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Smart Iron Box with Automatic Fabric Detection and Temperature Control

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ABSTRACT: The Smart Iron Box with Automatic Fabric Detection and Temperature Control is an intelligent household appliance designed to prevent fabric damage, reduce energy consumption, and enhance user safety. Traditional irons require manual temperature selection, which often leads to overheating, fabric burning, or inefficient ironing. This proposed system uses fabric detection sensors and a microcontroller to automatically identify the type of cloth and regulate the ironing temperature accordingly. The system ensures optimal heat for cotton, silk, wool, denim, and synthetic fabrics. It also includes safety features such as auto shut-off and real-time temperature monitoring. This smart ironing system improves convenience, energy efficiency, and fabric care.

KEYWORDS: Fabric Detection, Temperature Control, Smart Iron, Sensors, Microcontroller, Energy Efficiency

I. INTRODUCTION

Ironing is an essential domestic and commercial activity that plays a significant role in maintaining the appearance, hygiene, and longevity of garments. It involves the application of heat and pressure to remove wrinkles from fabrics, thereby improving their visual appeal and usability. Despite being a routine task, ironing requires a certain level of skill and attention, particularly when dealing with different types of fabrics that demand specific temperature settings.

Traditional electric irons are designed with manual temperature control knobs that allow users to select the appropriate heat level based on the fabric type. However, this manual approach often results in incorrect temperature selection due to lack of knowledge or carelessness. As a result, fabrics may get scorched, burned, or inadequately pressed. Delicate materials such as silk and synthetic fibers are especially vulnerable to heat damage, whereas thicker fabrics like denim and cotton require higher temperatures for effective ironing.

In recent years, advancements in embedded systems, sensor technologies, and automation have paved the way for the development of smart home appliances. These intelligent systems are capable of performing tasks autonomously with minimal human intervention, thereby improving efficiency, safety, and user convenience. The Smart Iron Box with Automatic Fabric Detection and Temperature Control is one such innovation that integrates sensing technology and microcontroller-based automation to revolutionize the traditional ironing process.

This project aims to design and develop a smart ironing system that can automatically detect the type of fabric and adjust the temperature accordingly. By eliminating the need for manual temperature control, the system reduces the risk of fabric damage, enhances energy efficiency, and ensures safe operation.

II. PROBLEM STATEMENT

Despite technological advancements, traditional ironing systems still suffer from several limitations that affect their usability and efficiency. The major problems associated with conventional irons include:

- Manual Temperature Selection: Users must manually adjust the temperature based on fabric type, which often leads to incorrect settings.

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- Fabric Damage: Overheating can cause burning, discoloration, or weakening of fabric fibers.
- Energy Inefficiency: Continuous heating without optimization results in unnecessary power consumption.
- Safety Risks: Lack of automatic shut-off features can lead to accidents such as fire hazards.
- User Dependency: The effectiveness of ironing depends heavily on user experience and attention.

These challenges create a need for an intelligent system that can automate the ironing process while ensuring safety and efficiency. The Smart Iron Box addresses these issues by incorporating automatic fabric detection and temperature control mechanisms.

III. EXISTING SYSTEM

The existing ironing system primarily consists of the following components:
- Heating element
- Thermostat for temperature control
- Soleplate for heat transfer
- Manual control knob
- Indicator light

The user selects the desired temperature by adjusting the control knob based on the fabric type. The thermostat maintains the temperature by switching the heating element ON and OFF. Once the desired temperature is reached, the indicator light turns off, signaling that the iron is ready for use.While this system is simple and cost-effective, it requires constant user attention and manual intervention.

