kiosk fall risk assessment system 100 includes a kiosk 120, a communications network 140, a comprehensive survey system 160, and a gait analysis system 170. The kiosk 120 may include or be coupled to a tablet device ~~120~~ 130 and a depth camera system 150. A user 110 utilizes the kiosk system 120 through a tablet device 130 that is coupled to a communications network 140, such as the Internet or cellular network. An Electronic Caregiver system may be installed on the tablet device 130 configured to provide a comprehensive fall risk assessment for the user 110, as will be described in greater detail throughout the present disclosure. To be sure, the tablet device 130 and kiosk 120 may be replaced with, or take the form of, any suitable computing device, such as those described with respect to FIG. 13. The depth camera system 150 facilitates a functional movement assessment to measure one or more parameters of the user's movement. While not shown, it is to be understood that the kiosk fall risk assessment system 100 may further comprise any number or combination of sensors, including video camera systems, movement sensors, vibration sensors, or the like.

[0026] The comprehensive fall risk assessment is based on results from one or both of the comprehensive survey system 160 and the gait analysis system 170. The comprehensive survey system 160 and/or the gait analysis system may be cloud-based, or comprise one or more remote servers. It is to be understood that the one or more servers providing services for the comprehensive survey system 160 and the gait analysis system 170 may be the same remote servers, separate remote servers, or have one or more shared servers. Through an assessment of the comprehensive survey system 160 and/or the gait analysis system 170, the kiosk fall risk assessment system 100 facilitates providing the user 110 with clinically relevant data describing their overall risk of falling.

[0027] The communications network 140 may include a wireless or wire network, or a combination thereof. For example, the network may include one or more of the following: the Internet, local intranet, PAN (Personal Area Network), LAN (Local Area Network), WAN (Wide Area Network), MAN (Metropolitan Area Network),

gait analysis system 170 will be described in greater detail with respect to FIGS. 4, 5a, 5b, and 6.

[0030] FIG. 2 depicts a high-level block diagram of an exemplary system 200 for providing and processing a comprehensive survey using the comprehensive survey system 160. It is to be understood that the exemplary system 200 may be a portion of the kiosk fall risk assessment system 100 illustrated in FIG. 1. In various embodiments, the comprehensive survey system 160 is coupled with an electronic caregiver derived interactive animated conversational interface system having an interactive, conversational text-based communication system (referred to herein as a conversational interface) 180 and an Electronic Caregiver Image (ECI) avatar 190. Examples of the conversational interface 180 and the ECI avatar 190 are described in related U.S. Patent Application Serial No. 16/169,760 filed on October 24, 2018 and titled "Computing Devices with Improved Interactive Animated Conversational Interface Systems," which is incorporated by reference in its entirety.

[0031] Through the exemplary system 200, the ECI avatar 190 engages with the user 110 to provide a survey comprising a series of questions directed to eliciting information regarding assessing falls risk across a plurality of domains, and receiving the elicited information comprising answers to the questions that are indicative of a risk of falling of the user. The ECI avatar 190 may communicate in multiple languages. The exemplary system 200 provides the user 110 with an option of selecting methods for data input, methods comprising either type-based data entry or voice communication data entry.

[0032] Following the user input of data, including the elicited information, the data may be transmitted from the tablet device 130, to the kiosk 120, through the communications network 140 to the conversational interface 180 and/or comprehensive survey system 160. The conversational interface 180 analyzes the data input and determines redundancy against data input errors. In response to determining an error in the data input, the conversational interface 180 causes feedback to be provided to the user 110 for correction of errors, for example by the

network 140, the conversational interface 180 compares the data type (e.g. yes/no, words, numbers, etc.) of the input to predefined data types stored in a validation utility. Thus, the conversational interface 180 assesses the validity of data input types provided by the user 110. Upon determining the input is valid by the validation utility, the conversational interface 180 activates a progression decision program, which causes the kiosk 120 to move on to the next item contained in the comprehensive survey to be inquired of the user 110. Alternatively, upon determining the input is invalid by the validation utility, the progression decision program is not activated, and instead the conversational interface 180 triggers the comprehensive survey system ~~190~~ 160 to inform the user 110 of the invalid data input. The kiosk 120, via the tablet device 130 and ECI avatar 190, informs the user 110 that the previous data input is invalid and asks the survey question again.

