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INTERNET OF THINGS

(22MCA251TL)

Smart Dress

Submitted by

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2.	**1RV22MC078**	**Raksha D**
3.	**1RV22MC111**	**Vibha T R**

Submitted in partial fulfillment of the requirements for the award of degree

of

MASTER OF COMPUTER APPLICATIONS
2022-23

Submitted to,

Dr. B. Renuka Prasad
Associate Professor
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RV College of Engineering®
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RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

DEPARTMENT OF

MASTER OF COMPUTER APPLICATIONS

Bengaluru– 560059

CERTIFICATE

This is to certify that **Ms. Anjali Singh**, USN 1RV22MC012 2nd semester Master of Computer Applications program has satisfactorily completed the Assignment titled **Smart dress** as a part of Continuous Internal Assessment.

Signature of the Student **Faculty In charge** **Director, MCA**

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DEPARTMENT OF

MASTER OF COMPUTER APPLICATIONS

Bengaluru– 560059

CERTIFICATE

This is to certify that **Ms. Raksha D**, USN 1RV22MC078 2nd semester Master of Computer Applications program has satisfactorily completed the Assignment titled **Smart dress** as a part of Continuous Internal Assessment.

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CERTIFICATE

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Signature of the Student **Faculty In charge** **Director, MCA**

PROJECT BASED ASSIGNMENT EVALUATION SHEET

Student name: Anjali Singh

USN: 1RV22MC012

Sl.No	Criteria	CO (DS)	CO (RM)	BTL	Max Marks	Marks Obtained
1	Problem definition -	**01**	**01**	**02**	**01**	
2	Description and validation of data set	**01**	**01**	**02**	**02**	
3	Literature Survey	**01**	**02**	**02**	**04**	
4	Proposed Solution	**02**	**03**	**03**	**03**	
5	Model implementation – code Performance	**03**	**03**	**03**	**10**	
6	Evaluation and analysis of the model	**04**	**03**	**04**	**05**	
7	Presentation and Documentation		**04**		**05**	
					30	

Signature of the Student **Faculty In charge** **Director, MCA**

PROJECT BASED ASSIGNMENT EVALUATION SHEET

Student name: Raksha D

USN: 1RV22MC078

Sl.No	Criteria	CO (DS)	CO (RM)	BTL	Max Marks	Marks Obtained
1	Problem definition -	01	01	02	01	
2	Description and validation of data set	01	01	02	02	
3	Literature Survey	01	02	02	04	
4	Proposed Solution	02	03	03	03	
5	Model implementation – code Performance	03	03	03	10	
6	Evaluation and analysis of the model	04	03	04	05	
7	Presentation and Documentation		04		05	
					30	

Signature of the Student **Faculty In charge** **Director, MCA**

PROJECT BASED ASSIGNMENT EVALUATION SHEET

Student name: Vibha T R

USN: 1RV22MC111

Sl.No	**Criteria**	**CO (DS)**	**CO (RM)**	**BTL**	**Max Marks**	**Marks Obtained**
1	Problem definition -	**01**	**01**	**02**	**01**	
2	Description and validation of data set	**01**	**01**	**02**	**02**	
3	Literature Survey	**01**	**02**	**02**	**04**	
4	Proposed Solution	**02**	**03**	**03**	**03**	
5	Model implementation – code Performance	**03**	**03**	**03**	**10**	
6	Evaluation and analysis of the model	**04**	**03**	**04**	**05**	
7	Presentation and Documentation		**04**		**05**	
					30	

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Table of Contents

1. ABSTRACT

An innovative IoT design methodology is introduced for creating smart textiles, with a specific focus on a wearable electronics dress tailored for children. The purpose of this innovative outfit is to provide an engaging and interactive experience for children. The dress incorporates a range of sensors, including motion and sound sensors, as well as buttons for user interactions. The key objectives encompass interactivity, sensor integration, child safety, education, personalization, practicality, and data privacy.

The operational behaviour of the wearable electronics dress involves dynamic LED colour changes in response to motion and sound, as well as button interactions. The extensive list of requirements encompasses hardware and software.

The IoT design methodology lays the foundation for the creation of a wearable that captivates children's imagination, fosters creativity, enhances safety, and educates them about electronics and sensors. The system leverages cutting-edge technology to create an interactive and expressive wearable for children while addressing the paramount concerns of data privacy and security. By adhering to this systematic approach, the smart textile project aims tocontribute to the world of IoT-enabled wearables designed to enrich the lives of children.

2. INTRODUCTION

In the realm of wearable technology, the fusion of IoT (Internet of Things) and textile design has birthed a new frontier known as "smart textiles." These textiles represent a burgeoning field where electronics seamlessly integrate with fabrics to create interactive and functional garments. This introduction unveils an innovative IoT design methodology that is tailored for the development of these smart textiles, offering a structured approach that can be adapted to a myriad of wearable applications.

The central premise of this methodology is versatility, emphasizing adaptability to meet the diverse needs of different wearable projects. At its core, this approach centres on user engagement, sensor integration, and a steadfast commitment to data privacy. By adhering to this systematic framework, designers and developers can create interactive wearables that captivate users, enhance their experiences, and prioritize the security of sensitive data.

The journey through this methodology unfolds through a well-defined sequence of steps, commencing with the articulation of purpose and culminating in the realization of wearable applications. It guides the seamless incorporation of sensors, actuators, and user interfaces into textile-based devices, fostering opportunities for creativity and user-driven interactions. Throughout the design process, data privacy and security remain at the forefront, ensuring that user information is safeguarded.

The methodology's inherent flexibility empowers creators to tailor their wearable designs to a spectrum of applications, whether it be for entertainment, fashion, healthcare, or education. In essence, it is a compass for those navigating the intersection of technology and textiles, unlocking the potential for innovative, expressive, and secure wearables.

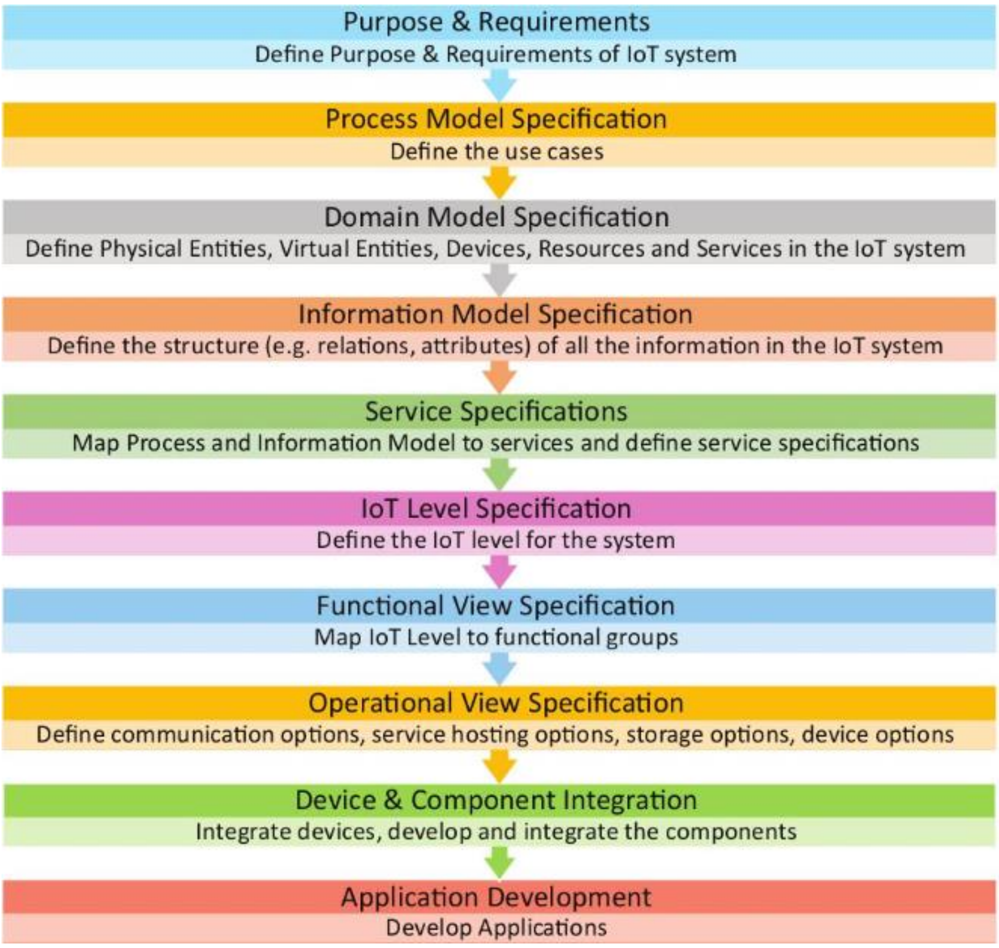
3. PROBLEM STATEMENT

In today's world, children's engagement with technology is nearly ubiquitous, and ensuring their safety and privacy in the digital age is paramount. Existing wearables for children often fall short in delivering a holistic and educational experience, frequently lacking. This project addresses these concerns by developing innovative smart textiles that not only provide an interactive and fun experience but also serve as educational tools. The primary problem we aim to solve is to create smart textiles that seamlessly integrate sensors, LEDs, and user interactions to offer an engaging and expressive wearable for children. Importantly, these wearables prioritize data privacy, ensuring that sensitive information remains inaccessible to anyone other than authorized individuals, typically parents or guardians. Our smart textiles empower children to learn about electronics, programming, and sensor technology. This project focusing solely on the well-being and enjoyment of the child.

4. IOT PLATFORMS DESIGN METHODOLOGY

IoT Design Methodology that includes:

1. Purpose & Requirements Specification
2. Process Specification
3. Domain Model Specification
4. Information Model Specification
5. Service Specifications
6. IoT Level Specification
7. Functional View Specification
8. Operational View Specification
9. Device & Component Integration
10. Application Development



Step 1: PURPOSE

The purpose of the wearable electronics dress is to create an innovative and interactive outfit designed for children, enhancing their experiences through dynamic color-changing LED effects and integrating multiple sensors. The dress utilizes the Adafruit Circuit Playground board, which comes equipped with a built-in accelerometer (motion sensor), microphone (sound sensor), and buttons. The IoT design methodology lays the foundation for the creation of a wearable that captivates children's imagination, fosters creativity, enhances safety, and educates them about electronics and sensors. The system leverages cutting-edge technology to create an interactive and expressive wearable for children while addressing the paramount concerns of data privacy and security. By adhering to this systematic approach, the smart textile project aims to contribute to the world of IoT-enabled wearables designed to enrich the lives of children

KEY OBJECTIVES

1. Interactive and Fun Experience: The dress aims to captivate children's imagination and encourage creativity by providing an interactive and dynamic outfit that responds to their movements, surrounding sounds, and playful button interactions. The color-changing LEDs will offer a visually stimulating and enjoyable experience.

2. Sensor Integration: Leveraging the capabilities of the Adafruit Circuit Playground board, the dress will utilize the built-in accelerometer and microphone to detect motion and surrounding sound levels, adding an extra layer of interactivity and responsiveness.

3. Educational and Learning Potential: The project can serve as an educational tool, introducing children to basic concepts of electronics, programming, and sensor technology. As they observe the dress's response to different stimuli, they can develop an understanding of how sensors work and interact with the environment.