IV. PROPOSED SYSTEM

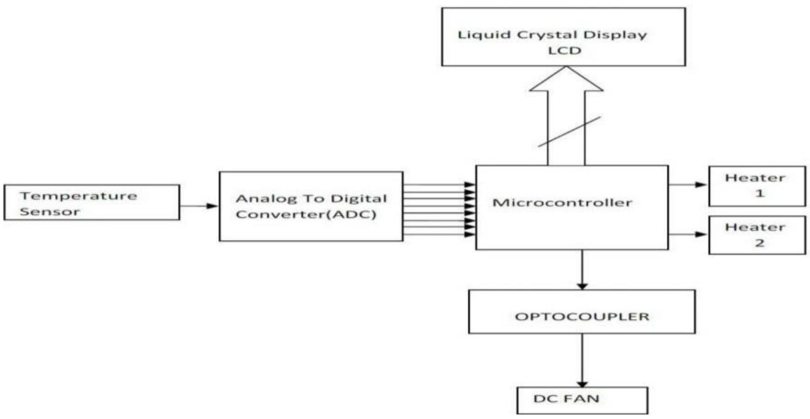
The proposed system consists of a microcontroller-based control unit integrated with various sensors and actuators.

The key idea is to detect the fabric type using sensors and adjust the heating element accordingly.

Main Components:
- Microcontroller (Arduino / ESP32)
- Fabric detection sensor (optical / capacitive)
- Temperature sensor (e.g., LM35 / DHT11)
- Heating element
- Relay module (to control heating)
- LCD display / LED indicators
- Power supply unit

The system continuously monitors the fabric characteristics and temperature, ensuring that the correct heat level is maintained throughout the ironing process.

V. BLOCK DIAGRAM



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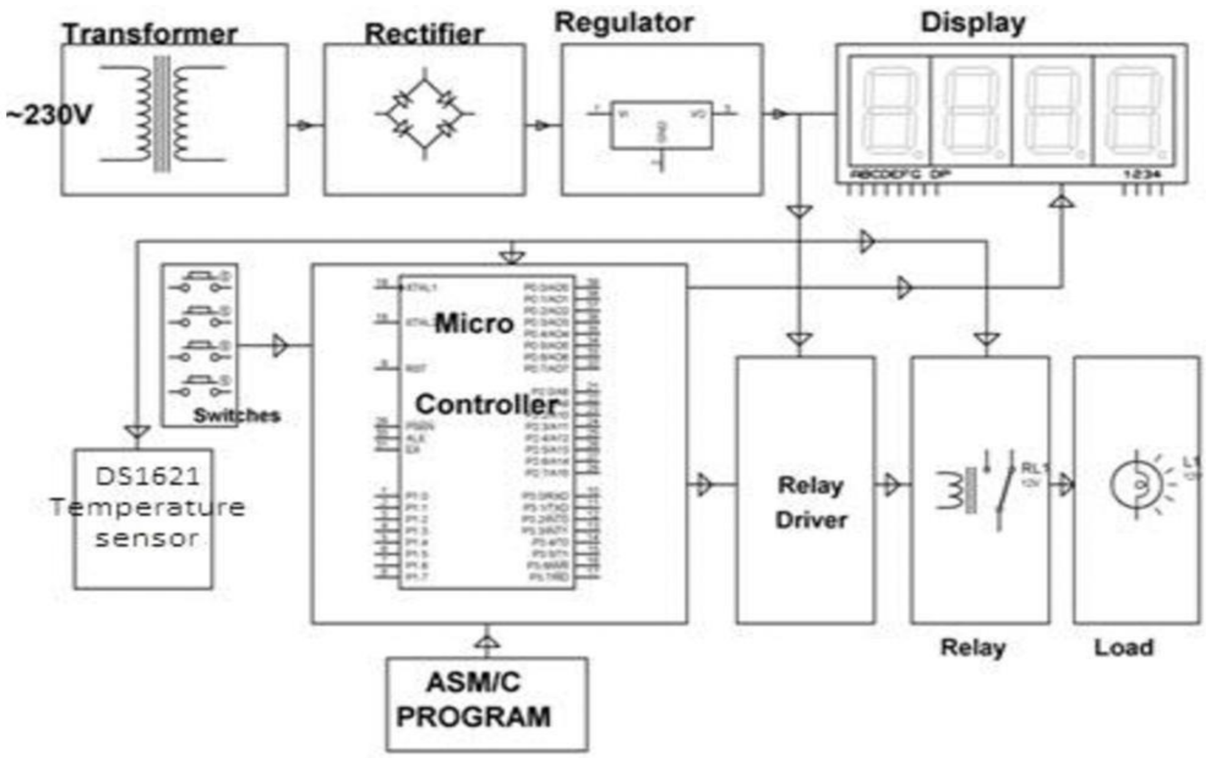