[0039] FIGS. 3a-3c illustrate instances of an exemplary graphical user interface 300 configured to facilitate receiving comprehensive survey responses. FIGS. 3a-3c depict the various decision paths based on input data from the user. It is to be understood that the graphical user interface 300 may be a part of the tablet device 130 depicted in FIGS. 1-2, or another suitable display coupled to the kiosk 120.

[0040] FIG. 3a depicts an initial set of uncompleted form fields displayed to the user 110 on the tablet device 130. FIG. 3b depicts the presentation of input data to the user 110 on the tablet device 130 that has been determined to be valid by the conversational interface 180. FIG. 3c depicts an invalid data input response from the ECI avatar 190.

[0041] FIG. 4 illustrates an exemplary system 400 for providing and processing a gait analysis using the gait analysis system 170. The gait analysis system 170 may include a body tracking module 172 and a movement parameter module 174, as will be described in greater detail below. It is to be understood that the exemplary system 400 may be a portion of the kiosk fall risk assessment system 100 illustrated in FIG. 1. In various embodiments, the kiosk 120 is further configured to facilitate assessing and quantifying one or more spatio-temporal gait characteristics of the

ECI avatar 830 provides a recommendation 820 that the user should consider decluttering his or her home environment to reduce the risk of falling, based on the environment score present in the user's comprehensive fall risk assessment 810. The ECI avatar 830 likewise recommends that the user discuss with a healthcare provider ways in which he or she could increase gait velocity, for example based on the determined spatio-temporal gait characteristic shown in FIG. 6 which is below a normative value threshold. FIG. 9 shows a graphical user interface 900 having an environment survey 910, recommendations 920, and ECI avatar 930. Based on the results of the ~~environmental~~ environment survey 910, in particular the user input that the user has area rugs but no rug-liners underneath, dual-sided tape, or non-skid backs, as well as that the user has floors, stairs, and landings not clear of clutter, the ECI avatar 930 provides the recommendation 920 that the user should replace his or her rugs with non-skid rugs to help reduce the risk of falling.

[0051] FIG. 10 depicts an exemplary ECI avatar 1000 configured to guide the user through the completion of the comprehensive fall risk assessment. The ECI avatar 1000 facilitates guiding the user 110 through the data collection process in a manner that serves three purposes: 1) to reduce user errors in data collection processes performed by the kiosk 120; 2) to provide an interactive method of click-free and type-free communication that is easily completed by the user 110 and 3) to provide both instructions and representative examples of the various tests to be performed by the user 110. For example, as depicted in FIG. 11, the ECI avatar 1100 may provide a representative example of a functional test to be performed by the user. In particular the ECI avatar 1100 depicted in FIG. 11 is demonstrating how the user should properly transition from a sitting position to a standing position such that the kiosk fall risk assessment system is able to adequately record depth information and properly analyze the activity. As such, the kiosk fall risk assessment system may utilize cloud-based resources coupled to the kiosk to allow survey responses to be received and assessed in a manner that is less intimidating than a more traditional laboratory setting or medical professional's office.

[0052] FIG. 12 is a process flow diagram showing a method 1200 for providing a comprehensive fall risk assessment according to one or more example embodiments. The method ~~700~~ 1200 may be performed by processing logic that may comprise hardware (e.g., dedicated logic, programmable logic, and microcode), software (such as software run on a general-purpose computer system or a dedicated machine), or a combination thereof. In one or more example embodiments, the processing logic resides at the kiosk 120, the tablet device 130, the comprehensive survey system 160, or the gait analysis system 170, or combinations thereof.

