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July 03, 2017

Sensor Configuration for Data Collection in A Voice Activated Computing System

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SENSOR CONFIGURATION FOR DATA COLLECTION IN A VOICE ACTIVATED COMPUTING SYSTEM

Voice activated computing systems provide a user with content or services in response to voice commands spoken by the user. Such systems can capture voice commands from a user, process the voice commands to determine requests and keywords in the voice commands, and provide the user with content or services related to the determined requests and keywords.

As discussed herein, a voice activated computing system manages multiple sensors in one or more devices carried by the user. The sensors can include, for example, location sensors, temperature sensors, light sensors, acoustic sensors, directional sensors, motion sensors, velocity sensors, etc. In some instances, the user may carry multiple devices, such as smartphones, smartwatches, navigation systems, etc., where more than one device include similar sensors. The system can manage the function, capability, and use of these sensors across the user's multiple devices.

For example, in one scenario, the system may need current location information of the user. The system may need this information, for example, in response to a voice command from the user requesting a taxi. The user may carry a smartphone, a smartwatch, a global position system (GPS) navigation device, or other such devices, each of which may include a location sensor capable of providing location information. The system determines the identities of these devices carried by the user. The system may also determine the battery levels of each of these devices. While multiple devices may be capable of providing the location information, the system may only request location information from the device that has the highest battery level. The system may use factors other than, or in addition to, the battery level to determine which device to request the location information from. For example, the system may use factors such

as proximity of the device to the system, degree of accuracy of location information, etc. In a

manner similar to acquiring location information, the system can acquire any other information

that the sensors in the devices carried by the user can provide.

Data Processing System

Sensor manager

Natural language processor

Audio signal generator

Task predictor

Content selector

Service Provider

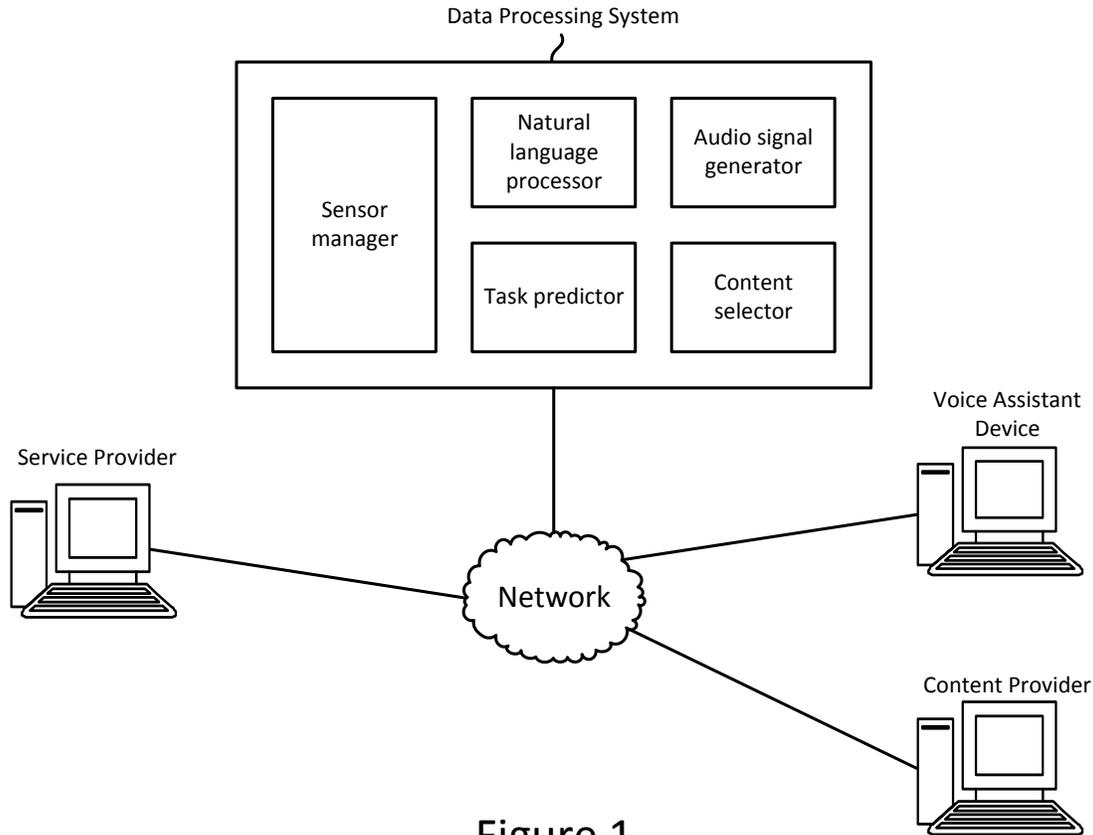Voice Assistant Device

Network

Content Provider

Figure 1

Figure 1 shows an example voice activated computing system. The system includes a