VI. DESIGN AND SELECTION OF COMPONENTS

A. Arduino Uno

Arduino is the main part of the project; hence it should be selected properly. In our project we have selected Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter. Arduino Uno has a number of facilities for communicating with a computer, another Arduino board, or other microcontrollers.

B. Fabric Detection Sensor

The fabric detection sensor is used to identify the type of material placed under the iron. Types Used:

- Optical Sensor (detects texture and reflectivity)
- Capacitive Sensor (detects dielectric properties)

Function:

- Scans the fabric surface
- Sends data to the microcontroller
- Helps in classifying fabric types such as cotton, silk, wool, and synthetic

C. Temperature Sensor (LM35 / DHT11)

The temperature sensor is used to measure the heat level of the iron. Features of LM35:

- High accuracy
- Linear output voltage proportional to temperature
- No external calibration required

Function:

- Continuously monitors the temperature of the heating element
- Sends real-time data to the microcontroller
- Helps maintain the desired temperature

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D.RELAY

The relay module acts as a switch to control the heating element. Features:

- Electrically operated switch
- Provides isolation between low voltage and high voltage circuits Function:
- Turns the heating element ON and OFF
- Operates based on signals from the microcontroller
- Ensures safe control of high-power devices

E.Heating Element

The heating element is responsible for generating heat required for ironing. Function:

- Converts electrical energy into heat
- Transfers heat to the soleplate
- Operates under the control of the relay module

F.LCD Display / LED Indicators

These components are used to provide user feedback.
Function:

- Displays detected fabric type
- Shows temperature status
- Indicates system operation (ON/OFF, heating, etc.)

VII. SOFTWARE INSTALLATION

Arduino IDE and embedded c program are used as software tools.

A.ARDUINO IDE

A program for Arduino hardware can be written in any programming language supported by compilers capable of producing binary machine code for the target processor. Atmel offers a development environment for their 8-bit AVR and 32-bit ARM Cortex-M based microcontrollers, such as AVR Studio (older) and Atmel Studio (newer). Overall, the Arduino IDE provides a comprehensive development environment for programming Arduino boards, enabling users to quickly prototype and develop projects for various applications. The IDE includes a code editor with features such as syntax highlighting, automatic indentation, and code completion, making it easier to write and navigate code. Arduino IDE comes with a set of built-in libraries that provide functions for interfacing with various sensors, actuators, and other hardware components. These libraries simplify the process of programming by abstracting complex functionality into simple function calls. The IDE allows users to compile their code with just a click of a button. It also procompiled code to Arduino boards via USB or other communication interfaces.

The binary code of Arduino is illustrated in Figure A

ARDUINO SOFTWARE IDE

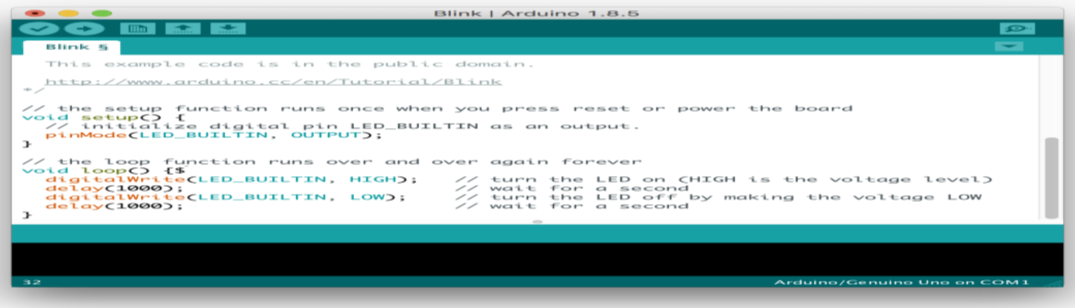

Fig A. Binary code of Arduino

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Integrated Development Environment (IDE)

