Safety Mechanism for an Iron Box

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***Abstract*— Ironing is an essential household task, yet it poses significant safety risks when an iron box is left unattended while powered. According to the National Fire Protection Association (2023), unattended iron boxes contribute to numerous domestic fire incidents annually. This project introduces a novel safety mechanism that integrates an accelerometer and servo motor to detect idle states, automatically raise the iron box, and disconnect power, thereby mitigating risks of burns and fires. The proposed system leverages advancements in sensor technology and automation to ad- dress the limitations of traditional iron boxes, which often lack intelligent safety features. By incorporating precise motion detection and mechanical actuation, the system ensures both power disconnection and physical separation of the iron from the fabric, enhancing user safety.**

***Index Terms*— iron boxes**

I. PROBLEM STATEMENT

Conventional iron boxes rely on manual intervention or basic thermostats, which fail to detect idle conditions effectively. When left idle on a fabric, the iron's heat can cause burns, damage materials, or ignite fires, posing significant safety hazards. The absence of an automated system to detect idle states and initiate preventive actions underscores the need for an innovative safety mechanism.
Movement: Implementing the chosen maneuver to navigate around the obstacle.
Autonomy: Operating independently, without external control, based on its internal programming.
Applications: Used in various fields like industrial automation, healthcare, and research.

II. OBJECTIVE

The primary objectives of this project are to:
• Develop a system to detect idle conditions using an ADXL345 accelerometer.
• Implement a servo motor (SG90) to automatically raise the iron box when idle for 3 seconds.
• Disconnect the power supply via a relay module to prevent overheating and fire hazards.
• Ensure a reliable, cost-effective, and user-friendly implementation suitable for household use.

III. SCOPE

This project focuses on designing and prototyping a safety mechanism that integrates an accelerometer, servo motor, and microcontroller (Arduino Uno) to enhance iron box safety. The system is tested for reliability, response time, and safety under various conditions. The scope excludes modifications to the iron boxs heating element and focuses on an external safety mechanism.

IV. LITERATURE REVIEW

4.1 Existing Safety Mechanisms

Traditional iron boxes rely on manual switches or thermostats, which do not address idle conditions. Modern irons may include timer-based auto-shutoff features, but these lack precise idle detection and fail tophysically separate the iron from the fabric, a critical factor in preventing burns.

4.2 Accelerometer-Based Systems

Accelerometers, such as the ADXL345, are widely used in motion detection applications, including wearable devices and automotive systems. The ADXL345s high-resolution 3-axis measurement and I2C communication make it idealfordetecting static conditions by monitoring zero acceleration in multiple axes.

4.3 Servo Motor Applications

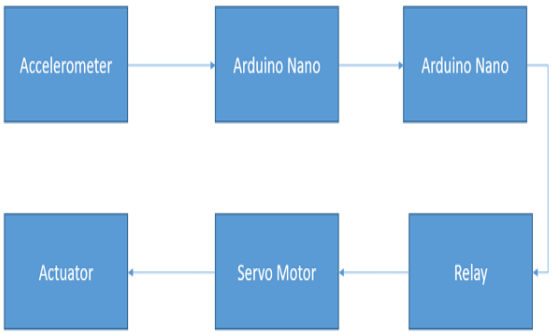
Servo motors, like the SG90, are employed in robotics and automation for precise positional control. With a torque of 1.8 kg-cm, the SG90
can reliably lift lightweight loads, such as an iron box, making it suitable for the proposed lifting mechanism.

4.4 Gap Analysis

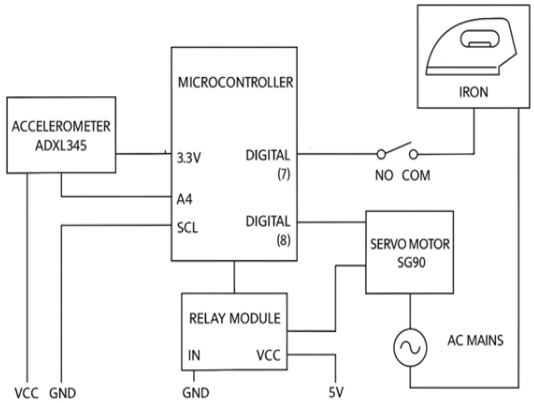
Existing auto-shutoff systems disconnect power but do not physically isolate the iron from the fabric. The

integration of accelerometers and servo motors in iron boxes is a novel approach, addressing both power disconnection and physical separation, thereby filling a critical gap in current safety mechanisms.

