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CHENNAI

BECE204L Microprocessors and Microcontrollers

Mini Project Report

Interactive Safety Education Toy for Children

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Interactive Safety Education Toy for Children

Problem Statement

In today's environment, it is important to create awareness among children about personal safety and the distinction between good and bad touch. Conventionally, teaching methods are often theoretical and very young children may not be able to understand it quite easily or remember which is what. To address this, the proposed project develops a touch-based awareness system that uses capacitive touch sensors to detect user interaction and provide immediate visual feedback. Safe or "good" touches trigger a steady green light, while unsafe or "bad" touches activate a blinking red alert. The system serves as an educational tool for awareness programs and early safety education.

Literature Review

Reference paper	Paper Description	Limitations
Bai, Q. (2022). Research on the Design of Interactive Children's Vocal Enlightenment Toys Based on Audiovisual Association Experience. Occupational Therapy International, 2022. [pmc.ncbi.nlm.nih]	Explores how integrating auditory and visual feedback in children's toys enhances creativity, engagement, and learning. Highlights how instant feedback links children's actions to responses (light/sound), improving motivation and accuracy during play.	Focused primarily on vocal-based toys; lacks implementation details on hardware/microcontroller integration. Does not address scalability or performance with varying sensory inputs.
Vickery, N. E. M., Tarlinton, D., Wang, Y., & Blackler, A. (2022). Digital toys as tangible, embodied, embedded interactions.	Discusses how tangible digital toys connect sensor inputs (e.g., pressing, pointing, light targeting) to visible/audible feedback,	Conceptual and user-experience oriented; provides limited technical specifications or microcontroller design parameters. Focuses on

DRS2022: Bilbao, Design Research Society Biennial Conference Proceedings, pp. 1–15.	strengthening understanding of cause-effect and sustaining engagement. Supports sensor-driven interaction design similar to your toy.	interaction theory over implementation.
Liu, S., & Huang, X. (2023). Design and Implementation of STM32 Microcontroller-based Smart Classroom System. 13th International Workshop on Computer Science and Engineering (WCSE 2023), pp. 209–214.	Demonstrates STM32-based sensing systems that read environmental data (e.g., light intensity) and trigger outputs (LEDs, buzzers) based on thresholds—showing high reliability and responsiveness for interactive educational applications.	Application context limited to classroom environments; does not evaluate child interaction or toy usability. Focuses on system performance, not engagement outcomes.
Ozcan, B., Sperati, V., Giocondo, F., Schembri, M., & Baldassarre, G. (2022). Interactive soft toys to support social engagement through sensory-motor plays in early intervention of kids with special needs. Proceedings of the ACM Interaction Design and Children Conference.	Presents the use of interactive soft toys to promote social engagement and sensory-motor play for children with special needs, showing the developmental benefits of multisensory feedback in toys.	Limited to specific target groups (children with special needs); results may not generalize to all children. Hardware and control mechanisms are not described in depth.

Proposed work

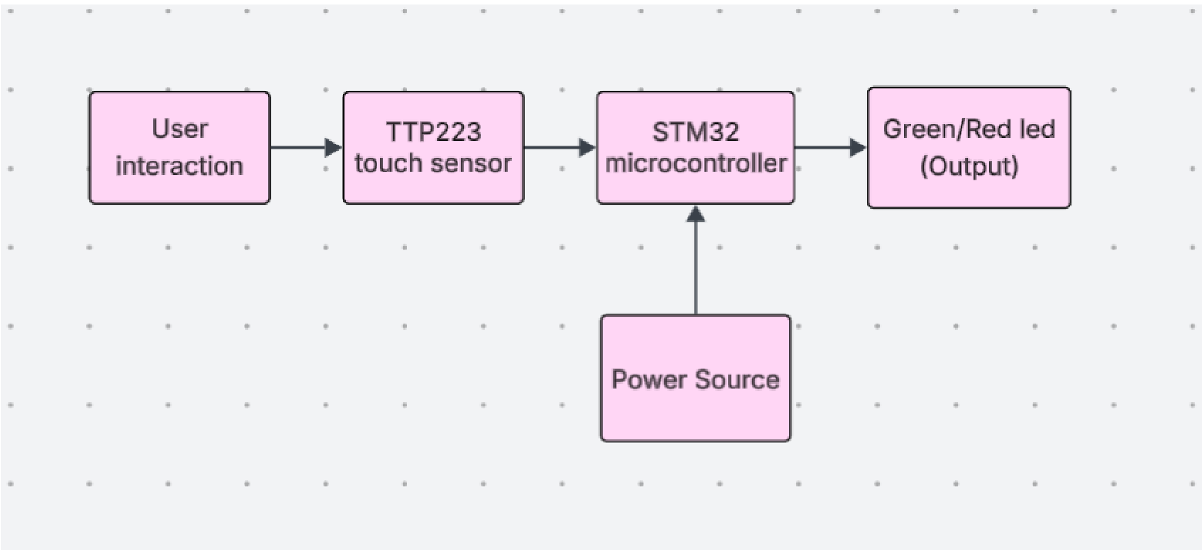
This project aims to create an interactive touch-based awareness model that helps children differentiate between good and bad touch using visual indicators. The setup uses TTP223 capacitive touch sensors placed at different body regions to represent safe and unsafe zones.