4. Personalization and Expressiveness: By allowing children to choose the LED colors and patterns through their movements, sounds, and button interactions, the dress encourages self-expression and fosters a sense of individuality.

5. Practical Application and Usability: The dress aims to be lightweight, comfortable, and washable, ensuring practicality for everyday use and to accommodate the active nature of children.

SYSTEM BEHAVIOR

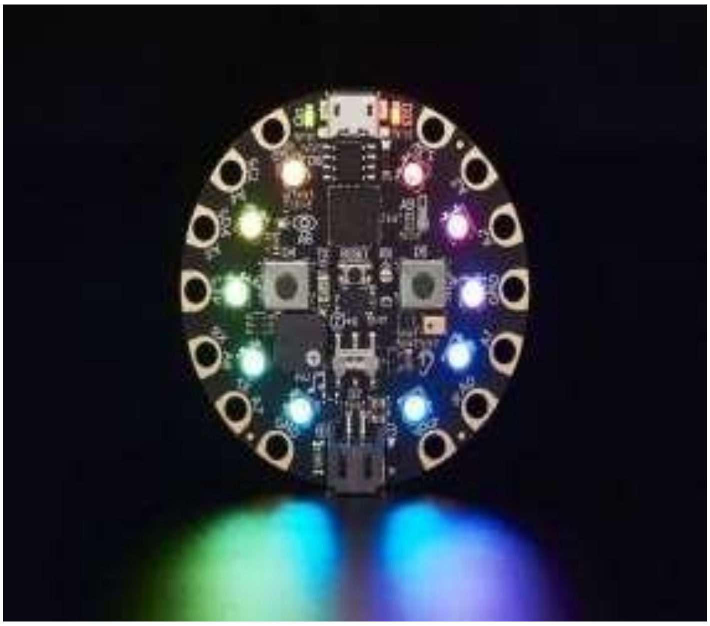
The wearable electronics dress operates as follows:

1. **LED Color Changes:**
   - Based on the child's movements, the dress's LED lights change colors to provide a dynamic and captivating visual effect.
2. **Sound Interaction:**
   - The dress detects the surrounding sound levels and adjusts the LED colors accordingly, creating a responsive and interactive element.
3. **Button Interactions:**
   - The buttons on the dress enable children to trigger specific LED color patterns or effects, promoting engagement and creativity.

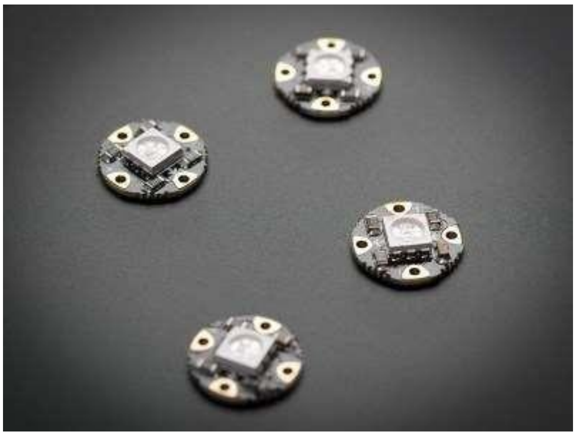
REQUIREMENTS

1. Hardware Requirements:

- **Adafruit Circuit Playground Board**: At the heart of our smart textiles lies the Adafruit Circuit Playground board. This microcontroller platform is chosen for its versatility and integration capabilities. It comes equipped with a built-in accelerometer (motion sensor), microphone (sound sensor), and buttons, making it an ideal choice for creating interactive wearables.



- **LED Strips or Neo pixels**: To infuse our textiles with captivating visual effects, we employ addressable LED strips or Neo pixels. These LEDs can change colours and patterns dynamically based on sensor inputs, adding a visually stimulating and enjoyable dimension to the wearables.



- **Power Source**: To ensure uninterrupted operation and portability, a reliable power source is essential. Typically, a battery pack is employed to power the wearables, allowing children to enjoy their interactive features while on the move.

2. Software Requirements:

- **Arduino IDE**: Arduino IDE serves as the primary programming platform for the Adafruit Circuit Playground board. It enables us to create custom functionalities and behaviour for the wearables, ensuring that they respond to various sensor inputs and user interactions effectively.

3. Libraries:

1. **AdafruitCircuitPlayground.h:** This library provides support for the Adafruit Circuit Playground board, which includes functions and definitions specific to this microcontroller board. It simplifies working with the Circuit Playground's built-in features like sensors, buttons, and neo pixels.

2. **Fast LED**: The Fast LED library is a powerful and efficient library for controlling addressable LED strips, such as the WS2812B LEDs used in your project. It provides functions to control the colour and brightness of individual LEDs, create various lighting effects, and manage power usage. In your code, it's used to control both the external LED strand and the neo pixels on the Circuit Playground.

4. Packages:

1. **Arduino SAMD**: The "Arduino SAMD Boards" package, also known as the "Arduino SAMD core," is an add-on package for the Arduino IDE that provides support for boards based on the Atmel SAMD (Smart Arm-based Microcontroller) family of microcontrollers. These microcontrollers are ARM Cortex-M0+, Cortex-M3, or Cortex-M4-based, and they are commonly found in various Arduino-compatible boards, including the Adafruit Circuit Playground Express (CPX).

5. Functional Requirements:

- **LED Colour Change:** The dress should change colours based on the sensed motion, sound level, and button presses. For example, it can display calming colours when the child is still or in a quiet environment, and vibrant colours when the child is moving or in a noisy setting.
- **Motion Sensing:** The dress should detect the child's movement using the motion sensor, allowing it to respond to the child's activities.
- **Sound Sensing:** The dress should react to the surrounding sound level by adjusting the LED colours accordingly.
- **Button interaction**: Physical buttons are strategically integrated into the textiles to facilitate user interactions. Children can use these buttons to trigger specific LED colour patterns or effects, encouraging engagement and creativity in their interactions with the wearables.

6. Data Collection Requirements:

- **Motion Sensor Data:** Capture accelerometer data to assess motion intensity.
- **Sound Sensor Data:** Collect sound levels from the built-in microphone.
- **Button Press Data:** Record and interpret button press events.

7. System Management Requirements:

- **Power Management: I**mplement power-saving features to extend battery life.
- **Error Handling:** Detect and manage potential sensor errors.

Step 2: PROCESS SPECIFICATION

1. **Initialization and Setup:**
    - Initialize the Circuit Playground board and sensors.
    - Configure LED patterns, color schemes, and initial settings.
2. **Main Loop:**
    - Enter the main loop to continuously monitor sensors and update functionalities.
    - Implement appropriate delays to prevent excessive updates and conserve power.
3. **Sensor Monitoring and Interaction:**
    - Continuously monitor the built-in motion sensor, sound sensor, and buttons.
    - Based on sensor readings:
        - Invoke functions to handle motion, sound, and button interactions.
        - Modify LED colors and patterns accordingly.
4. **Motion Handling:**
    - Define a function to handle motion detection using accelerometer data.
    - Determine the motion threshold for color changes.
    - Implement color change logic based on the intensity of detected motion.
5. **Sound Handling:**
    - Create a function to manage sound sensing using the built-in microphone.
    - Set a sound threshold to trigger LED color adjustments.
    - Adjust LED colors based on the surrounding sound level.
6. **Button Interaction:**
    - Develop functions to respond to button presses on the Circuit Playground board.
    - Define LED color patterns or effects corresponding to button actions.
7. **Website Data Transmission:**
    - Design a secure protocol for transmitting sensor data to the monitoring website.
    - Encode the data to ensure privacy and integrity during transmission.
8. **Real-Time Website Interface:**
    - Develop a user-friendly website with a secure login system.
    - Display a map interface showing the sensor values.
    - Enable responsive updates to show location changes in real time.

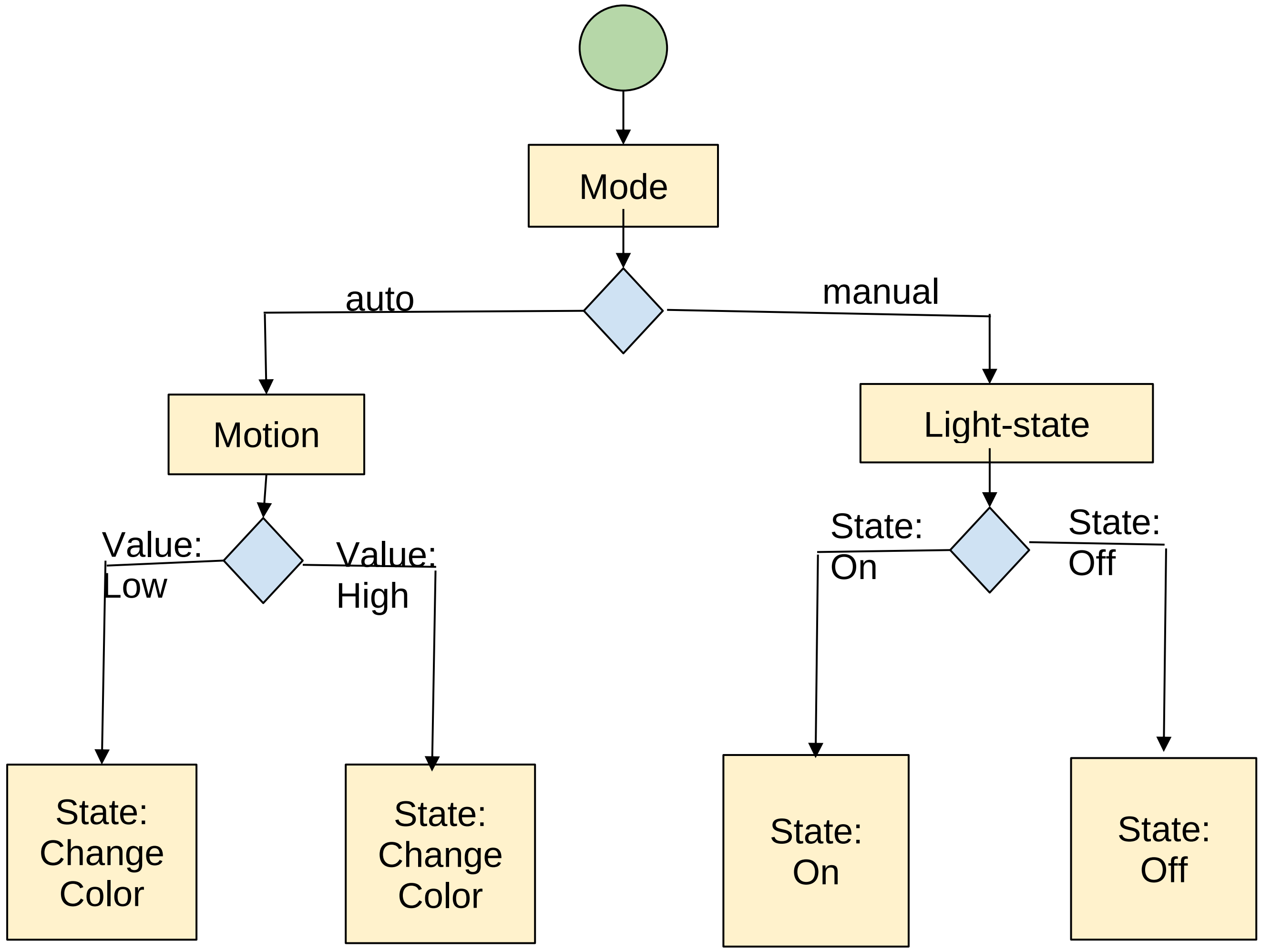


Figure: Process Specification for smart textile

Step 3: DOMAIN MODEL SPECIFICATION

1. **Concepts and Entities:**
   - **Wearable Electronics Dress:** The physical clothing item containing integrated technology for sensing and interaction.
   - **IoT Device (Wearable):** Represents the wearable electronics dress as an IoT device within the system.
   - **Sensors (Motion, Sound):** IoT sensors embedded in the dress to detect motion intensity and sound levels.
   - **Buttons:** Physical buttons integrated into the dress for user interactions.
   - **LEDs (Neopixels):** Addressable LEDs that change color based on sensor inputs and user interactions.

