FEELUX: Style Transfer-based Ferrofluid Tactile Touchscreen for the Visually Impaired

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Conventional touchscreen interfaces primarily rely on visual cues, posing substantial accessibility barriers for visually impaired users. This project introduces a tactile touchscreen system enabling users to interact intuitively without visual dependency. By integrating a ferrofluid layer, electromagnets arranged in a grid pattern, and precisely controlled magnetic pulses, three-dimensional tactile shapes of ferrofluid dynamically emerge on the touchscreen surface. Users can physically perceive and interact with these tactile interface elements solely by touch. However, ferrofluid interferes with the accuracy of capacitive touchscreens, in a manner similar to conductive liquids like water. To address this, a U-Net-based artificial neural network called the "Touch Enhancer" was developed. The model utilizes a style transfer approach to convert ferrofluid-distorted touch data into a distribution resembling normal touch input. This significantly reduces positional errors—defined as discrepancies between the detected touch point and the user's actual touch location—by over 80%, with an average inference time of only 4.32 milliseconds. This short processing time ensures effective real-time interaction. In user tests, blindfolded participants successfully located and selected tactile elements with a 91% accuracy rate within approximately 3.5 seconds, confirming the system’s practical usability. Unlike traditional braille displays, this innovation is unique in supporting multiple gesture inputs and rapid real-time interactions while remaining cost-effective. Thus, it holds significant promise for enhancing digital autonomy and touchscreen accessibility for visually impaired individuals.

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