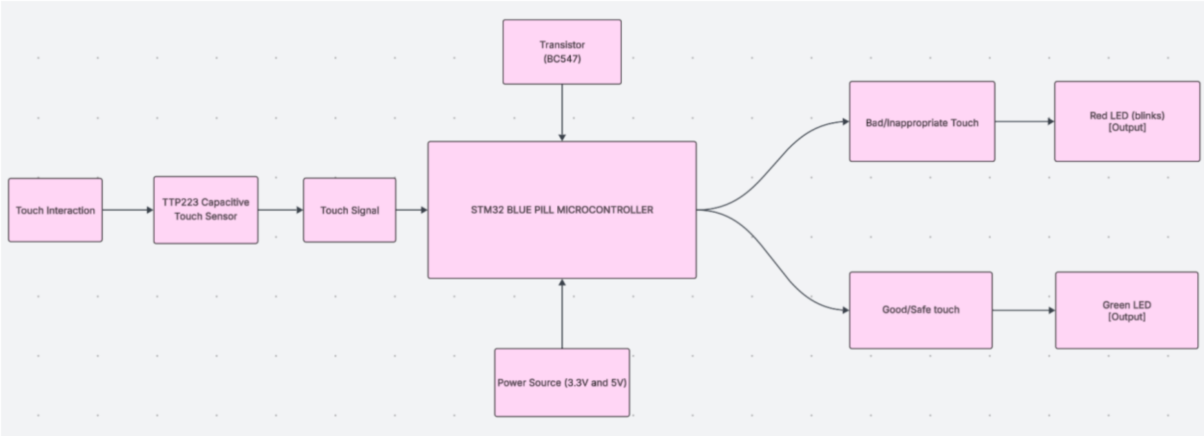
Each sensor detects physical contact and sends a digital signal to the STM32 Blue Pill microcontroller, which processes the inputs and activates corresponding LEDs through transistor-based switching circuits.

- Good touch sensor: When activated, it turns on a green LED steadily, indicating safe or appropriate touch.
- Bad touch sensors: When activated, they trigger a blinking red LED, symbolizing an unsafe or inappropriate touch.

The system is powered by a dual voltage source — 3.3 V for logic and sensor operation, and 5 V for LED driving through transistors. This ensures reliable operation without overloading the microcontroller pins.

Block Diagram





Block Diagram Explanation

The system is designed to differentiate between *good* and *bad* touch interactions through visual feedback using LEDs. When a user interacts with the touch-sensitive surface, the TTP223 capacitive touch sensors detect the change in capacitance and send digital signals to the STM32 Blue Pill microcontroller. Based on the sensor inputs, the controller classifies the touch as either “good” or “bad” and drives the corresponding LED indicators through transistor driver circuits.

A green LED glows steadily for a good touch, while a red LED blinks for a bad touch. The circuit is powered by a dual voltage supply—3.3 V for the microcontroller and sensors, and 5 V for the LEDs through transistors.

STM32 Blue Pill Microcontroller:

The STM32 Blue Pill acts as the central processing unit of the project. It receives input signals from multiple TTP223 sensors connected to its digital input pins. The microcontroller is programmed to process these inputs and identify whether the touch corresponds to a good or bad region. Based on the result, it outputs digital signals through pins PB0 (green LED) and PB4 (red LED). These signals control external BC547 transistors, which switch the LEDs on or off accordingly.