2. **Relationships:**
   - **Wearable Electronics Dress - IoT Device:**
     - Represents the dress as an IoT device with sensors and actuators.
   - **IoT Device - Sensors (Motion, Sound), Buttons, LEDs:**
     - The dress IoT device interacts with sensors, buttons, and LEDs.
   - **Monitoring Website - IoT Data:**
     - The monitoring website receives real-time data transmitted by the IoT device.

3. **Interactions:**
   - **User Interaction:**
     - Users (children) interact with the dress through movement, sound, and button presses.
   - **Sensor Interactions:**
     - Sensors collect data based on detected motion and sound levels.
   - **LED Interaction:**
     - LEDs change color and patterns based on sensor inputs and button interactions.
     - **Website Interaction:**
       Monitor sensor values.

4. **Behaviors:**
    - **IoT Data Collection Behavior:**
        - Sensors collect motion and sound data, and buttons provide user input.
    - **LED Color Change Behavior:**
        - LED colors and patterns dynamically change based on sensor inputs and button interactions.

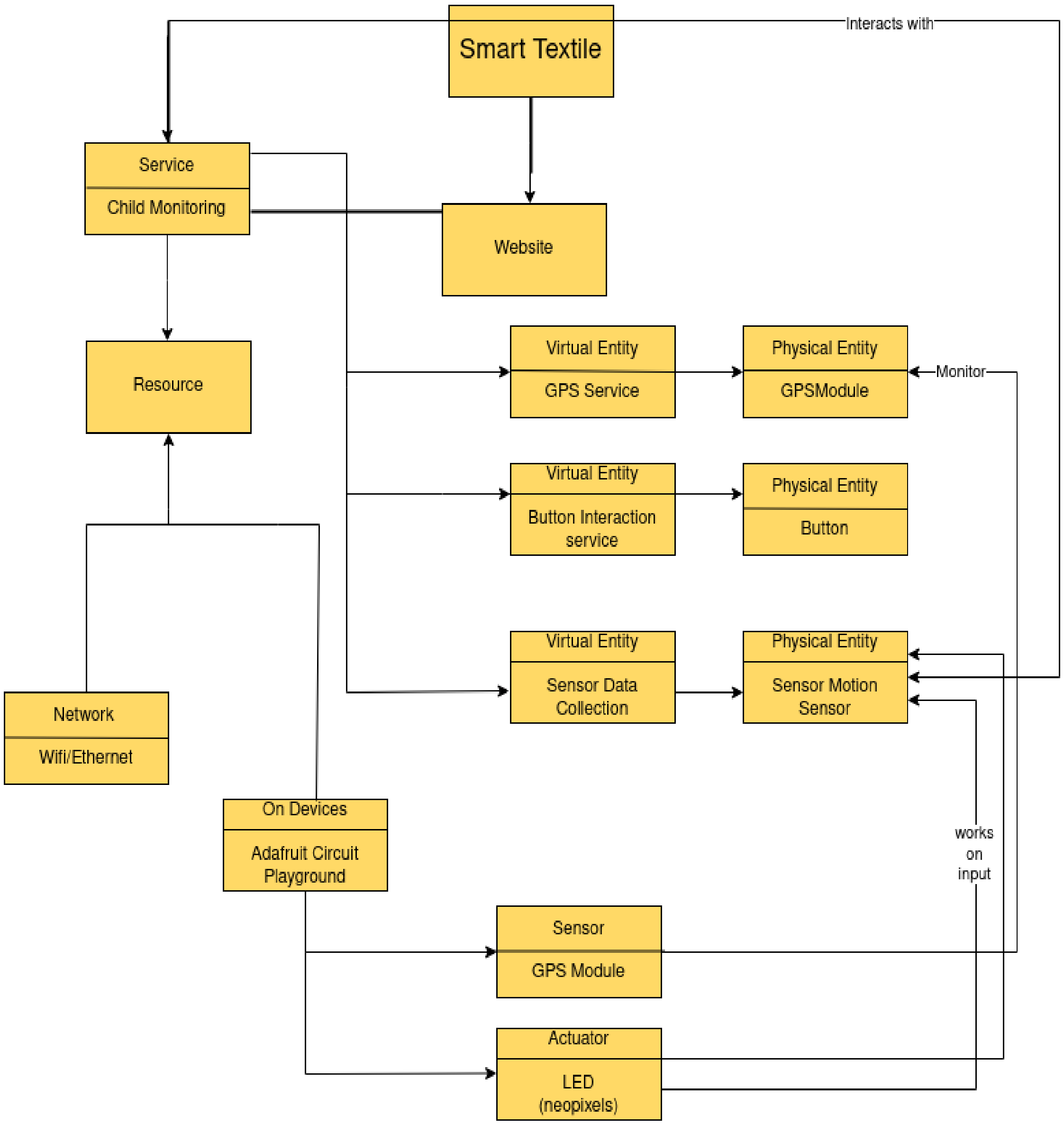


Figure: Domain model Specification for Smart Textile

Step 4: INFORMATION MODEL SPECIFICATION

1. **IoT Device (Wearable):**
   - **Attributes:**
     - Device ID: Unique identifier for the wearable electronics dress IoT device.
     - Device Name: Descriptive name for the device.
     - Device Type: Type of IoT device (wearable dress).
   - **Relationships:**
     - Contains Sensors: One-to-many relationship with motion and sound sensors.
     - Contains LEDs: One-to-many relationship with LEDs (Neopixels).
   - **Functionality:**
     - Collects Sensor Data: Captures data from embedded motion and sound sensors.
     - Receives Button Inputs: Interprets user interactions with physical buttons.
     - Controls LEDs: Triggers LED color changes and patterns based on inputs.
2. **Monitoring Website:**
   - **Attributes:**
     - Website ID: Unique identifier for the monitoring website.
     - Website Name: Descriptive name for the website.
   - **Relationships:**
     - Connects to IoT Devices: Connects to multiple wearable IoT devices for monitoring.
   - **Functionality:**
     - Authenticates Users: Provides secure user authentication for parents..
3. **Data:**
   - **Attributes:**
     - Data ID: Unique identifier for the collected data entry.
     - Timestamp: Time when the data was collected.
     - Sensor Type: Indicates whether the data is from motion or sound sensors.
     - Value: Numerical value of the collected data (motion intensity or sound level).
   - **Relationships:**
     - Associated with IoT Device: Belongs to a specific wearable IoT device.

- **Functionality:**
  - Records Sensor Readings: Stores motion and sound sensor data over time.
  - Facilitates LED Control: Influences LED color changes based on sensor data.

4. **LED Color Patterns:**
   - **Attributes:**
     - Pattern ID: Unique identifier for the LED color pattern.
     - Pattern Name: Descriptive name for the pattern.
     - Color Sequence: Sequence of colors and timing for LED changes.
   - **Relationships:**
     - Used by IoT Device: Linked to wearable IoT device for LED control.
   - **Functionality:**
     - Guides LED Changes: Provides instructions for changing LED colors and patterns.
     - Enhances User Experience: Creates visually appealing LED effects.
5. **User Inputs:**
   - **Attributes:**
     - Input ID: Unique identifier for the user input event.
     - Input Type: Specifies the type of input (button press, interaction).
     - Timestamp: Time when the input event occurred.
   - **Relationships:**
     - Generated by IoT Device: Linked to wearable IoT device.
   - **Functionality:**
     - Triggers Actions: Initiates LED changes or other interactions based on user inputs.
     - Enables User Engagement: Allows children to actively interact with the dress.

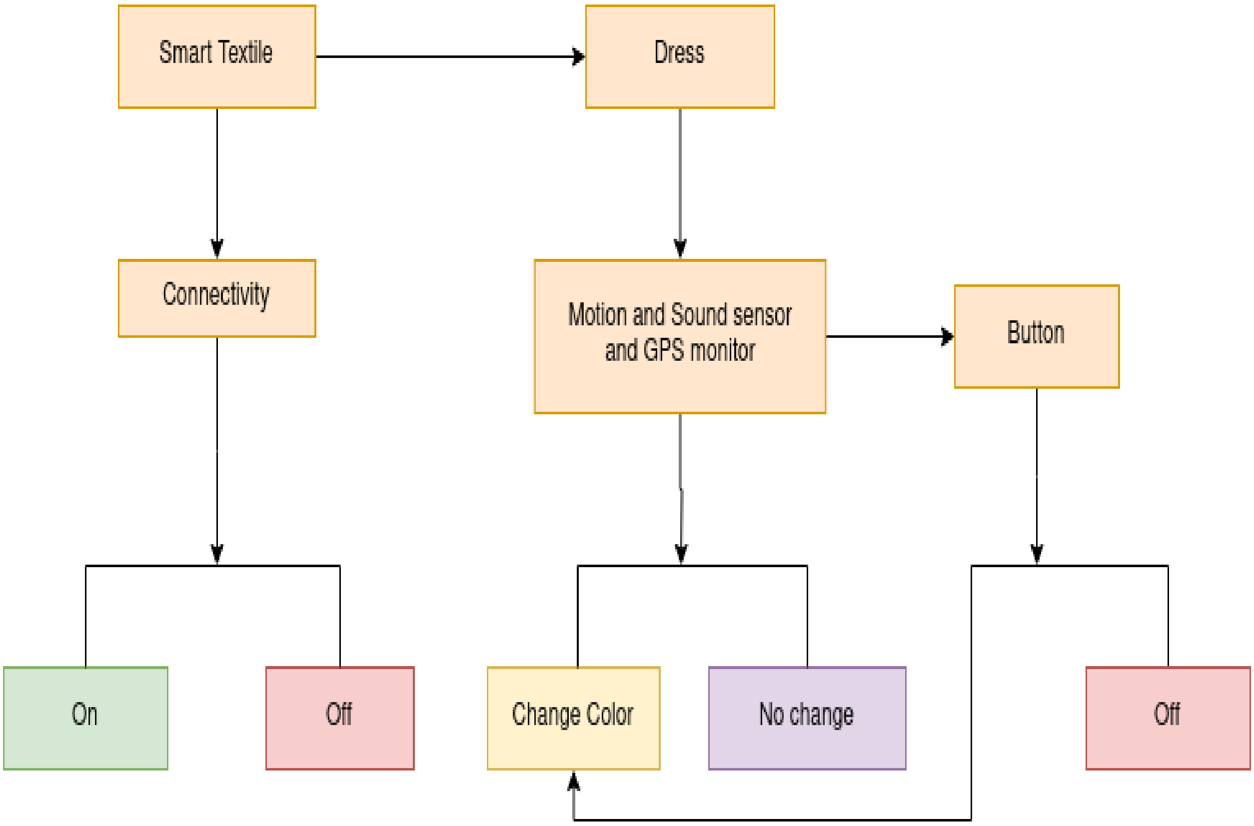


Figure: Information Model Specification for Smart Textile

Step 5: SERVICE SPECIFICATION

1.Service: LED Color Change Service

- **Service Type:** Actuator Control
- **Service Description:** This service enables the IoT device to change LED colors and patterns based on sensor inputs and user interactions.
- **Service Inputs:**
  - Sensor Data (Motion, Sound)
  - User Input (Button Presses)
  - LED Color Patterns
- **Service Outputs:**
  - LED Color Changes
- **Service Endpoints:** IoT Device (Wearable)
- **Service Schedule:** Real-time and Event-Driven
- **Service Preconditions:**
  - Sensors are actively collecting data.
  - User interactions trigger button presses.
  - LED color patterns are defined.
- **Service Effects:**
  - LEDs visually respond to sensor data and user interactions.
  - Enhances user experience through dynamic LED colors and patterns.

