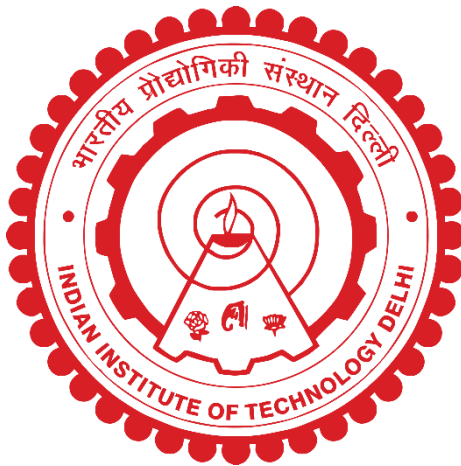


UNDERSTANDING TACTILE PERCEPTION FOR DESIGN OF EFFECTIVE TACTILE GRAPHICS

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INDIAN INSTITUTE OF TECHNOLOGY DELHI

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UNDERSTANDING TACTILE PERCEPTION FOR DESIGN OF EFFECTIVE TACTILE GRAPHICS

by

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Submitted

in fulfilment of the requirements for the degree of Doctor of Philosophy

to the



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CERTIFICATE

This is to certify that the thesis entitled “**Understanding Tactile Perception for Design of Effective Tactile Graphics**” submitted by **Ms. Richa Gupta** to the Indian Institute of Technology Delhi, in partial fulfilment for the award of the degree of **Doctor of Philosophy** is a record of original research work carried out by her under my supervision. The contents of this thesis, in full or in part, have not been submitted to any other Institute or University for the award of any other degree or diploma.



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ABSTRACT

Many students with blindness become interested in STEM in their school years, but unlike their sighted peers, blind and visually impaired (BVI) students often find themselves at a disadvantage because the ubiquitous use of diagrams, charts and graphical information in education is not available to them in accessible formats. In addition to conversion of text into braille or audio, accessible adaptations of visual representations are essential to support the learning of most STEM subjects. To promote participation and interest of blind students in STEM, thus paving a way for prospective future academic and career opportunities, the urgent need for accessible educational resources should be met.

The primary method for making visual graphical information more accessible to BVI individuals is to translate visual graphics into tactile graphics (TGs), sometimes called “raised line” graphics. Tactile perception is key to comprehension of tactile graphics. Making effective tactile graphics requires an in-depth understanding of how BVI students perceive and learn with TGs. This is the subject of present research.

The present work investigates and evaluates the discriminability, memorability and semantic capacity of TG shapes composed of design primitives, whether as individual shapes or in table-top layouts. It evaluates the role of these primitives in tactile perception of graphical and positional/spatial information and its retention. The research also attempts to evaluate the pedagogical use of the empirical insights through validation trials and games. Further, this work evaluates the use of variable height in tactile graphics and how it can be used to make graphics more effective and intuitive.

The above-mentioned questions have been addressed by studying different tactile graphic design strategies and elements. A set of experiments which use a two-step exploration approach

has been adopted: (1) tactile graphical stimuli designed using novel strategies were presented to participants followed by a recall test using verbal questions or a test challenging subjects to learn then recreate sequences or layouts of tactile tiles; (2) information is presented in association with these tactile stimuli to test how well they facilitate the retention of information presented verbally in association with the tactual experience.

The results of this work can help in improving guidelines for various types of information media, primarily in tactile graphics which are frequently part of tactile books and accessible interfaces. They can facilitate the development of effective tactile material. Additionally, the insights can help shape and evolve the pedagogies for students with blindness, to make learning more effective and engaging.

