January 18, 2017

Sensor Based Auditory And Haptic Guidance System

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ABSTRACT

A system and method are disclosed that use data provided by a mobile device equipped with sensors to guide a human or machine along a vector path through sensory feedback. The system uses motion and depth sensor information and object recognition to create models of an interior space, which facilitate movement for a person who has never been inside a space before, and to use those models for navigation. The method utilizes interior space maps to identify "safe" vectors. A realtime algorithm compares the user's location and direction of movement with the desired path in the model, providing a measure of the deviation. It then plays an auditory and/or haptic signal that focuses the user's attention to follow a safe path in response to the deviation. Using realtime object recognition sensor data allows the detection of spatial obstacles that are otherwise difficult to navigate using traditional solutions for aiding the visually impaired.

BACKGROUND

For persons with visual impairment, finding a safe path from point A to B (to N) is difficult and requires repetitive familiarity with an unchanging environment. Visually impaired persons must use tactile information to walk through unknown interior spaces, for which current solutions include guide railings, use of canes, or seeing-eye dogs. For public spaces this presents a problem in being able to navigate through essential buildings or dwellings. In addition, most approaches for navigating interior spaces do not solve for vertical obstacles (low roofs, signage or other overhead areas). Floor space also has a similar problem where new or unknown path obstacles can create challenges in moving through non-fixed areas.

This problem extends to artificial systems as well. Robots, drones, industrial transports (forklifts, pallet movers etc.) rely on finding boundaries (hitting walls), manual human guidance or fixed rail systems. This results in inefficiencies in preparing spaces because of the requirement to construct fixed movement arrangements (rails) or programming devices to follow rotational counters (number of wheel turns) or acceleration, pitch and yaw programming. In these cases the device, like a visually impaired person, encounters path transversal failure upon a change in the space or presence of obstacles.

DESCRIPTION

A system and method are disclosed that use data provided by a mobile device equipped with infrared, gyroscope, camera and image processing sensors, to guide a human through sensory feedback or control a machine along a vector path. The system uses motion and depth sensor information and object recognition to create models of an interior space. The method then utilizes the interior space models (from cameras, infrared, gyroscope and directional inertia recognition) to match a user or device’s path to a "safe" vector. The method would facilitate movement for a person who has never been inside a space before, and to use those models for navigation, as illustrated in FIG. 1.

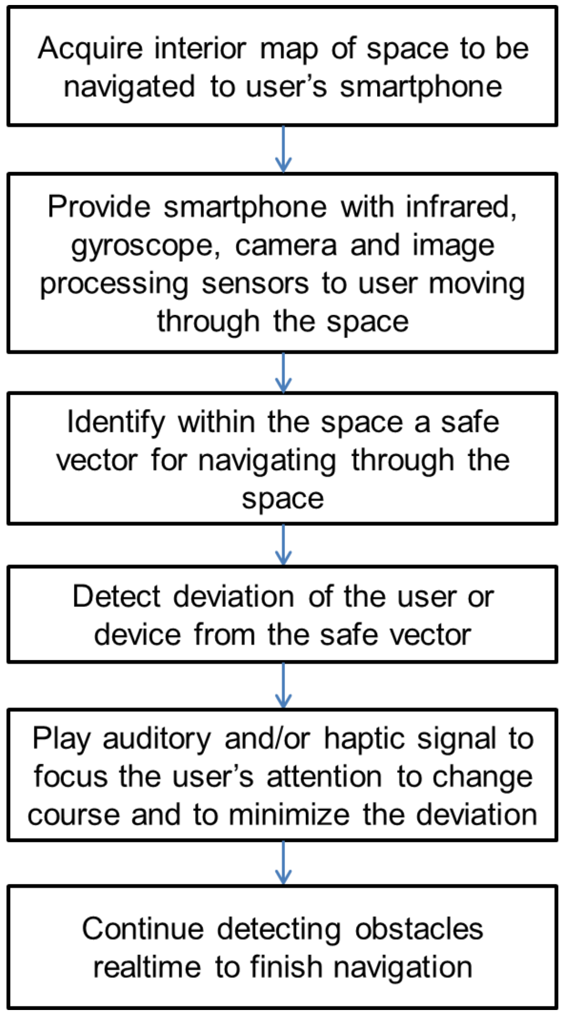

FIG. 1: Method of sensor-based auditory and haptic guidance

A real-time algorithm detects that the user or device is moving in the correct direction and within configurable distance from the safe path. While the user moves through the modeled space, the system compares the user's location and direction of movement with the desired path in the model, providing a measure of the deviation. It then plays an auditory and/or haptic signal that focuses the user's attention to follow a safe path in response to the deviation. Should the user veer from the indicated path, the strength and/or pitch/frequency pattern of the signals rapidly change until the user returns to the path. This process of matching the user's trajectory and the safe path continues in real-time as the user transverses the path.

The output for path matching is a stream of numerical values that correspond to deviation from the path. Those values are used directly as control inputs when guiding machines. When guiding humans, the numerical values may be converted to a stream of audio and/or haptic (vibration) feedback. The system recognizes obstacles in the pathway and provides such feedback accordingly. The system allows the distance or angle at which an obstacle is signaled to be configurable.

If the user's direction of movement intersects with an object on the path (such as an obstacle, another person, or something that changed in realtime), the system will provide audio and/or haptic response (for example, a short buzz of the device's rumblers) to indicate that an obstacle is in the way. In this way, the user is able to 'feel' for the boundaries of the object and navigate around it using the device.

The system utilizes area definition maps (as provided by a device capable of spatial image recording) depth sensors and infrared cameras to recognize a location. The system extends the ability of the user to navigate by creating path models through space as points of interest. A user can intersect with the path and be guided to follow it by way of the audio and haptic signaling.

The system serves artificial devices (robots, drones, transports) by providing a dynamic feed of information that may be interpreted and used to guide the user. Alternatively, instead of an auditory signal, a numerical value could be fed to a hardware drive to correct path transversal and obstacle detection.

Using realtime sensor data and object recognition allows the detection of spatial obstacles that are otherwise difficult to navigate using traditional solutions (seeing-eye animals, canes, etc.). Auditory signaling for humans is an effective natural method for following a path. It has the benefit of a greatly reduced battery and CPU requirement over text-to-speech realtime output and is naturally responsive for humans. The method of using virtual paths as disclosed removes cost and time from constructing artificial pathways.