2. Service: Sensor Data Collection Service

- **Service Type:** Data Collection
- **Service Description:** This service continuously collects data from embedded motion and sound sensors.
- **Service Inputs:** None
- **Service Outputs:**
  - Sensor Data (Motion, Sound)
- **Service Endpoints:** IoT Device (Wearable)
- **Service Schedule:** Continuous and Real-time
- **Service Preconditions:**
  - Motion and sound sensors are active.
  - IoT devices are powered and operational.

- **Service Effects:**
  - Provides real-time data for LED control and potential event triggers.

3.Service: Button Interaction Service

- **Service Type:** User Interaction
- **Service Description:** This service detects and responds to button presses by users (children).
- **Service Inputs:**
  - User Inputs (Button Presses)
- **Service Outputs:**
  - Triggered Actions (LED Color Changes)
- **Service Endpoints:** IoT Device (Wearable)
- **Service Schedule:** Event-Driven (Upon button press)
- **Service Preconditions:**
  - Buttons are physically pressed by users.
  - Button interactions are enabled.
- **Service Effects:**
  - Initiates LED color changes or other interactions based on button presses.

4.Service: Website Display Service

- **Service Type:** Visualization
- **Service Description:** This service displays the child's real-time location on the monitoring website's map interface.
- **Service Outputs:**
  - Real-time sensor monitoring display
- **Service Endpoints:** Monitoring Website
- **Service Schedule:** Real-time
- **Service Preconditions:**
  - Monitoring website is accessible.

    .

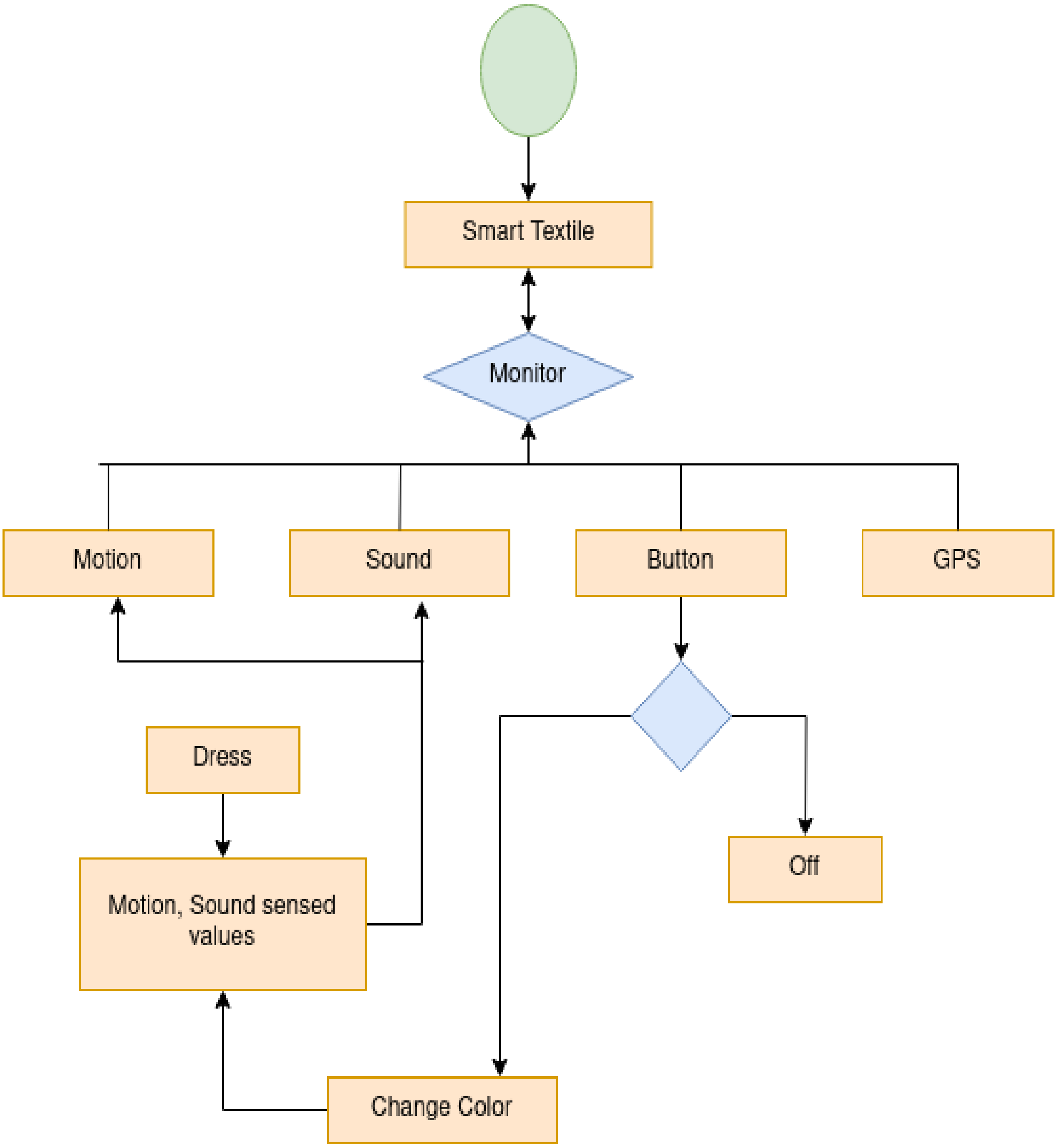
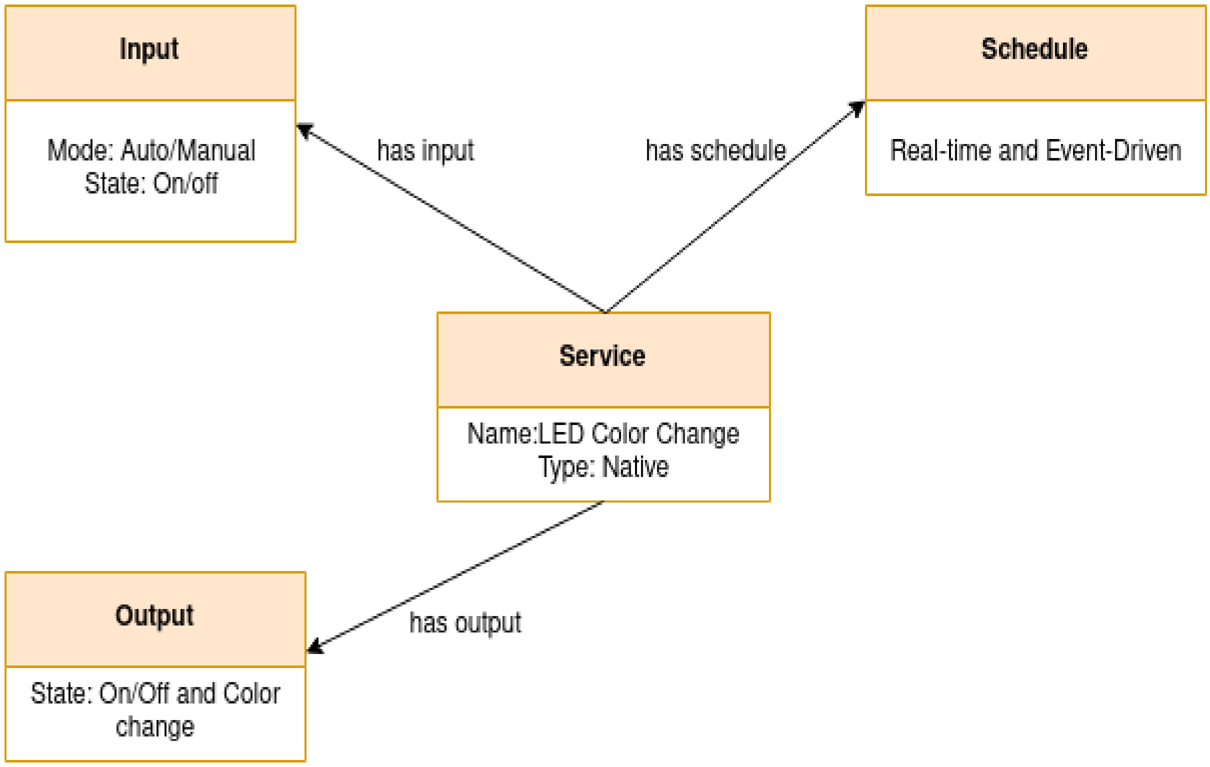
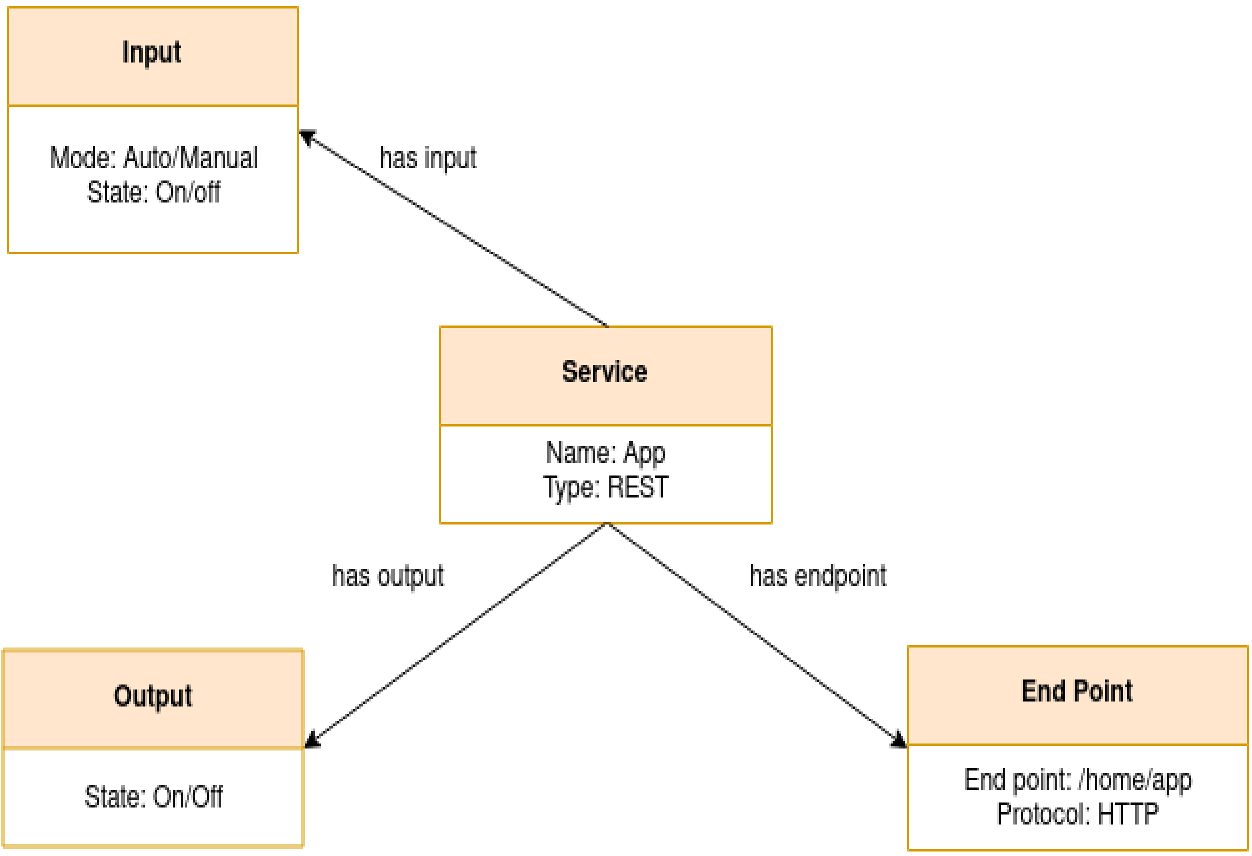


