# Using BLE (Bluetooth Low Energy) Beacons and 2D (Two Dimensional) Trilateration in a Smartphone Application as an Affordable Positioning System to Assist People Suffering from Severe Vision Loss and Blindness with Indoor Navigation and Spatial Awareness

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Blindness is a severe vision impairment that cannot be corrected. Over 12 million Americans are blind or visually impaired; this will double by 2030 (CDC, 2017). Blindness causes transportation stress, a feeling of anxiety while walking, using public transportation, or navigating, causing the visually impaired to avoid such activities. The elderly have high rates of blindness and lack sensory acuity, making them reliant on visual cues and causing them to struggle with alternative navigation techniques. This experiment uses BLE (Bluetooth Low Energy) beacons and smartphones to ease the transition to blindness. This solution could reduce injury and improve confidence in home and workplace navigation. This experiment develops an indoor positioning system based on BLE trilateration in a smartphone application and tests the accuracy of that system. If verbal signals or other non-visual aids are added, it could be used for a variety of applications, but the main uses investigated were guiding the visually impaired out of buildings in an emergency, increasing spatial awareness in the home and workplace, and aiding navigation in unknown areas. It was found that current technology is unreliable. Measurements calculated by the system were varied and incorrect. Trilaterated points were an average of 8.76m away from actual positions, an unacceptable error. The accuracy of outputted distance values was, on average, off by 57.7%, an unacceptable error. Follow up experiments were conducted to determine reasons for the inaccuracy. Though the system failed to meet requirements, the trilateration algorithm is correct, and similar locationing techniques are used in industry. The adaptation of an affordable, BLE and trilateration based system for aiding the visually impaired is feasible.

**Awards Won:**