TTP223 Capacitive Touch Sensors:

The TTP223 sensors serve as the primary input devices of the system. They detect touch without requiring physical pressure by measuring changes in capacitance when a human finger approaches or contacts the surface. Each sensor outputs a HIGH signal when touched.

- The *good-touch sensor* is connected to the green LED, representing safe touch.
- The *bad-touch sensors* are connected to the red LED, representing bad touch.

BC547 Transistor:

Since the STM32's GPIO pins cannot supply sufficient current to power external LEDs directly, BC547 NPN transistors are used as electronic switches. The base of each transistor is connected to the STM32 output pin via a 4.7 kΩ resistor, while the collector drives the LED connected to the 5 V rail through a 100 Ω resistor. This setup allows the LEDs to operate safely and brightly while protecting the microcontroller from overcurrent.

LED Indicators (Outputs):

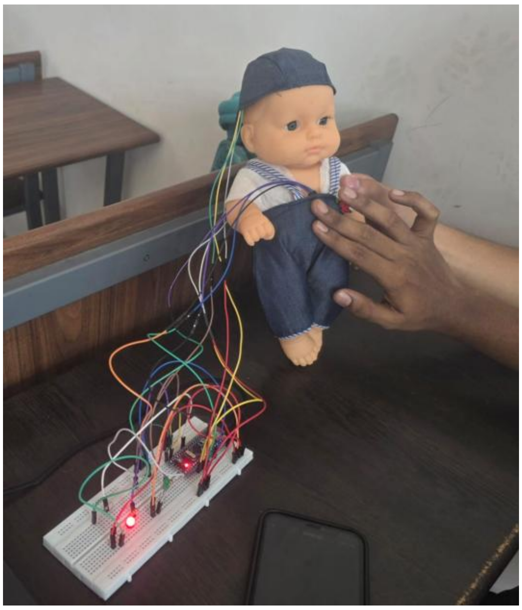
The LEDs provide clear visual feedback for the user interaction:

- The Green LED remains ON steadily to indicate a *good* or *safe* touch.
- The Red LED blinks to indicate a *bad* or *unsafe* touch.

List of components and cost analysis

S no.	Components name	Quantity	Total Price (in Rs)
1	STM32 Blue Pill Microcontroller	1	399
2	Breadboard	1	200
3	USB to micro-USB	1	149
4	Green LED	(Set of 5)	32
5	Red LED	(Set of 5)	32
6	200 ohm resistors	(Set of 10)	10
7	4.7k ohm resistors	(Set of 10)	10
8	100 ohm resistors	(Set of 10)	10
9	Transistors (BC547)	(Set of 5)	25
10	Wires to connect	a few	
11	TTP223 touch sensors	(Set of 5)	200
12	Educational model	1	450
13	ST-Link V2	1	285
14	Soldering kit	1	251
	TOTAL PRODUCT COST	**Rs. 2053**	

Output – Photo Snapshot

References

1. Bai, Q. (2022). Research on the Design of Interactive Children’s Vocal Enlightenment Toys Based on Audiovisual Association Experience. Occupational Therapy International, 2022.[pmc.ncbi.nlm.nih]

2. Vickery, N. E. M., Tarlinton, D., Wang, Y., & Blackler, A. (2022). Digital toys as tangible, embodied, embedded interactions. DRS2022: Bilbao, Design Research Society Biennial Conference Proceedings, pp. 1–15. https://doi.org/10.21606/drs.2022.804[sciencedirect]

3. Liu, S., & Huang, X. (2023). Design and Implementation of STM32 Microcontroller-based Smart Classroom System. 13th International Workshop on Computer Science and Engineering (WCSE 2023), pp. 209–214. https://doi.org/10.18178/wcse.2023.06.030[frontiersin]

4. Ozcan, B., Sperati, V., Giocondo, F., Schembri, M., & Baldassarre, G. (2022). Interactive soft toys to support social engagement through sensory-motor plays in early intervention of kids with special needs. Proceedings of the ACM Interaction Design and Children Conference.[acm]