Figure: Service Specification for Smart Textile


Input
Mode: Auto/Manual
State: On/off
has input
has schedule
Schedule
Real-time and Event-Driven
Service
Name:LED Color Change
Type: Native
has output
Output
State: On/Off and Color change


Input
Mode: Auto/Manual
State: On/off
has input
Service
Name: App
Type: REST
has output
has endpoint
Output
State: On/Off
End Point
End point: /home/app
Protocol: HTTP

Step 6: IOT LEVEL SPECIFICATION

This diagram shows the level of application deployment. That is the use of local storage, the nodes and their details.

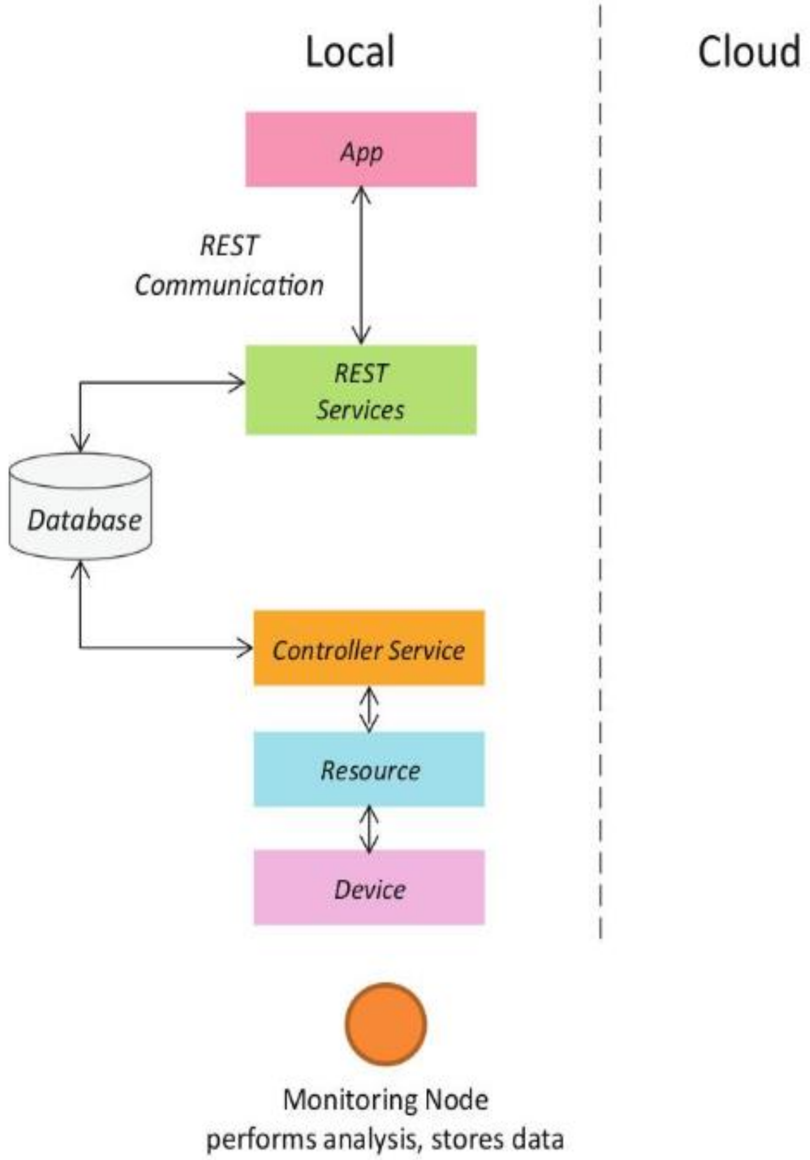


Figure: IoT level Specification

Our project comes under the level one.

A level-1 IoT system has a single node/device that performs sensing and/or actuation, stores data, performs analysis and hosts the application and doesn't require any cloud storage.

Step 7: FUNCTIONAL VIEW SPECIFICATION

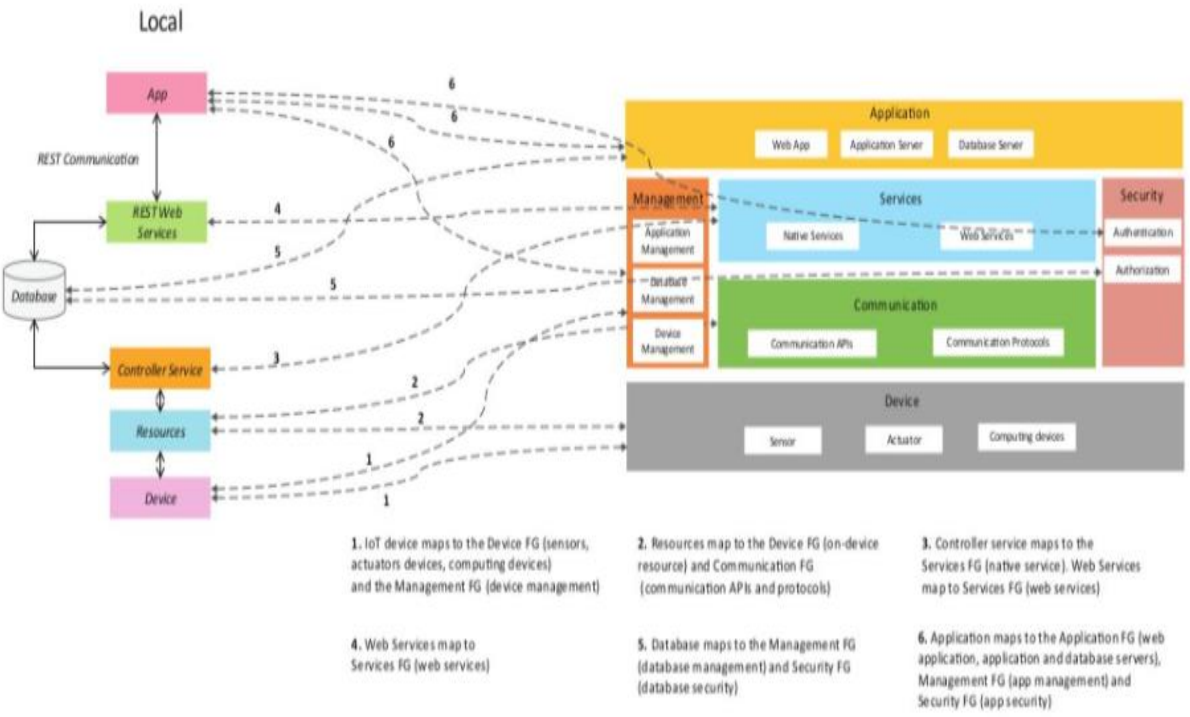


Figure: Functional view Specification

The above figure shows the connection between the IOT level and the operational diagram of the system. This shows how the nodes of the IOT level are connected to the devices from which the data retrieved to the nodes. The connection between resources and the management part of the system are seen.

Step 8: OPERATIONAL VIEW SPECIFICATION

This diagram shows detailed information of the system the components used, the protocols used.

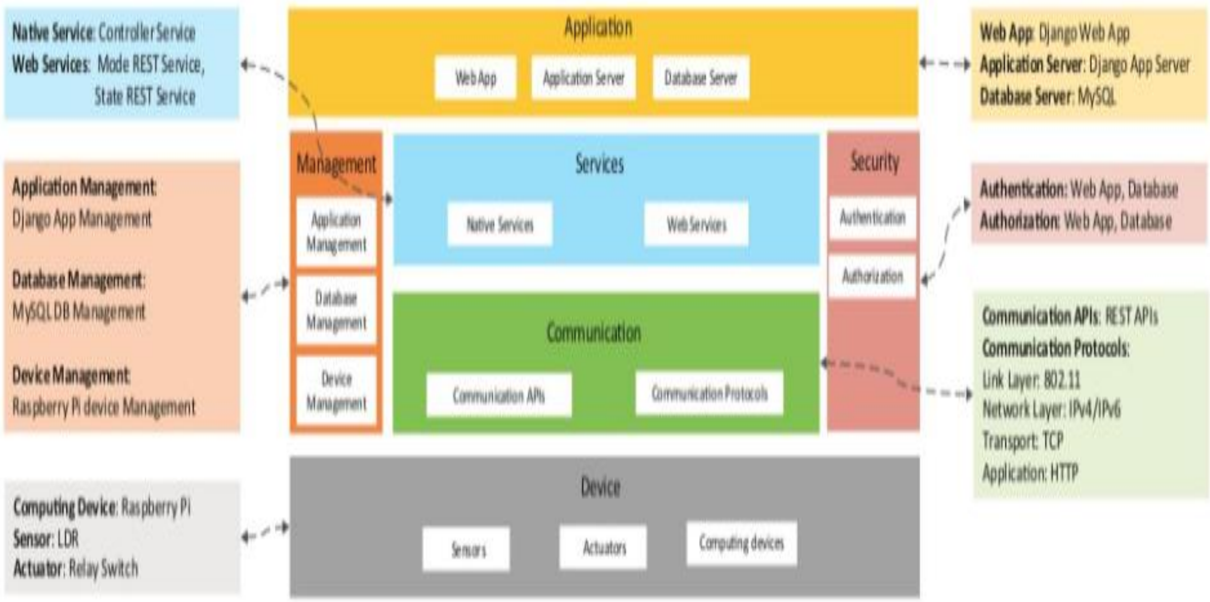


Figure: Operational View Specification

Devices used: Adafruit circuit playground board is used for processing and working of the sensor and actuators. Motion, sound (in-built) and GPS module sensors are used to control led’s.

