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Boundary Sensor

Komalakumari.[1], Syed shuaib [2], Prahlad P [3], Sougata Chakraborty.[4], Prajna T. [5]

[1]BE,Mtech, E&C. Dept,Assistant Professor,VVIET,Mysuru, Karnataka, India

[2]BE, E&C. Dept,,VVIET,Mysuru, Karnataka, India

[3]BE, E&C. Dept,,VVIET,Mysuru, Karnataka, India

[4]BE, E&C. Dept,,VVIET,Mysuru, Karnataka, India

[5]BE, E&C. Dept,,VVIET,Mysuru, Karnataka, India

Abstract:

This project presents the design and implementation of an Arduino-based boundary detection system utilizing load cells, LED indicators, and a tare switch. The system is aimed at detecting when an object crosses a predefined weight threshold, indicating it has reached a boundary.The hardware setup includes an Arduino microcontroller interfaced with an HX711 load cell amplifier module and various peripheral components. LED indicators are employed to visually signal boundary detection, while a tare switch allows for resetting the weight measurement after each boundary crossing. Additionally, a 16x2 LCD display provides real-time feedback on the weight status.The project workflow encompasses initialization, continuous weight monitoring, boundary detection, and tare functionality. The Arduino reads weight data from the load cell, compares it with the predefined threshold to detect boundaries, and triggers LED indicators accordingly. Upon boundary detection, the system waits for the user to press the tare switch for weight reset.Future enhancements may include data logging capabilities, threshold adjustment mechanisms, and remote monitoring options, expanding the system's versatility and applicability in various scenarios.This project serves as a foundation for building robust boundary detection systems suitable for applications such as object sorting, inventory management, and industrial automation.

Index Terms – HX711, 16x2 LCD, LED, Arduino board etc.

I. INTRODUCTION

Cricket has always been a popular sport in India. Whenever the ball hits the boundary, the decision is given by the ‘Third Umpire’. This leads to delays during decision making. To avoid this, delay a microprocessor-based device named ‘Boundary sensor’ is implemented to give a spot-on result and save further time delays. A microcontroller (MCU for microcontroller unit, also MC, UC, or µc) is a small computer on a single VLSI integrated circuit (IC) chip. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. A microcomputer made on a single semiconductor chip is called a single-chip microcomputer. Since single chip microcomputers are generally used in control applications, they are also called microcontrollers. Microcontroller contains all essential components of a microcomputer such as CPU, RAM, ROM/EPROM, I/O lines etc. Some single chip microcontrollers contain devices to perform specific functions such as DMA channels, A/D converter, serial port, pulse width modulation, etc.In this project, microcontroller-based system entitled ‘Boundary Sensor’ is implemented, which will help in detecting whether the boundary is a six or a four. This system is based on touch sensing of the ball using piezo sensor. If the ball touches the sensor the LED light glows.

Motivation

In a live cricket match when a batsman hits the ball and its trajectory pitches at the boundary Then there is a confusion whether it’s a six or four. That would involve third umpire to take a decision based on reviewing the scene repeatedly and make a judgement this could be avoided by designing a Boundary Sensor. Which will decide whether it’s a six or four directly.

II. PROBLEM STATEMENT

Designing a Boundary Sensor that could make a decision whether the ball hits to the boundary is six or four.

III. OBJECTIVES

1. The main objective of the boundary sensor is to make a decision that the ball arrived at the boundary is six or four.
2. To detect the boundary hit using load cell sensor.
3. To make the decision with maximum efficiency or accuracy.

