SnT 2025
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Tangible Programming Learning for Visually Impaired Individuals

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INTRODUCTION AND MAIN RESULTS

This project demonstrates how tangible interaction and audio feedback can transform highly visual subjects, such as museum exhibits, into inclusive experiences for visually impaired individuals. By combining a web application with a tangible model, the approach illustrates a scalable method that CTBTO exhibitions could potentially adopt to make verification science more accessible to wider audiences.

This project draws on principles from Human-Computer Interaction(HCI), computer vision for 2D marker recognition, and tangible programming concepts to create an interactive, multisensory learning tool.

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Introduction

Visually impaired individuals often face barriers when engaging with museum exhibitions, which rely heavily on visual presentation. While some museums provide tactile replicas or audio guides, many displays remain inaccessible. This project explores how tangible interaction and audio feedback can transform museum exhibits into inclusive, multisensory experiences. Building upon the Tangible Inclusive Block-Based Language (TIBBL) framework and the TopCode JavaScript library, the project adapts concepts from tangible programming to create an accessible way for visually impaired visitors to interact with a fossil exhibit at the Natural History Museum, London.

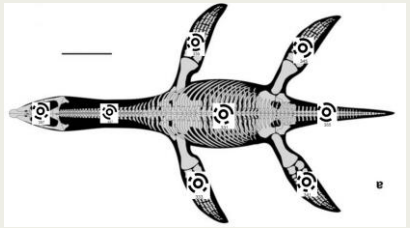
Implementation

This project combines a paper model of the Rhomaleosaurus fossil with a web application. Each fossil piece (skull, body, limbs, tail, neck) is embedded with a unique TopCode, enabling recognition by a webcam.

Users interact with the model through two structured challenges:

1.Presence verification – confirming that all pieces are present.

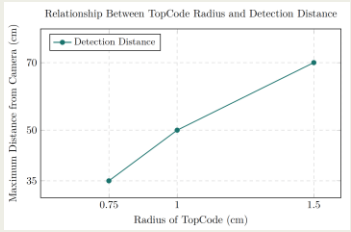
2.Spatial arrangement – guiding users to assemble pieces in the correct anatomical layout.

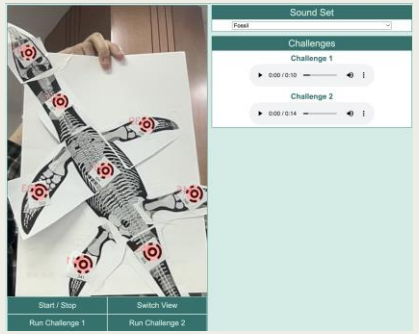


Audio instructions and feedback, delivered via the Web Speech API, support users throughout. Prototyping and implementation emphasized low-cost accessibility, real-time detection, and independence from visual navigation. The design process included iterative testing of TopCode sizes, arrangement detection accuracy, and tactile usability of the paper model.

Results & Evaluation

The prototype enabled real-time audio and tangible interaction with fossil model pieces, low-cost engagement. Larger TopCodes improved detection range, though constraints remained around camera framing, angle and the stability of paper components.





Audio feedback provided effective guidance, but there exist limitations like reliance on flat, stable placement of paper pieces; need for assistance to position webcams; and durability issues with paper components. Accessibility testing suggested that users with severe vision loss might still require facilitator support.

Despite these constraints, the system achieves specifications of building a multisensory, low-cost engagement. By aligning fossil assembly with computational thinking skills such as spatial reasoning and error correction, the project shows an example of how tangible programming methods can enhance museum accessibility and encourage inclusive programming education.

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