V. BLOCK DIAGRAM



5.1 SYSTEM DESIGN



5.2 SOFTWAREIMPLEMENTATION

The Arduino code initializes the accelerometer, monitors its readings,
and controls the relay and servo based on idle detection. Below is the
complete code:

```
#include <Wire.h>
#include
<Adafruit_ADXL345_U.h>
#include <Servo.h>
Adafruit_ADXL345_Unified accel =
Adafruit_ADXL345_Unified();          Servo
liftingServo;
const int relayPin =
7; const int servoPin
= 9;
unsigned long
idlestartTime = 0; bool
isIdle = false;
void setup() {
Serial.begin(9600);
pinMode(relayPin,
OUTPUT);
Serial.println("ADXL345 not
detected"); while (1);
digitalWrite(relayPin, HIGH); // Relay ON
(power
connected) liftingServo.attach(servoPin);
liftingServo.write(0); // Initial
position (down) if (!accel.begin())
{
}
accel.setRange(ADXL345_RANGE_2_G);
}

void loop() {
sensors_event_t event;
accel.getEvent(&event);
if (abs(event.acceleration.x) < 0.1 &&
abs(event.acceleration.y) < 0.1) { if (!isIdle) {
idlestartTime =
millis(); isIdle = true;
}
if (millis() - idlestartTime >= 3000) {
digitalWrite(relayPin, LOW); //
Disconnect power liftingServo.write(90);
// Lift iron

}
} else {
isIdle = false;
digitalWrite(relayPin, HIGH); // Reconnect
power
liftingServo.write(0); // Lower iron
}
delay(100);
}
```

VI. TESTING AND RESULTS

6.1 Test Scenarios

6.1.1 Idle Detection Test

The iron box is placed stationary for 3 seconds. The system should detect zero acceleration, disconnect power, and lift the iron.

6.1.2 Motion Detection Test

The iron is moved to verify that the system resets, lowering the iron and restoring power.

6.1.3 Load Test

The servo is tested with a 1.5 kg load to ensure reliable lifting.

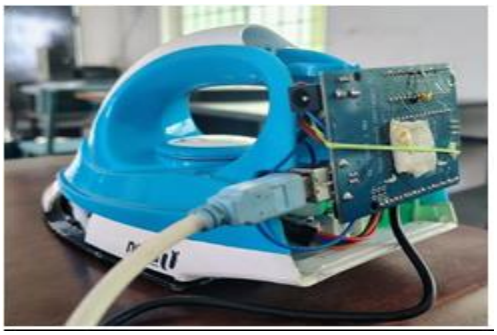
6.1.4 Environmental Test

The system is tested under varying temperatures (20˚rC to 40˚rC) to ensure consistent performance.

VII. RESULT

8.1 RESULT:

Test Case	Expected Outcome	Actual Outcome
Idle for 3 seconds	Power off, iron lifted	Pass
Motion detected	Power on, iron lowered	Pass
Load test (1.5 kg)	Stable lifting	Pass
Environmental test	Consistent performance	Pass



IX. CONCLUSION AND FUTURE WORK

9.1 Conclusion

The safety mechanism successfully detects idle conditions, raises the
iron box, and disconnects power, demonstrating effectiveness in
preventing fire hazards. The prototype is reliable, cost- effective, and
suitable for household use.

9.2 Future Work

• Integrate a temperature sensor to monitor iron plate temperature.
• Develop a wireless alert system for idle notifications.
• Optimize the mechanical design for commercial integration.
• Explore IoT connectivity for remote monitoring.

REFERENCES

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