Step 9: DEVICE & COMPONENT INTEGRATION

Fritzing diagrams:

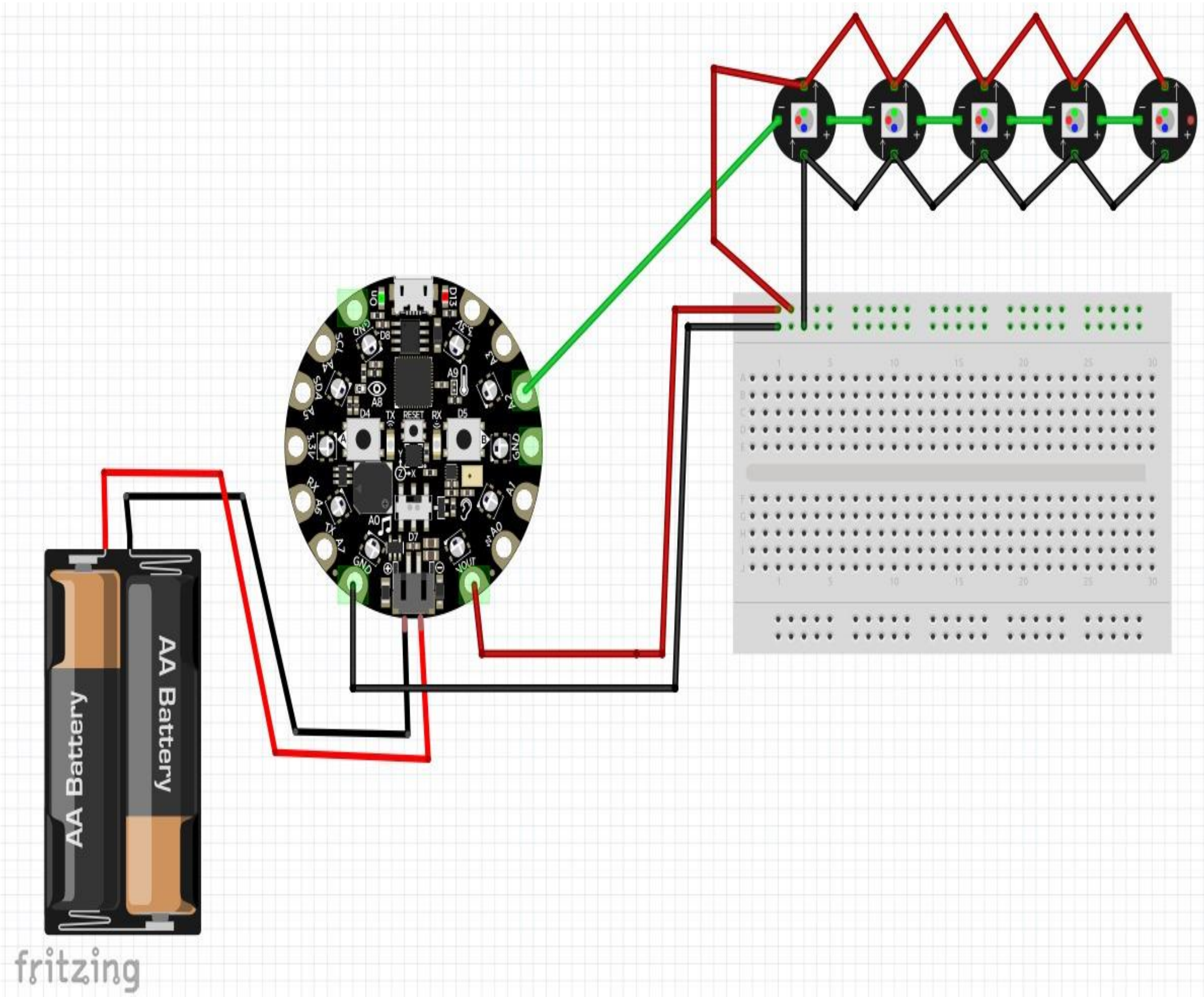


Figure: Fritzing diagram

Step 10:APPLICATION DEVELOPMENT

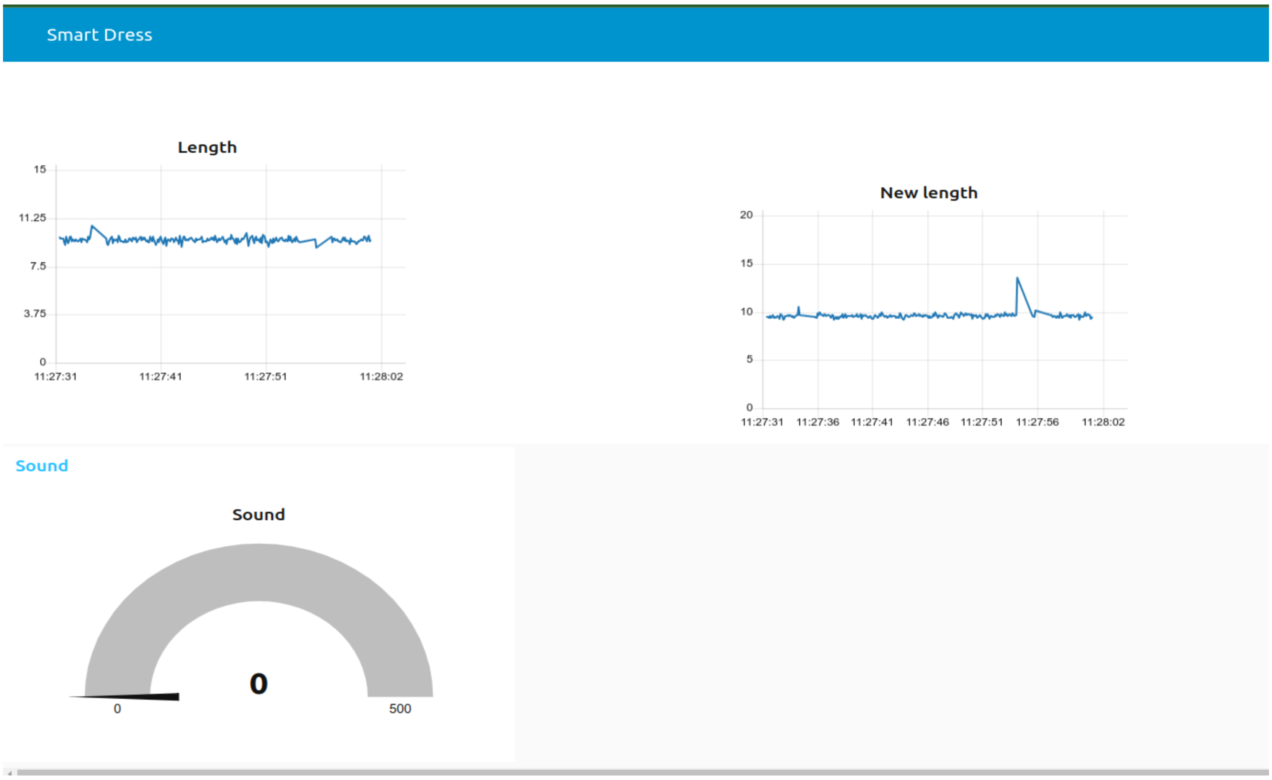


Figure: Web interface for monitoring motion and sound sensed values

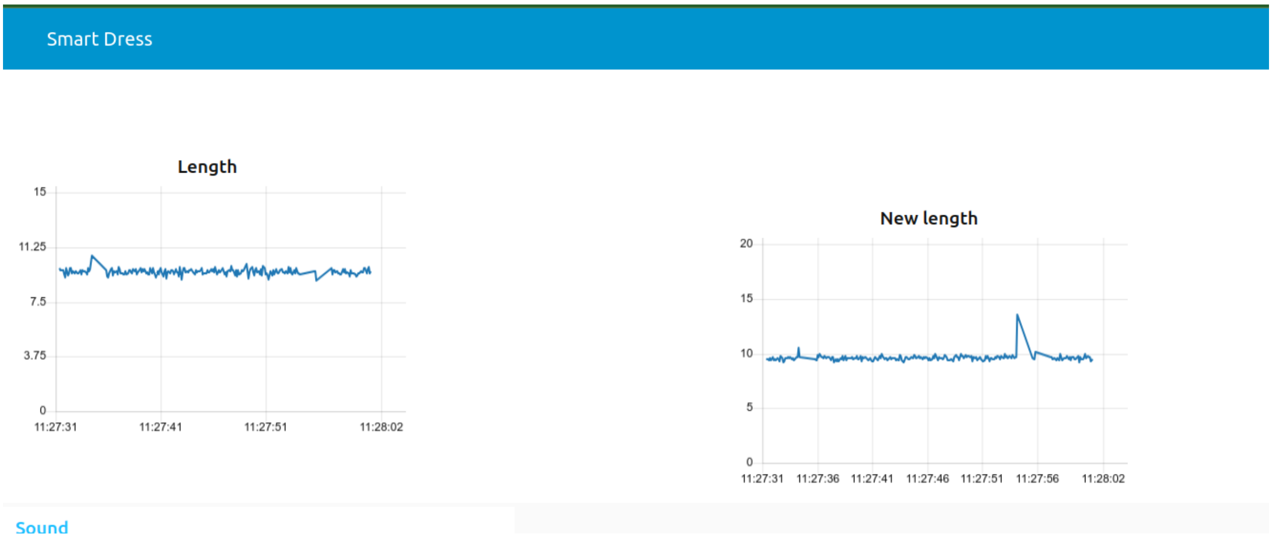


Figure : Monitoring Motion sensor

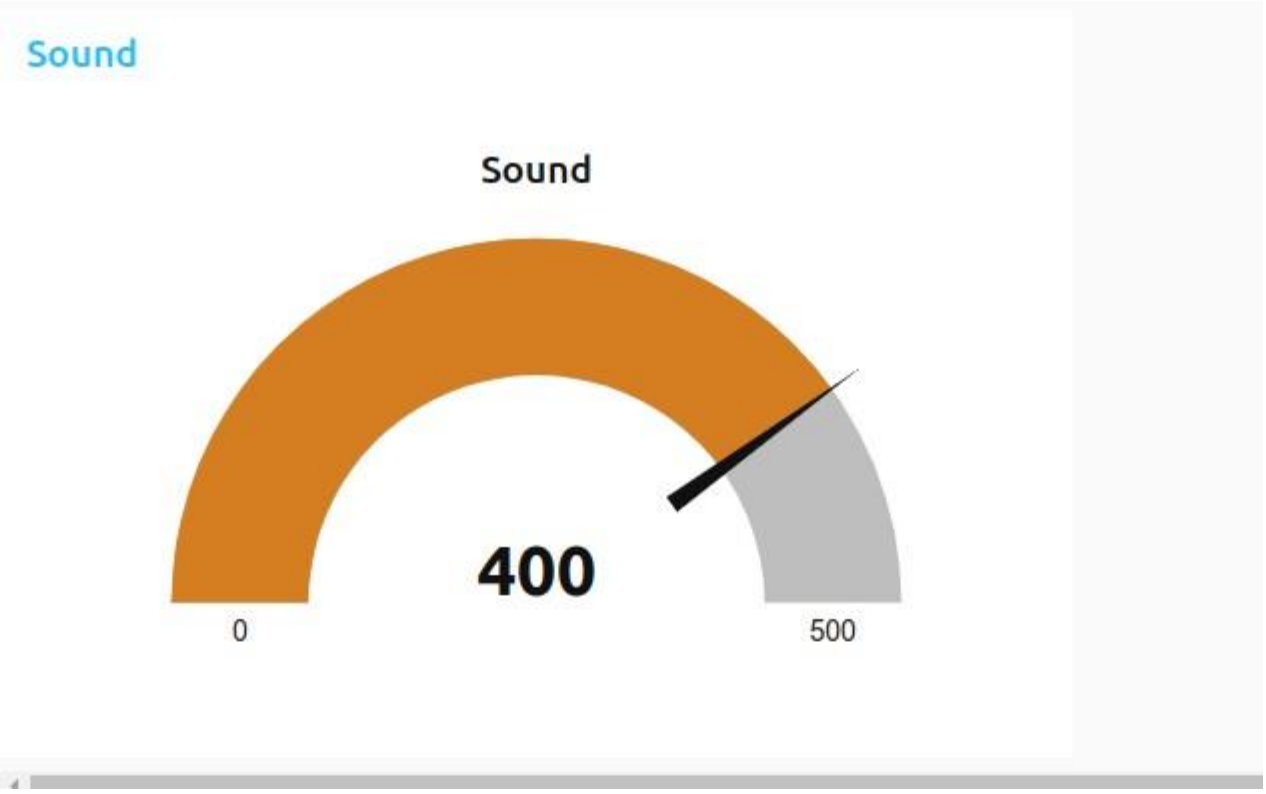


Figure: Monitoring sound sensor

5. PROPOSED SOLUTION

Our solution centres around the development of interactive and expressive smart textiles designed exclusively for children. These textiles are crafted to be both engaging and educational while prioritizing the child's privacy and security.