अनुसंधान सार

कई नेत्रहीन छात्र अपने स्कूल के वर्षों में एसटीईएम विषयों में रुचि रखते हैं, लेकिन उनके दृष्टिबोध साथियों के विपरीत, अंधे और नेत्रहीन (बीवीआई) छात्र अक्सर खुद को नुकसान में पाते हैं क्योंकि शिक्षा में चित्रमय जानकारी का सर्वव्यापी विकल्प उपलब्ध नहीं है। उन्हें सुलभ स्वरूपों में ब्रेल या ऑडियो में पाठ के रूपांतरण के अलावा, दृश्य प्रतिनिधित्व के सुलभ अनुकूलन अधिकांश एसटीईएम विषयों को सीखने के समर्थन करने के लिए आवश्यक हैं। एसटीईएम में नेत्रहीन छात्रों की भागीदारी और रुचि को बढ़ावा देने के लिए, इस प्रकार भावी शैक्षणिक और कैरियर के अवसरों के लिए एक मार्ग प्रशस्त करना, सुलभ शैक्षिक संसाधनों की तत्काल आवश्यकता को पूरा करना चाहिए।

BVI व्यक्तियों के लिए दृश्य चित्रमय जानकारी को अधिक सुलभ बनाने के लिए प्राथमिक विधि दृश्य ग्राफिक्स का स्पर्शनीय ग्राफिक्स (TGs) में अनुवाद करना है, जो उभरे हुए रेखाओं से बनाये जाते हैं। स्पर्शनीय धारणा स्पर्शात्मक ग्राफिक्स की समझ के लिए महत्वपूर्ण है। प्रभावी स्पर्श ग्राफिक्स बनाने के लिए BVI के छात्रों को TGs के साथ कैसा अनुभव और सीखना है, इसकी गहन समझ की आवश्यकता होती है। यही इस शोध का विषय है।

प्रस्तुत शोध कार्य डिजाइन की आदिमियों से बनी टीजी आकृतियों की भेदभावपूर्णता, स्मरणशक्ति और अर्थ क्षमता की जांच और मूल्यांकन करता है, चाहे वह व्यक्तिगत आकृतियों के रूप में हो या टेबल-टॉप लेआउट में। यह ग्राफिकल और स्थिति / स्थानिक जानकारी और इसकी अवधारण के स्पर्शात्मक धारणा में इन आदिम की भूमिका का मूल्यांकन करता है। यह शोध कार्य सत्यापन परीक्षणों के माध्यम से प्रायोगिक अंतर्दृष्टि के शैक्षणिक उपयोग का मूल्यांकन करने का प्रयास भी करता है। इसके अलावा, यह कार्य स्पर्शनीय ग्राफिक्स में चर ऊंचाई के उपयोग का मूल्यांकन करता है और इसका ग्राफिक्स को अधिक प्रभावी और सहज बनाने के लिए कैसे उपयोग किया जा सकता है।

उपर्युक्त प्रश्नों को विभिन्न स्पर्शिय ग्राफिक डिजाइन रणनीतियों और तत्वों का अध्ययन करके संबोधित किया गया है। प्रयोगों को दो-चरणों में किया गया है: (1) नयी प्रक्रियाओं का उपयोग करके तैयार की गई सुव्यवस्थित चित्रमय उत्तेजनाओं को प्रतिभागियों के लिए प्रस्तुत किया गया था, जिसके बाद मौखिक प्रश्नों या परीक्षण चुनौतीपूर्ण विषयों का उपयोग करके अनुक्रम या लेआउट को बनाया गया। स्पर्श टाइलों की; (2) जानकारी को इन स्पर्शनीय उत्तेजनाओं के सहयोग से प्रस्तुत किया जाता है ताकि यह पता लगाया जा सके कि वे सामरिक अनुभव के सहयोग से मौखिक रूप से प्रस्तुत जानकारी की अवधारण को कैसे सुगम बनाते हैं।

इस काम के परिणाम विभिन्न प्रकार के सूचना मीडिया के लिए दिशानिर्देशों को बेहतर बनाने में मदद कर सकते हैं, मुख्य रूप से स्पर्श ग्राफिक्स में जो अक्सर स्पर्श पुस्तकों और सुलभ इंटरफेस का हिस्सा होते हैं। वे प्रभावी स्पर्श सामग्री के विकास की सुविधा प्रदान कर सकते हैं। इसके अतिरिक्त, अंतर्दृष्टि सीखने और अधिक प्रभावी और आकर्षक बनाने के लिए, नेत्रहीन छात्रों के लिए शिक्षा को आकार देने में मदद कर सकती है।

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