emerging trends in IoT-enabled appliances that prioritize automation and energy efficiency [3].

## II. LITERATURE REVIEW

Existing solutions for food temperature maintenance often rely on resistive heating elements, which exhibit slow response times and uneven heat distribution [4]. Induction heating, while efficient, typically operates at high frequencies, raising concerns about electromagnetic interference (EMI) and compatibility with non-ferromagnetic cookware [5]. Recent studies have explored low-frequency induction systems to mitigate these issues [6], but none have integrated them with autonomous temperature detection.

The Arduino platform has been widely adopted in smart appliance prototyping due to its low cost and flexibility [7]. However, prior works, such as [8], focused on manual temperature input, overlooking the potential of analog sensors like the LM35 for automated control. This gap motivates our integration of LM35 sensors with Arduino Nano to achieve fully autonomous operation.

## III. METHODOLOGY

### System Architecture

#### The system comprises three subsystems:

**Sensing:** LM35 analog temperature sensors (accuracy:  $\pm 0.5^\circ\text{C}$ ) detect the initial food temperature upon placement.

**Control:** Arduino Nano processes sensor data, implements a PID algorithm, and regulates LIH coils.

**Heating:** Custom LIH coils (15–25 kHz frequency range) provide localized heating with minimal EMI.

### Hardware Design

**Arduino Nano:** Manages sensor input, PID computation, and coil control via PWM signals.

**LM35 Sensor:** Outputs a linear voltage ( $10\text{ mV}/^\circ\text{C}$ ) proportional to food temperature, interfaced with the Nano's ADC.

**LIH Coils:** Designed with ferrite cores to concentrate magnetic flux, reducing stray emissions by 40% compared to conventional coils [9].

### Software Design

A PID control loop (Equation 1) optimizes heating efficiency:

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{de(t)}{dt}$$

#### where

$u(t)$  is the PWM duty cycle, and  $e(t)$  is the error between the target and sensed temperatures. The coefficients  $K_p$ ,  $K_i$  and  $K_d$  were tuned empirically for minimal overshoot ( $\pm 2^\circ\text{C}$ ).

### IoT Integration

A Wi-Fi module (ESP8266) transmits temperature and energy data to a web dashboard, enabling remote monitoring via MQTT protocol [10].

## Results and Discussion

### Temperature Stability

The system maintained food within  $\pm 2^\circ\text{C}$  of its initial serving temperature over 45-minute intervals, outperforming conventional warmers ( $\pm 5^\circ\text{C}$  deviation) [11]. The LM35's linear response reduced calibration errors, achieving 95% accuracy in temperature retention.

### Energy Efficiency

The LIH system consumed 35% less energy than resistive heaters, as the PID algorithm minimized standby power by deactivating coils upon reaching setpoints.

### User Satisfaction

In trials with 20 participants, 95% praised the system's automation, with no manual input required.

### Limitations and Future Work

The current design assumes ferromagnetic cookware for optimal induction heating. Future iterations will explore compatibility with non-metallic containers. Additionally, machine learning could enhance predictive heating for heterogeneous food loads [12].

## IV. CONCLUSION

This work demonstrates a cost-effective, energy-efficient Smart Dining Table that autonomously preserves food at its initial serving temperature. By integrating LM35 sensors with Arduino Nano and LIH technology, the system bridges gaps in user convenience and sustainability, offering applications in residential and commercial settings.

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