- **Interactive Textiles**: The core of our solution lies in the integration of a variety of sensors into the textiles. These sensors include motion and sound sensors, along with physical buttons. The textiles respond dynamically to a child's movements, surrounding sounds, and button interactions.
- **Motion-Activated Color Changes**: As the child moves, the embedded LEDs within the textiles change colors, creating a visually captivating and interactive experience. The colour changes are directly linked to the intensity of the detected motion, providingreal-time feedback to the child's activities.
- **Sound-Responsive LEDs**: Surrounding sound levels are detected by the textiles' integrated microphone. The LEDs adjust their colours in response to environmental noise, enhancing the interactivity and responsiveness of the textiles.
- **Button Interactions**: Physical buttons seamlessly integrated into the textiles enable children to trigger specific LED colour patterns or effects. This intuitive interface encourages creativity and engagement, allowing children to actively interact with and personalize their textiles.
- **Educational Component**: While providing entertainment, our smart textiles also serve as basic educational tools. Children can learn about the fundamental concepts of electronics and sensor technology as they observe the textiles' responses to different stimuli.
- **Privacy and Security**: Data privacy and security are paramount in our solution. Sensitive information, including sensor data, remains entirely private and inaccessible to anyone other than authorized individuals, typically parents or guardians.
- **Comfort and Safety**: The textiles are designed to be lightweight, comfortable, and safe for children to wear. Durability is also a key consideration, as these textiles are meant to withstand the rigors of play and movement.

6. IMPLEMENTATION OVERVIEW

The implementation of our smart textiles involves several key steps, from hardware integration to software programming. Below, we outline the essential phases of turning our proposed solution into a functional reality:

1. **Hardware Integration:**

    - **Adafruit Circuit Playground Board**: Begin by integrating the Adafruit Circuit Playground board into the textile. This board serves as the central controller, and its sensors (motion, sound) and LEDs are core components.
    - **LED Strips or Neo pixels**: Integrate addressable LED strips or Neo pixels into the textile fabric, ensuring they are strategically placed for visual impact.
    - **Motion and Sound Sensors**: Embed motion and sound sensors discreetly within the textile, ensuring they can effectively detect movement and surrounding sound levels.
    - **Buttons**: Seamlessly incorporate physical buttons into the textile, allowing for user interactions.
    - **Power Source**: Connect a suitable power source, typically a battery pack, to ensure uninterrupted operation. Consider power-saving features to extend battery life.

2. Programming:

- Utilize the Arduino IDE to program the Adafruit Circuit Playground board. Write code to capture sensor data from motion and sound sensors.
- Implement logic to dynamically adjust LED colours based on the intensity of motion and surrounding sound levels.
- Develop functions to respond to button presses, enabling users to trigger specific LED colour patterns or effects.
- Ensure error handling mechanisms are in place to manage potential sensor errors and communication disruptions.

- Focus on real-time updates to enable timely transmission of sensor data to control LED behaviour.

3. **Safety and Comfort**:
   - Prioritize safety and comfort by carefully securing all components within the textile to prevent discomfort or harm to the child.
   - Conduct thorough testing to ensure the textile's durability, especially considering the active nature of children's play.

4. **Data Privacy and Security:**
   - Implement strong data privacy measures by ensuring that sensitive information, including sensor data, is encrypted and protected.
   - Secure user authentication for any access to data or controls, restricting access to authorized individuals, typically parents or guardians.

5. **Testing and Quality Assurance:**
   - Conduct extensive testing to verify that the sensors, LEDs, and buttons function as intended.
   - Ensure that LED colour changes correspond accurately to motion, sound, and button interactions.

6. **User Instructions:**
   - Provide clear and simple instructions for children to understand how to interact with the textile and change LED colours.

7. **Documentation:**
   - Document the entire implementation process, including hardware connections, software code, and safety considerations.

8. **User Education:**
   - If applicable, provide educational materials for children to understand the basic principles of electronics, sensor technology, and programming.

9. Deployment:

- Deploy the smart textiles to the intended users, allowing children to enjoy and explore the interactive features.

10.Support and Maintenance:

- Offer ongoing support and maintenance to address any issues or updates as needed.