[0053] As shown in FIG. 12, the method 1200 may commence at operation 1210, with providing a user with a survey comprising questions directed to eliciting information regarding assessing falls risk across a plurality of domains. The user may be provided with the survey via kiosk, and more specifically, an ECI avatar represented by a graphical user interface of a coupled tablet device.

[0054] At operation 1220, the method 1200 may proceed with receiving the elicited information comprising answers to the questions that are indicative of a risk of falling of the user.

[0055] At operation 1230, the method 1200 may include recording, via a depth camera system, depth video data of an activity of the user.

[0056] At operation 1240, the method 1200 may proceed with determining, based on the recorded depth video data, at least one spatio-temporal gait characteristic associated with the activity performed by the user. The determining may include tracking body movements via a body tracking module and calculating the spatio-temporal gait characteristic via a movement parameter module, as previously described. It is to be understood that the calculation of the spatio-temporal gait characteristic may be performed by the kiosk or by a remote server such as the gait analysis system 170 depicted in FIG. 1. In this way, the kiosk may determine the at least one spatio-temporal gait characteristic by transmitting the depth video data to such a remote server for processing, and receiving the spatio-temporal gait characteristics from the remote server.

CLAIMS

What is claimed is:

1. A method for providing real-time assessment of fall~~ing~~ risk, the method comprising:

providing a user with a survey comprising questions directed to eliciting information regarding assessing the fall~~s~~ risk across a plurality of domains;

receiving the elicited information comprising answers to the questions that are indicative of ~~a~~ the fall risk of falling of the user;

recording, via a depth camera system, depth video data of an activity of the user;

determining, based on the depth video data, at least one spatio-temporal gait characteristic associated with the activity performed by the user;

conducting a quantitative fall risk analysis based on the at least one spatio-temporal gait characteristic and the elicited information and further based on at least one environmental score and environment survey, the environment score being personalized home environmental fall risk factors based on user input received in response to the environment survey; and

displaying ~~at least a portion~~using a representation of the ~~quantitative fall risk analysis~~activity to be performed by the user , via an interactive animated conversational graphical user interface and displaying at least a portion of the quantitative fall risk analysis to the user.

2. The method as recited in claim 1, wherein the providing the user with the survey includes presenting the questions with ~~an~~ the interactive animated conversational graphical user interface.

~~3. The method as recited in claim 2, further comprising displaying a representation of the activity to be performed by the user via the interactive animated conversational graphical user interface.~~

~~4~~3. The method as recited in claim 1, wherein the plurality of domains include history, medication, environmental, physical, and vision.

~~5~~4. The method as recited in claim 1, wherein the determining the at least one spatio-temporal gait characteristic includes tracking a position and orientation of the user in the depth video data.

~~6~~5. The method as recited in claim 1, wherein the at least one spatio-temporal gait characteristic includes one or more of a gait velocity, a stride length, a step length, and a step width.

~~7~~6. The method as recited in claim 1, wherein the at least one spatio-temporal gait characteristic includes one or more of a time in stance, a time in swing, a time in double support, a stance time variability, and a swing time variability.

~~8~~7. The method as recited in claim 1, wherein the at least one spatio-temporal gait characteristic includes one or more of a test duration, a turning duration, a sit-to-stand duration, a stand-to-sit duration, a number of sit-to-stand repetitions completed within a predetermined period of time, and a number of stand-to-sit repetitions completed within a predetermined period of time.

~~9~~8. The method as recited in claim 1, further comprising providing, in real-time, consultative recommendations based on the quantitative fall risk analysis.

~~10~~9. The method as recited in claim ~~9~~8, wherein providing the consultative recommendations includes:

accessing a cloud-based normative data storage having normative data, fall risk ratios, and recommendations;

comparing the quantitative fall risk analysis to the normative data and fall risk ratios; and

based on the comparison, selecting a recommendation of the recommendations accessed from the cloud-based normative data storage.