voice assistant device, a service provider, a data processing system and a content provider

communicating over a network. The voice assistant device can be a device that accepts voice

commands, and provides audio or visual output. The voice assistant can include one or more

mics and cameras, such that voice commands received by the user are converted into

corresponding audio signals. The voice assistant can send the audio signals to the data

processing system and the service provider. The voice assistant device also can receive data such as audio signals or video signals from the data processing system or the service provider. The voice assistant device also can include audio speakers that can convert the audio signals received from the data processing system or the service provider into sound.

The data processing system can process voice commands received from the voice assistant device. The data processing system includes a natural language processor, an audio signal generator, a task predictor, and a content selector. The natural language processor is capable of processing voice commands included in the audio signals received from the voice assistant device. The natural language processor can convert the audio signals into recognized text by comparing the audio signals against a stored, representative set of audio waveforms, and choosing the closest matches. The representative waveforms are generated across a large set of users, and can be augmented with speech samples. After the audio signals are converted into recognized text, the natural language processor can match the text to words that are associated, for example via training across users or through manual specification, with actions that the data processing system can serve. Basically, the natural language processor identifies requests and trigger words in the converted text, based on which the natural language processor can determine the content and actions to be carried out.

The task predictor can predict tasks or actions based on the converted text, and in particular by identifying requests and trigger keywords in the converted text. The task predictor also can predict sponsored content related to the converted text. The content selector can select content, such as services or actions to be offered to the user based on the actions identified by the task predictor. The content selector also can communicate with the content provider to obtain sponsored content identified by the task predictor. The audio signal generator can generate audio

signals based on the actions selected by the content selector. The audio signals can be representative of voice responses or voice instructions provided to the user in response to the voice commands.

The service provider can provide one or more service to the user. For example, the service provider can provide weather forecast, traffic conditions, and the like. The service provider can communicate with the data processing system to provide information related to the requested service. Alternatively, the service provider can communicate directly with the voice assistant device independently of the data processing system. The service provider also can include a natural language processor, similar to the one discussed above in relation to the data processing system, to convert user voice commands into text, and identify requests and keywords to determine the services requested by the user.

Referring again to the voice command example mentioned above, the user can speak the voice command "I would like to go to the beach," to the voice assistant device. The mics at the voice assistant device can convert the voice commands into corresponding audio signals, which are be transmitted by the voice assistant device to the data processing system over the network.

At the data processing system, the natural language processor processes the audio signal received form the voice assistant device and identify requests for "beach" and "today." The natural language processor also can identify a trigger keyword "go" or "to go to," which can indicate a need for transportation to the beach. The task predictor can generate actions such as arranging transportation to the beach and providing the weather forecast for the beach.

The content selector can communicate with the service provider, such as a taxi service provider, to request for a ride for the user. In sending the request, the content selector may have

to send the current location of the user to the taxi service provider. As discussed below, the

location information can be received from a sensor selected by the sensor manager.
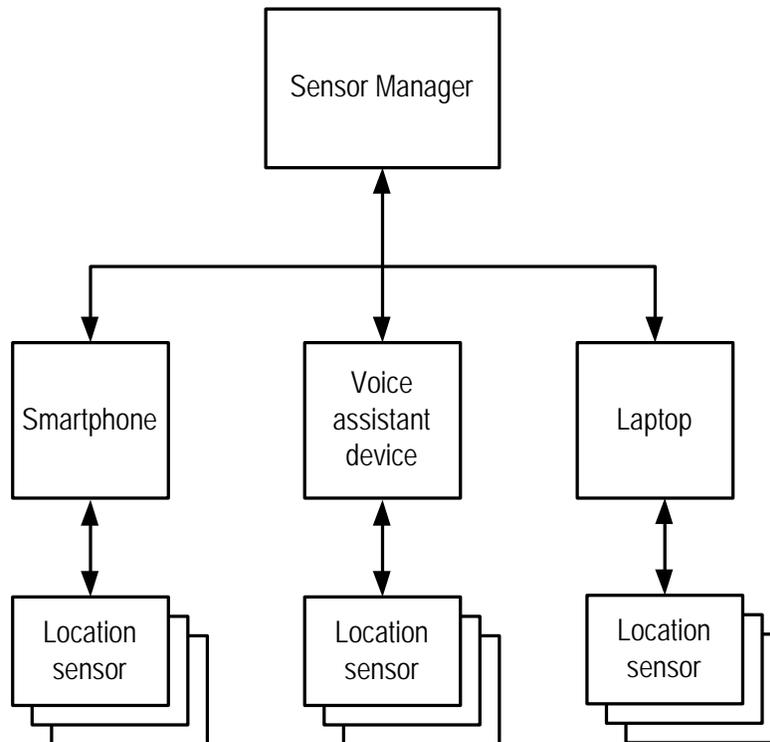