IV. IMPLEMENTATION

1.Hardware and Software Requirements

a) Hardware Requirements:

- 16x2LCD Display
- I2CSerial InterfaceAdapter
- PowerSupply
- Arduino UNO
- Load cell HX711
- Relay

Block Diagram

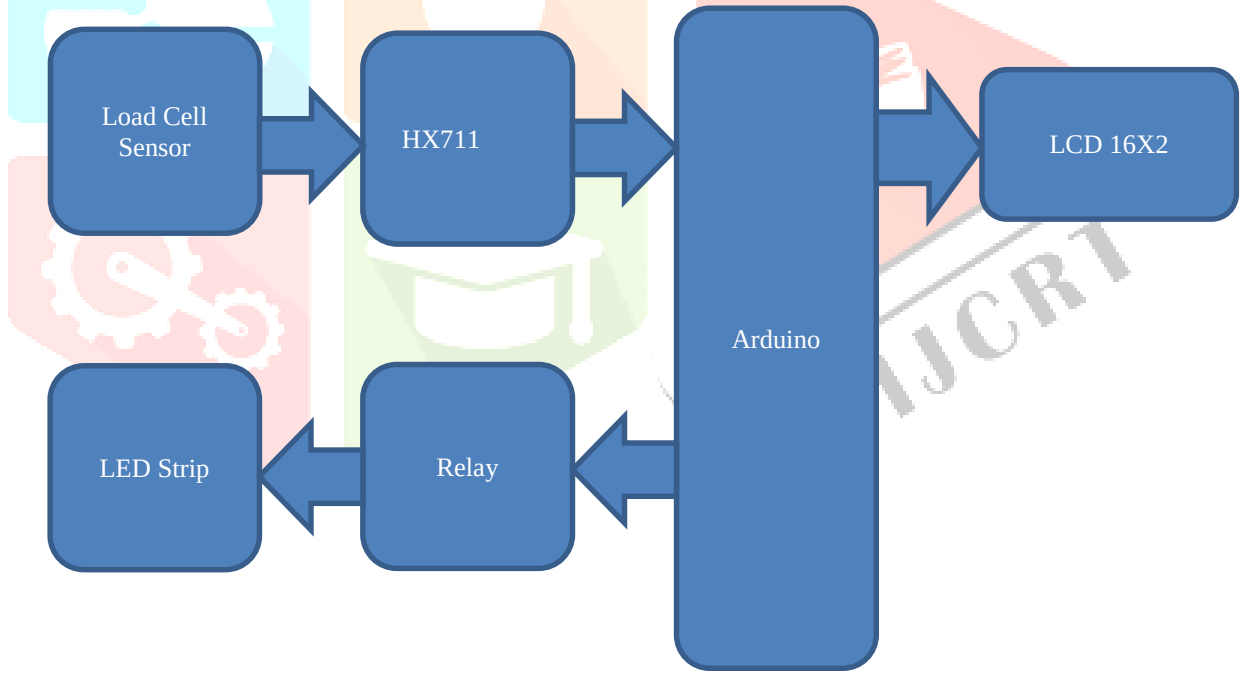

Fig1,Block diagram of Implementation of heart rate and Temperature monitoring device using wireless system

Here's a step-by-step guide to implementing the Arduino-based boundary detection system using load cells and LED indicators:

Step 1: Gather Components

- Arduino board (e.g., Arduino Uno)
- HX711 load cell amplifier module
- Load cell compatible with HX711
- LED lights (preferably different colors for visual indication)
- Tare switch
- LCD display (I2C 16x2)
- Breadboard and jumper wires
- Power source (e.g., USB cable, battery pack)

Step 2: Circuit Setup

- Connect the load cell to the HX711 amplifier module.
- Connect the HX711 module to the Arduino following the pinout diagram.
- Connect the LED lights to Arduino pins for output.
- Connect the tare switch to the Arduino.
- Connect the LCD display using the I2C protocol (SCL, SDA, VCC, GND).

Step 3: Install Libraries

- Install necessary libraries for HX711 (e.g., HX711_ADC).
- Install LiquidCrystal_I2C library for the LCD display.

Step 4: Calibration

- Calibrate the load cell using a known weight to ensure accurate measurements.
- Adjust calibration parameters in the code if needed.

Step 5: Write Arduino Code

- Initialize variables and pins for load cell, LED lights, tare switch, and LCD display.
- Set up the LCD display and print initial messages.
- Continuously read weight data from the load cell using the HX711 library.
- Compare the weight with a predefined threshold to detect boundary crossings.
- If a boundary is detected, activate the LED indicators and display relevant messages on the LCD.
- Wait for the user to press the tare switch to reset the weight measurement.
- Update the LCD display with the new weight status after tare operation.

