BrailleSense: A Modular, Low-Cost Solution for Accessible Braille Displays

Devkar, Anush (School: Thomas Jefferson High School for Science and Technology)
Malhotra, Ansh (School: Thomas Jefferson High School for Science and Technology)

Braille literacy is essential for educational and professional success among visually impaired individuals. Traditional refreshable braille displays (RBDs), which dynamically raise and lower pins to form braille characters, are expensive and rely on complex piezoelectric actuators, limiting their accessibility. We introduce BrailleSense, a novel, low-cost system for RBDs. Each module features six tactile braille dots arranged in two vertical columns. At the core of each module, a circular drum rotates to encode all possible configurations of a braille column. Protrusions on the drum's surface engage free-moving pins, translating rotational motion into vertical displacements of the tactile dots. Each module uses two micro-DC motors, one for each drum. However, to achieve precise control in drum positioning, the module incorporates a diametric magnet mounted on the drum's cap and an AS5600 magnetic encoder. This encoder provides high-resolution angular feedback, which is processed within a proportional-integral-derivative (PID) control loop. The control system ensures reliable and fast transitions between different drum states. BrailleSense reduces mechanical complexity while enhancing reliability. The system's seamless integration of advanced feedback mechanisms and precise motor control ensures high-speed operation with accurate position tracking. Its modular design is highly scalable, making it an ideal solution for affordable, accessible RBDs. We set a new benchmark for accessibility technologies by delivering a low-cost, high-performance alternative to traditional braille displays. BrailleSense has the potential to significantly improve access to braille technology, empowering visually impaired individuals and advancing braille literacy.

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