Figure 2

The sensor manager can determine the identities of the devices of the user, and also

determines the capabilities of those devices. As shown in Figure 2 above, the sensor manager

can determine that a smartphone and a laptop, in addition to the voice assistant device, are

associated with the user. Each device includes multiple sensors, one of which is a location

sensor. Of course, each device can include additional sensors, such as temperature sensors, light

sensors, acoustic sensors, directional sensors, motion sensors, velocity sensors, etc. The sensor

manager can maintain a list of sensors included in each device.

As discussed above, the sensor manager can be requested to provide the location

information of the user so that the content selector can send the location information to the taxi

service provider as part of the taxi service request for the user. The sensor manager can determine that two additional devices, the smartphone and the laptop, also include a location sensor. The sensor manager may also refer to past sensor information provided by the location sensors of the smartphone and the laptop to ensure that that the smartphone or the laptop are located within a threshold distance from the user. For example, if past data suggests that the smartphone or the laptop are within 20 meters of the user, then the sensor manager can use the sensor data from these devices with a high degree of certainty of being representative of the actual location of the user. The sensor manager may also determine the resource levels of the smartphone and the laptop. For example, the sensor manager may determine the current battery levels of the smartphone and the laptop, and may additionally determine the amount of power each device may consume in powering up its respective location sensor and providing the location information. Based on these factors, the sensor manager may select one of the smartphone and the laptop for providing the location information. After selecting the device, the sensor manger can poll the sensor of the selected device to provide the location information, which the data processing system can provide to the taxi service provider. Therefore, the sensor manager can request device, other than the voice assistant device, through which the user sent voice commands, to determine location information of the user.

In some instances, the sensor manager can reduce resource utilization by retrieving from memory a measurement previously provided by a sensor and stored in the memory. The sensor manager can ensure that the measurement in memory is not too old, by setting an appropriate threshold time, and accepting the measurement if the measurement is not older than the threshold time.

In some instances, the sensor manager can adjust a configuration of a sensor. For example, the sensor manager may adjust a sample rate, a sample interval, or a sample duration of the measurements provided by a sensor.

In some instances, the sensor manager may disable one or more sensors of one or more devices. For example, the sensor manager may disable the location sensor on the smartphone. The sensor manager may disable the sensor based on the unsatisfactory accuracy, unacceptably low battery levels, or other criteria.

In some instances, the sensor manager can use data collected from one sensor to disable another sensor in the same device or a sensor in another device. For example, the sensor manager may receive unacceptably low battery levels from a battery sensor on the smartphone. Based on this information, and to save power, the sensor manager may disable the location sensor on the smartphone. In another example, the sensor manager may disable the location sensor on the smartphone if a temperature sensor measurement on the smartphone indicates that the smartphone is overheating. In yet another example, the sensor manager may disable location sensors of all but one device, saving power in the devices that have their location sensor disabled.

In some instances, the sensor manager can instruct the smartphone, the laptop, or the voice assistant device to batch upload collected sensor data. The batch upload can include sensor data associated with one or more sensors of the respective device. The sensor manager can store the received sensor data and use the stored sensor data as needed in the future. The devices can be instructed to perform batch uploads at regular intervals, or at particular events, such as powering-up, reconnecting to a Wi-Fi network, or being in the line-of-sight to a GPS satellite.

Abstract

This document describes a technique for managing multiple sensors in one or more devices carried by the user in a voice activated computing system. The sensors can include, for example, location sensors, temperature sensors, light sensors, acoustic sensors, directional sensors, motion sensors, velocity sensors, etc. In some instances, the user may carry multiple devices, such as smartphones, smartwatches, navigation systems, etc., where more than one device include similar sensors. The system can manage the function, capability, and use of these sensors across the user's multiple devices. The system may request sensor data, such as location data, from a sensor on only one of the multiple devices having similar sensors based on resource utilization of each of the multiple devices.