Step 6: Upload Code to Arduino

- Verify and upload the Arduino code to the board using the Arduino IDE.

Step 7: Testing and Debugging

- Test the system by placing objects on the load cell to simulate boundary crossings.
- Verify that LED indicators and LCD display function correctly.
- Debug any issues and fine-tune the code as necessary.

Step 8: Integration and Deployment

- Integrate the boundary detection system into your desired application or setup.
- Ensure proper mounting and positioning of components for optimal performance.
- Deploy the system and monitor its operation in real-world conditions.

2.software requirements

1. **Arduino IDE**

The Arduino coordinated improvement climate (IDE) (Fig 2) is a cross-stage application for Windows, macintosh, operating system, and Linux that is written in the programming language Java. It is utilized to compose and transfer projects to Arduino-viable sheets, yet in addition, with the assistance of outsider centers, other merchant improvement sheets is displayed in Fig 4.6. The Arduino IDE upholds the dialects C and C++ utilizing extraordinary principles of code organizing. It is an authority Arduino programming, creating code gathering too simple that even a typical individual with no earlier specialized information can consider going all in with the growing experience.

The principal code, otherwise called a sketch, made on the IDE stage will at last produce a Hex Document which is then moved and transferred to the regulator on the board The IDE climate is primarily conveyed into three segments:

- MenuBar
- TextEditor
- OutputPanel

Fig,2 Arduino IDE

3.Flow Chart

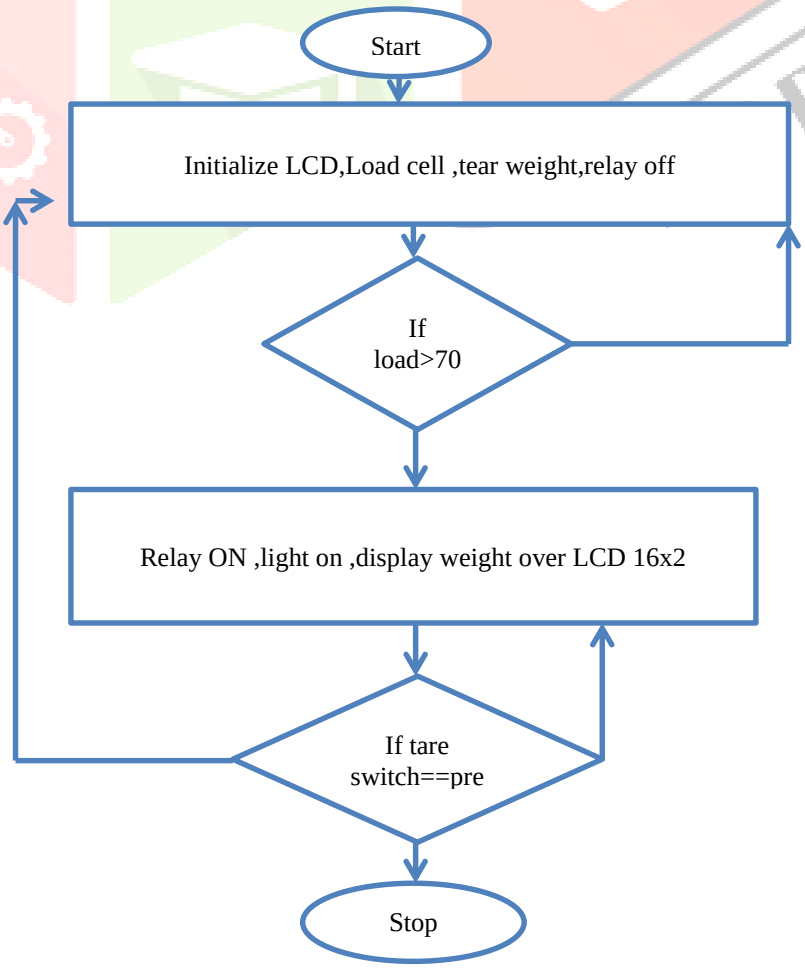

Fig 4.1 Flow Chart of Boundary Sensor Model

3.Circuit Diagram

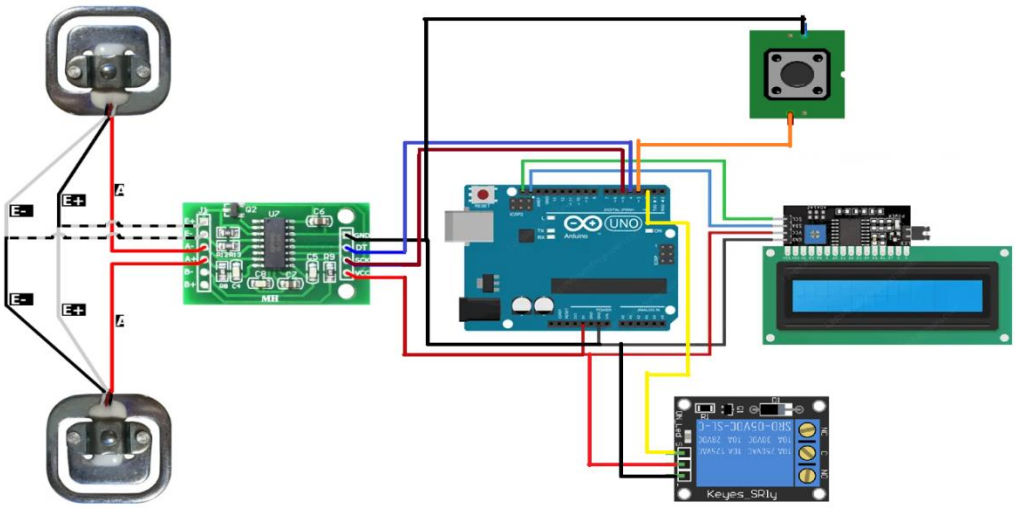

Fig 4.2 *Circuit Diagram of Boundary Sensor*

- **Methodology**

1. **System Design:**
   - Define the requirements and objectives of the boundary detection system.
   - Design the system architecture, including the hardware components (load cell, HX711 module, LED indicators, tare switch, LCD display) and their interconnections.
2. **Component Selection:**
   - Select appropriate components based on factors such as accuracy, sensitivity, cost, and availability.
   - Choose a suitable load cell compatible with the HX711 amplifier module.
   - Opt for LED lights with different colors for clear visual indication.
   - Select a tare switch that provides reliable user interaction.
3. **Circuit Implementation:**
   - Set up the circuit on a breadboard or custom PCB according to the system design.
   - Connect the load cell, HX711 module, LED indicators, tare switch, and LCD display to the Arduino microcontroller.
   - Ensure proper wiring and connections to prevent signal interference and ensure stable operation.
4. **Calibration:**
   - Calibrate the load cell to establish a relationship between weight applied and the corresponding sensor readings.
   - Use known weights to calibrate the system and adjust calibration parameters as necessary.
   - Verify the accuracy and consistency of weight measurements across different loads.+
   - -
5. **Arduino Programming:**
   - Write Arduino code to implement the functionality of the boundary detection system.
   - Initialize variables for sensor readings, threshold values, LED pins, switch pins, and LCD display.
   - Set up libraries for HX711 (e.g., HX711_ADC) and LiquidCrystal_I2C for the LCD display.
   - Implement algorithms for continuous weight monitoring, boundary detection, LED activation, tare operation, and LCD display updates.
   - Include error handling mechanisms and debug code to ensure robust operation.
6. **Testing and Validation:**
   - Test the system under various conditions to verify functionality and performance.
   - Use test cases to simulate boundary crossings and evaluate system response.

- Verify that LED indicators and LCD display provide accurate feedback.
- Test user interaction with the tare switch for weight reset functionality.
- Conduct iterative testing and debugging to address any issues or inconsistencies.

7. Integration and Deployment:

- Integrate the boundary detection system into the target application or setup.
- Ensure proper mounting and positioning of components for optimal performance.
- Conduct final validation tests to ensure reliable operation in real-world conditions.
- Deploy the system for practical use and monitor its performance over time.