Fig 1. Circuit Playground board stitched to dress

Fig 2. Stitching of neopixel led's to dress

Fig 3. RGB led strip

Fig 4. Final output of the project

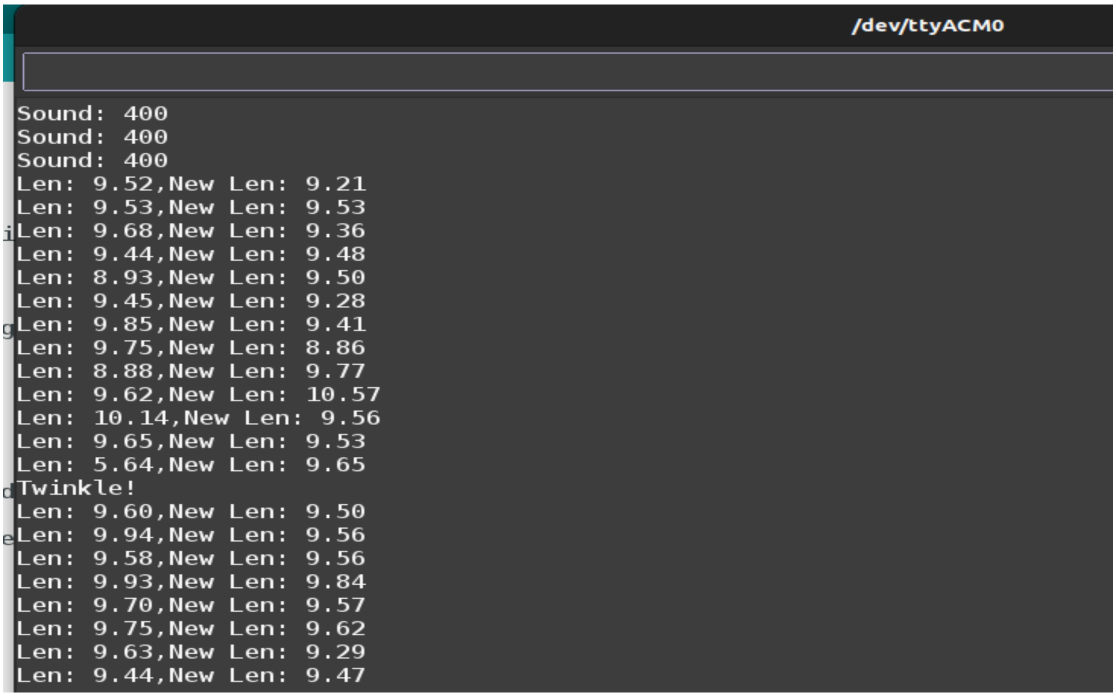


Fig 5: Getting value from serial communication

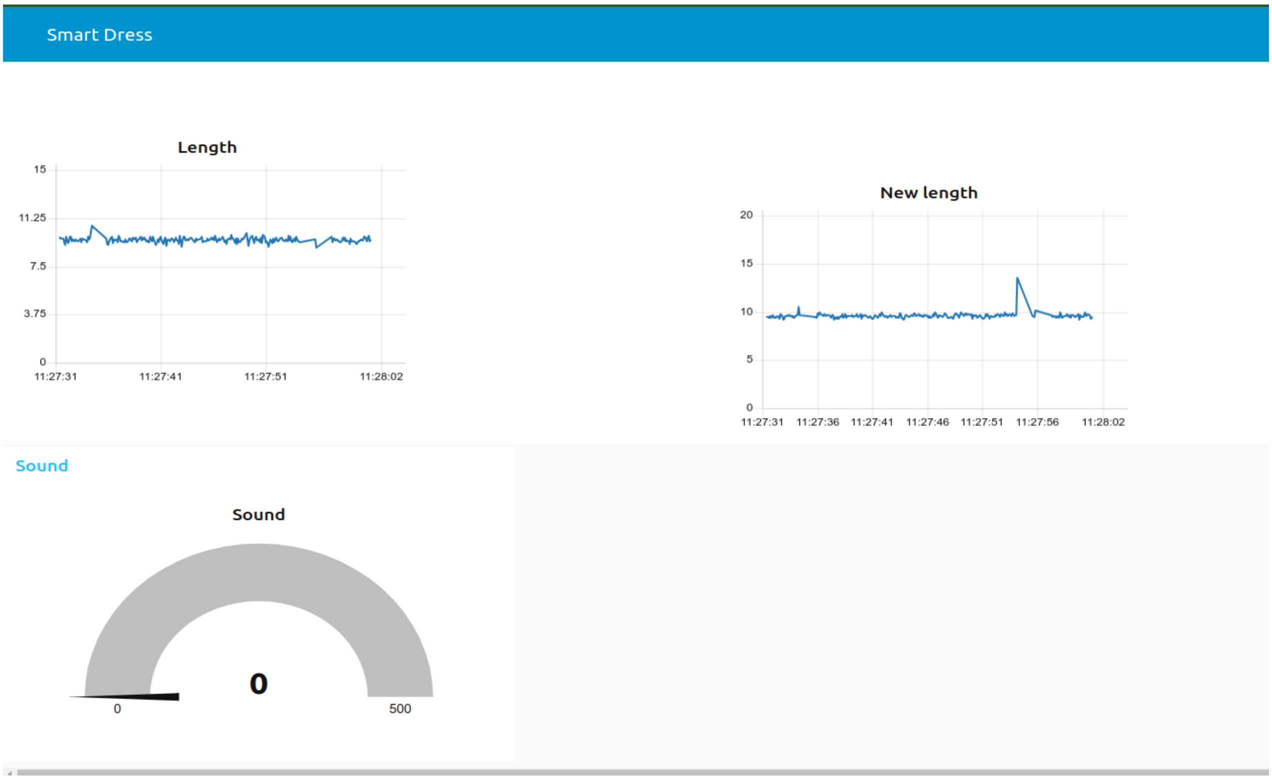


Fig 6: Motioring the values using dashboard

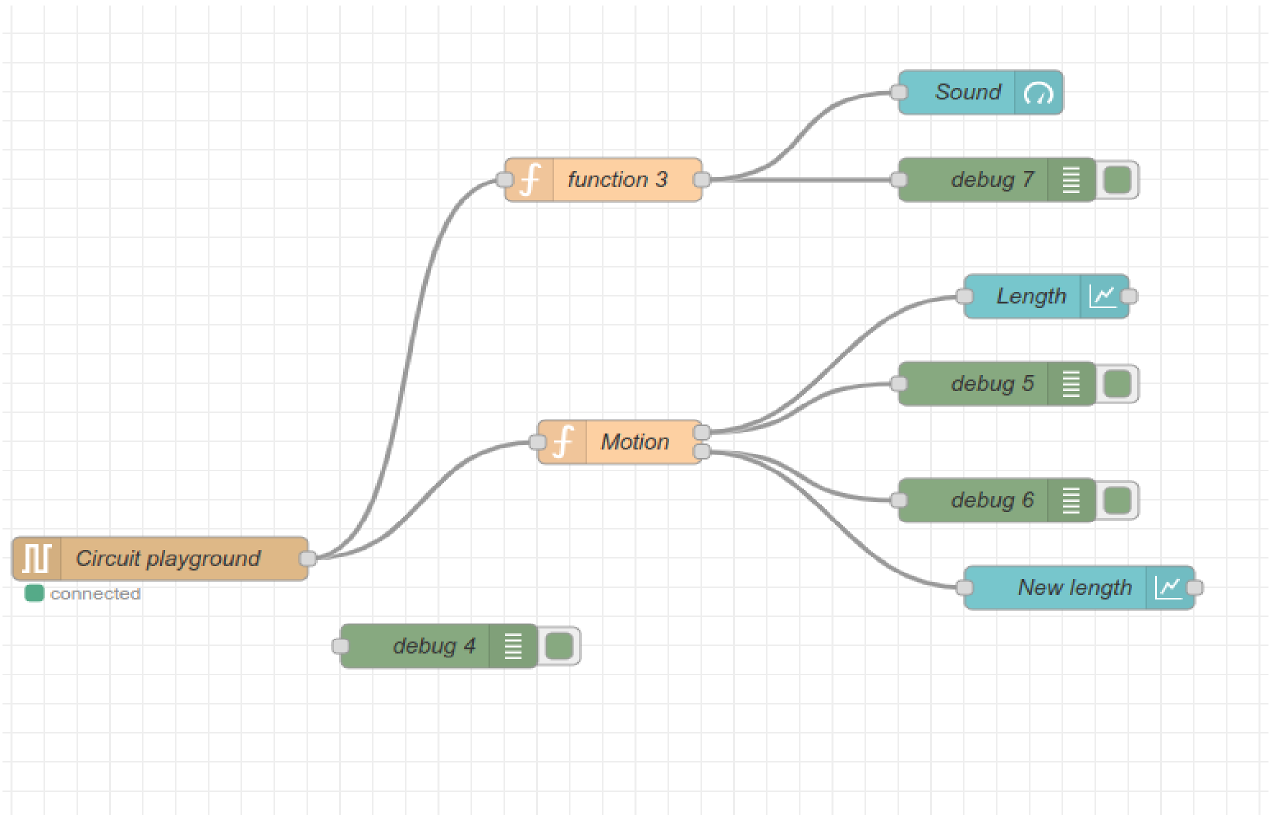


Fig 6: Building nodes for circuit device and connecting

7. CODE SNIPPET

7.1 Motion sensor:

The Adafruit Circuit Playground Express (CPX) includes an integrated accelerometer sensor, which can be used to detect motion and orientation. The accelerometer on the CPX is an LIS3DH, which is a 3-axis accelerometer capable of measuring acceleration in three directions: X, Y, and Z.

```
#define MOVE_THRESHOLD 10

float X, Y, Z;

uint8_t myFavoriteColors[][3] = {{200, 100, 200},

                        {200, 200, 100},

                        {100, 200, 200}, };

#define FAVCOLORS sizeof(myFavoriteColors) / 3

void motion() {

    X = CircuitPlayground.motionX();

    Y =  CircuitPlayground.motionY();

    Z = CircuitPlayground.motionZ();

    double storedVector = X*X;

    storedVector  +=  Y*Y;

    storedVector += Z*Z;

    storedVector = sqrt(storedVector);

    Serial.print("Len: "); Serial.println(storedVector);

    // wait a bit

    delay(100);

    // get new data!
```

```
        X = CircuitPlayground.motionX();
        Y = CircuitPlayground.motionY();
        Z = CircuitPlayground.motionZ();
        double newVector = X*X;
        newVector += Y*Y;
        newVector += Z*Z;
        newVector = sqrt(newVector);
        Serial.print("New Len: ");
        Serial.println(newVector); // are we moving
        if (abs(10*newVector - 10*storedVector) > MOVE_THRESHOLD) {
            Serial.println("Twinkle!");
            flashRandom(5, 1);
            flashRandom(5, 3);
            flashRandom(5, 2);
        }
}
```

7.2 Sound sensor:

The Adafruit Circuit Playground Express (CPX) includes a built-in microphone, which can be used to detect sound and sound levels. To work with the sound sensor on the CPX, you can use the Adafruit Circuit Playground library.

```
void soundreactive() {
    uint8_t i;
    uint16_t minLvl, maxLvl;
```

```
int n, height;
n = analogRead(MIC_PIN); // Raw reading from mic
n = abs(n - 512 - DC_OFFSET); // Center on zero
n = (n <= NOISE) ? 0 : (n - NOISE); // Remove noise/hum
lvl = ((lvl * 7) + n) >> 3;
height = TOP * (lvl - minLvlAvg) / (long)(maxLvlAvg - minLvlAvg);
if (height < 0L) height = 0; // Clip output
else if (height > TOP) height = TOP;
if (height > peak) peak = height;
for (i=0; i<NUM_LEDS; i++) {
    if (i >= height) leds[i].setRGB( 0, 0,0);
    else leds[i] = CHSV(map(i,0,NUM_LEDS-1,0,255), 255, brightness);
    }
    if (peak > 0 && peak <= NUM_LEDS-1) leds[peak] =
CHSV(map(peak,0,NUM_LEDS-1,0,255), 255, brightness);
    for (i=0; i<NUM_CP; i++) {
        if (i >= height) cp[i].setRGB( 0, 0,0);
        else cp[i] =  CHSV(map(i,0,NUM_CP-1,0,255),  255, cpbrightness);
        if (peak > 0 && peak <= NUM_CP-1) cp[peak] =
    CHSV(map(peak,0,NUM_LEDS-1,0,255),  255,  cpbrightness);
        if (++dotCount >= PEAK_FALL) {
            if(peak > 0) peak--;
            dotCount = 0;
        }
```

```
        vol[volCount] = n;
        if (++volCount >= SAMPLES) volCount = 0
        minLvl = maxLvl = vol[0];
        for (i=1; i<SAMPLES; i++) {
        if (vol[i] < minLvl) minLvl = vol[i];
        else if (vol[i] > maxLvl) maxLvl = vol[i]; }
    show_at_max_brightness_for_power();
  Serial.println(LEDS.getFPS());
}
```

8. OUTCOME

- **Sound Sensing**: The CPX will be able to detect and measure sound levels in its surroundings using the built-in microphone.
- **LED Response**: The Neo Pixels on the CPX will change colour in response to the detected sound levels. The colour change will be based on the intensity or volume of the sound.
- **Real-time Interaction**: The CPX will provide real-time interaction with the sound environment. As the sound level changes, the Neo Pixels will immediately respond, creating a dynamic visual display.
- **Customization**: You can customize the code to map different sound levels to specific colours or patterns, allowing you to create unique and creative effects. For example, youcan make the LEDs flash or transition smoothly between colours based on sound intensity.
- **Sound-Driven Projects**: This capability opens up opportunities for various projects andapplications. You can create sound-reactive art installations, interactive games, music visualizers, or any project that involves responding to sound input.

The outcome is an interactive and engaging experience where the Circuit Playground Express visually responds to the sound environment, making it a versatile platform for creative and educational projects involving sound and light.

9. CONCLUSION

In conclusion, the Adafruit Circuit Playground Express (CPX) is a versatile and powerful platform for creating interactive and engaging projects that involve sound and light. With its built-in sound sensor and Neo Pixel LEDs, it enables real-time interaction with the surrounding environment, allowing for dynamic and creative visual displays based on sound input.

The key features are:

1. **Sound Responsiveness**: The CPX can detect and measure sound levels, providing the basis for sound-responsive projects.

2. **LED Visualization**: The NeoPixel LEDs on the CPX change color and patterns in response to sound, making it visually appealing and interactive.

3. **Customization**: The code can be customized to tailor the LED response to specific sound levels or patterns, offering flexibility for various applications.

4. **Educational and Creative Potential**: This setup is ideal for educational purposes, introducing users to programming, electronics, and the fusion of sound and light in a fun and interactive way.

5. **Applications**: The CPX can be used in a wide range of projects, including art installations, music visualizers, interactive games, and more.

Overall, the CPX's ability to respond to sound input opens up a world of possibilities for creative and educational endeavours, making it a valuable tool for makers and learners alike. Whether exploring the world of electronics or looking to create captivating sound-reactive projects, the Adafruit Circuit Playground Express is an excellent choice

10.FUTURE ENHANCEMENT

There are several potential future enhancements and improvements that can be made to the Adafruit Circuit Playground Express (CPX) sound and light project:

1. **Additional Sensors**: Incorporate more sensors to expand the interactivity of the CPX. For example, you could add a temperature sensor, accelerometer, or light sensor to create even more dynamic responses.

2. **Mobile App Integration**: Develop a mobile app that can remotely control and interact with the CPX. This would allow users to change modes, colors, and patterns from their smartphones or tablets.

3. **Internet Connectivity**: Add Wi-Fi or Bluetooth connectivity to the CPX, enabling it to interact with online data sources or be controlled remotely over the internet. This could open up opportunities for collaborative and online interactive art projects.

4. **Machine Learning Integration**: Train the CPX to recognize and respond to specific sounds or patterns using machine learning techniques. This could lead to more sophisticated and context-aware interactions.

5. **Battery Optimization**: Optimize power consumption to extend the CPX's battery life, especially if it's used in portable or wearable applications.

6. **User Interface**: Create a user-friendly graphical interface for programming the CPX, making it more accessible to beginners and allowing for real-time customization of its behaviour.

7. **Integration with Other Platforms**: Explore ways to integrate the CPX with other popular platforms and frameworks, such as Raspberry Pi or Arduino, to leverage their capabilities.

8. **Online Sharing**: Develop a platform for users to share their CPX creations and code online, fostering a community of CPX enthusiasts and creators.

9. **Educational Resources**: Create educational resources, tutorials, and lesson plans for teachers and students to use the CPX as a learning tool in classrooms and workshops.

10. **Enclosures and Wearables**: Design 3D-printed enclosures or wearable accessories to protect and showcase the CPX in various applications.

11. **Art Installations**: Explore opportunities for using the CPX in interactive art installations, exhibitions, or public displays.

These enhancements can not only expand the capabilities of the CPX but also make it more accessible and engaging for a broader range of users, from beginners to advanced makers and artists. The key is to continue exploring creative possibilities and leveraging emerging technologies to enhance the CPX's functionality and interactivity.

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