The Arduino Integrated Development Environment (IDE) is a cross-platform application compatible with Windows, macOS, and Linux. It is primarily written in the Java programming language and originated from the IDE for languages such as Processing and Wiring. The IDE features a comprehensive code editor equipped with various functionalities including text cutting and pasting, text search and replace, automatic indentation, brace matching, and syntax highlighting. Additionally, it offers convenient one-click mechanisms for compiling and uploading programs to an Arduino board.

Furthermore, the Arduino IDE comprises a message area, a text console, a toolbar with common function buttons, and a hierarchical menu structure. The source code for the IDE is released under the General Public License GNU.

The Arduino IDE supports programming languages C and C++, utilizing specific code structuring rules. It also provides a software library from the Wiring project, offering numerous common input and output procedures. User- written code typically necessitates only two fundamental functions: one for initializing the sketch and another for the main program loop. These functions are compiled and linked with a program stub main() into an executable cyclic executive program using the GNU toolc hain, which is included in the IDE distribution.
Moreover, the Arduino IDE employs a program argument to convert the executable code into a text file encoded in hexadecimal format. This file is subsequently loaded into the Arduino board by a loader program embedded in the board's firmware.

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B.Embedded C

Embedded C is an extension of the C programming language, developed by the C Standards committee, specifically tailored to address common challenges encountered in embedded systems development. These systems often require nonstandard extensions to C to support advanced microprocessor features such as fixed-point arithmetic, multiple memory banks, and basic I/O operations. The C Standards committee introduced enhancements to the language in 2008 to provide a unified standard for embedded systems development, including support for fixed-point arithmetic, named address spaces, and low-level hardware access.

Embedded C retains most of the syntax and semantics of standard C, including main() function, variable declarations, data types, conditional statements (if, switch case), loops (while, for), functions, arrays, strings, structures, unions, bit operations, macros, and more.

Embedded software refers to computer software designed to control non-computer devices, known as embedded systems. It is optimized for the specific hardware it runs on and is subject to constraints such as time and memory limitations. Embedded software is often referred to interchangeably with firmware.A defining characteristic of embedded software is that it may not be directly initiated or controlled via a human interface, relying instead on machine interfaces. Manufacturers integrate embedded software into various devices, including cars, telephones, modems, robots, appliances, toys, security systems, pacemakers, televisions, set-top boxes, and digital watches. The complexity of embedded software can vary greatly, from simple lighting controls on a microcontroller with limited memory to sophisticated applications requiring advanced computation frameworks.

VIII. RESULT AND ANALYSIS

The implementation of the Smart Iron Box with Automatic Fabric Detection and Temperature Control has yielded significant positive outcomes, including improved energy efficiency and enhanced fabric safety. Through its automatic detection and real-time temperature adjustment capabilities, the system ensures optimal heat for different types of fabrics, preventing damage and reducing energy wastage. The system improves user convenience by eliminating manual temperature settings and provides a safer ironing experience. Moving forward, further improvements can focus on increasing accuracy, integrating IoT features, and enhancing the overall performance to promote smarter and more efficient household appliances.

IX. CONCLUSION

In conclusion, the implementation of the Smart Iron Box with Automatic Fabric Detection and Temperature Control represents a significant advancement in smart household appliances. By utilizing sensors and microcontroller-based automation, the system effectively identifies fabric types and adjusts the temperature

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accordingly, ensuring safe and efficient ironing. This technology minimizes fabric damage, reduces energy consumption, and enhances user convenience. As future improvements are explored, such as integrating advanced sensors and smart connectivity, this project has the potential to contribute to more intelligent, energy-efficient, and user-friendly home applians.

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