8. Documentation and Maintenance:

- Document the system design, component selection, circuit implementation, and Arduino code for future reference.
- Provide user manuals or instructions for system operation and maintenance.
- Perform regular maintenance checks and updates to ensure continued functionality and reliability.

V. RESULT AND DISCUSSION

The following conclusions can be made from the following proposed prototype:

- The subject (boundary score) can be easily measured by the hit of the ball on theboundary.
- Once the ball nits the boundary the wight sensor determines the weight of the ball and passes the signal to the Arduino board hence the results are displayed in the LCD display accordingly.

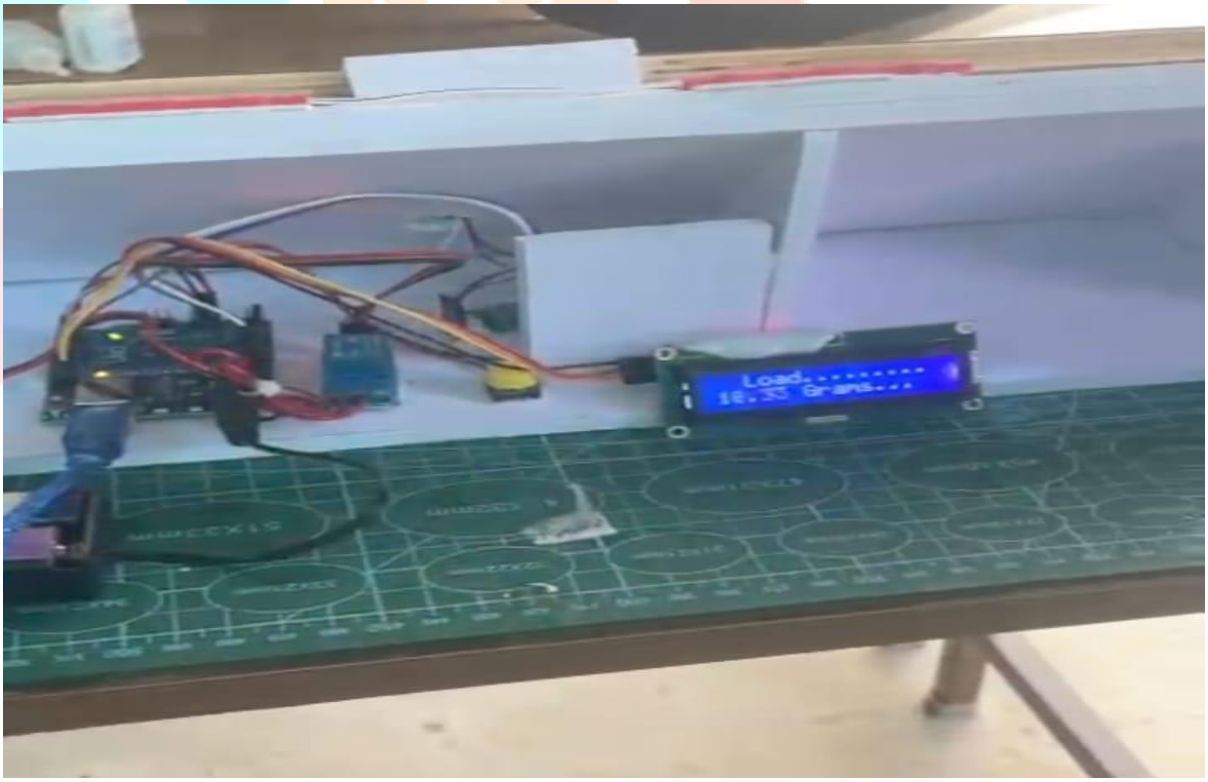

Fig 4.5 Project Final Result

VI. CONCLUSION AND FUTURE ENHANCEMENT

A. CONCLUSION

- The boundary sensor provides a quick result.
- It is time efficient and brings about a quick response in the heat of the game, thus keeping the interest of the audience intact.

B. FUTURE SCOPE

- It can be implemented in IPL matches and in international matches.
- It can terminate the confusion during the match regarding about the boundaries.
- It can be opted other sports applications.
- The product is scalable and can be used for the other purposes.

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