~~11~~10. A system for providing real-time assessment of falling risk, the system comprising:

a mobile kiosk;

a tablet device communicatively coupled to the kiosk;

a depth camera system communicatively coupled to the kiosk;

at least one processor; and

a memory storing processor-executable instructions, wherein the at least one processor is configured to implement the following operations upon executing the processor-executable instructions:

providing, by the tablet device, a user with a survey comprising questions directed to eliciting information regarding assessing the falls~~-~~ risk across a plurality of domains;

receiving, by the tablet device, the elicited information comprising answers to the questions that are indicative of the fall risk~~a risk of falling~~ of the user;

recording, via ~~a~~ the depth camera system, depth video data of an activity of the user;

determining, on the at least one processor, based on the depth video data, at least one spatio-temporal gait characteristic associated with the activity performed by the user;

conducting a quantitative fall risk analysis based on the at least one spatio-temporal gait characteristic and the elicited information and further based on at least one environmental score and environment survey, the environment score being personalized home environmental fall risk factors based on user input received in response to the environment survey; and

displaying, on the tablet device, at least a portion of the quantitative fall risk analysis to the user.

~~12~~11. The system as recited in claim ~~11~~10, further comprising an interactive animated conversational graphical user interface displayed by the tablet device.

~~13~~12. The system as recited in claim ~~12~~11, wherein the at least one processor is further configured to implement ~~the~~ an operation of displaying a representation of the activity to be performed by the user via the interactive animated conversational graphical user interface.

~~14~~13. The system as recited in claim ~~11~~10, wherein the determining the at least one spatio-temporal gait characteristic includes tracking a position and orientation of the user in the depth video data.

~~15~~14. The system as recited in claim ~~11~~10, wherein the at least one spatio-temporal gait characteristic includes one or more of a gait velocity, a stride length, a step length, and a step width.

~~16~~15. The system as recited in claim ~~11~~10, wherein the at least one spatio-temporal gait characteristic includes one or more of a time in stance, a time in swing, a time in double support, a stance time variability, and a swing time variability.

~~17~~16. The system as recited in claim ~~11~~10, wherein the at least one spatio-temporal gait characteristic includes one or more of a test duration, a turning duration, a sit-to-stand duration, a stand-to-sit duration, a number of sit-to-stand repetitions completed within a predetermined period of time, and a number of stand-to-sit repetitions completed within a predetermined period of time.

~~18~~17. The system as recited in claim ~~11~~10, wherein the at least one processor is further configured to implement ~~the~~ an operation of providing, in real-time, consultative recommendations based on the quantitative fall risk analysis.

~~19~~18. The system as recited in claim ~~18~~17, wherein providing the consultative recommendations includes:

receiving a predetermined threshold associated with a domain from a cloud-based normative data storage;

comparing a domain score of the quantitative fall risk analysis to the predetermined threshold;

determining, based on the comparison, that the domain score exceeds the predetermined threshold; and

displaying, if the domain score exceeds the predetermined threshold, a recommendation to the user.

~~20~~19. A non-transitory computer readable medium having embodied thereon instructions being executable by at least one processor to perform a method for providing real-time assessment of fall~~ing~~ risk, the method comprising:

providing a user with a survey comprising questions directed to eliciting information regarding assessing the fall~~s~~ risk across a plurality of domains;

receiving the elicited information comprising answers to the questions that are indicative of ~~a~~ the fall risk ~~of falling~~ of the user;

recording, via a depth camera system, depth video data of an activity of the user;

determining, based on the depth video data, at least one spatio-temporal gait characteristic associated with the activity performed by the user;

conducting a quantitative fall risk analysis based on the at least one spatio-temporal gait characteristic and the elicited information and further based on at least one environmental score and environment survey, the environment score being personalized home environmental fall risk factors based on user input received in response to the environment survey;; and

displaying at least a portion of the quantitative fall risk analysis to the user.