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Audible-to-Infrared Bridging

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Audible-to-Infrared Bridging

Abstract:

Home entertainment devices, such as televisions, stereos, and media players, have, traditionally, been equipped with remote controls so that a user might be able to activate or control the home entertainment device wirelessly. Many remote controls' only wireless communication capabilities are tied to infrared (IR) signaling to control the entertainment device, and as such, are not equipped to respond to communications that might be received through other means. An IR bridge module is described that is capable of "bridging" communications between an entertainment device and another device that might be used as part of home automation, such as a voice-recognizing personal assistant. The IR bridge module receives a wi-fi or ethernet signal from the voice-recognizing personal assistant and, in response, transmits infrared signals to the entertainment device. The IR bridge module may operate in a training mode, during which it learns and maps infrared remote control commands to a voice command. The IR bridge module may also operate in an execution mode, during which it "bridges" active communication and commands between the voice-recognizing personal assistant and an entertainment device.

Keywords:

Internet-of-Things (IoT), home automation, remote control, infrared, bridge, voice-recognizing personal assistant

Background:

Today, with advancements in communication technologies and with computing/sensing electronics embedded in a myriad of devices, the ability for devices to collect and exchange data

with one another is escalating. Devices such as smart phones, voice-recognizing personal assistants, computers, automobiles, home entertainment systems/appliances, and the like, are able to communicate with one another either directly, in a machine-to-machine environment, or indirectly over a network. Such communications and exchange of data across the myriad of devices is commonly referred to as the Internet-of-Things (IoT). The communications and exchange of data can have purposes that include, for example, collecting usage data for vendor analytics, remote initiation/shut-down of an operating system, automating a home environment, monitoring a person's health, and so forth.

A view of an example IoT environment is represented in Fig. 1 below:

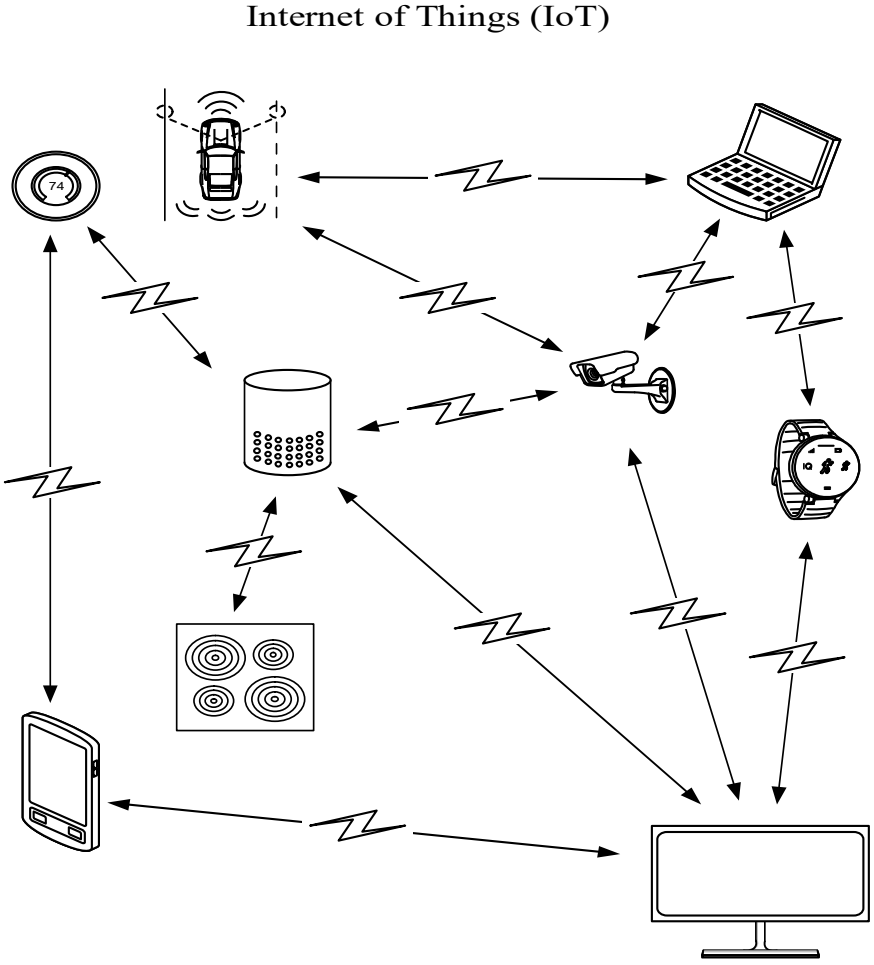

Fig. 1

In the IoT environment of Fig. 1, data may be collected by sensors of a device and shared with another device. Processing of data may be performed local to the device collecting the data or remote from the device collecting the data. Combinations of hardware (*e.g*, sensors, microprocessors, memory), software (*e.g.,* algorithms, GUI's), and services (*e.g.*, communication networks) may be used to sense, collect, and exchange data. Large amounts of data are expected to be exchanged, as part of the IoT, across a horizon that is developing and changing frequently.

A particular aspect of the IoT environment may include using a voice-recognizing personal assistant to communicate to a bridge module equipped with infrared (IR) communication capabilities. The IR bridge module may, in turn, communicate with an entertainment device, such as a television, a stereo, a soundbar, or a DVD player, using its infrared communication capabilities to control the entertainment device.

Description:

Capabilities of voice-recognizing personal assistants, a combination of voice-recognizing applications and two-way speakers, are rapidly advancing. Generally, a voice-recognizing personal assistant is capable of interacting with other devices of an environment, inclusive of interactions that might be realized in a shared environment or in a remote environment via communications over the internet.

In addition to presenting media (such as music streamed from the internet), or accessing a variety of information (movie schedules, trivia, news), voice-recognizing personal assistants are capable of supporting home automation. For any device that is able to communicate with the voice-recognizing personal assistant, either directly or indirectly using communications supported by wi-fi, ethernet, Bluetooth ®, and the like, the voice-recognizing personal assistant may, in

response to an audible command, control the device. For example, the voice-recognizing personal assistant may send a wi-fi signal to a wi-fi capable thermostat, via a wireless router in a shared environment, which is effective to set a temperature of the thermostat. As another example, the voice-recognizing personal assistant may send, via an ethernet connection, a message to turn on an ethernet-capable alarm system. Signals may, in some instances, be exchanged directly between the voice-recognizing personal assistant and a device or, in other instances, be exchanged indirectly via a cloud-based service.

Certain home devices, in particular older entertainment equipment such as televisions, DVD players, sound bars, and the like, rely exclusively upon infrared (IR) technology (*e.g.*, IR remote controls) within the environment for any type of control and cannot be controlled via other technologies (wi-fi, ethernet, etc.). Such devices are currently stranded from the home automation advancements, not capable of interfacing with a device such as the voice-recognizing personal assistant. An IR bridge module, capable of communicating with the voice-recognizing personal assistant and also capable of providing IR signals, resolves this challenge, allowing "IR-only" devices to be integrated into an automated home environment. The IR bridge module may, in certain instances, serve to completely replace a remote control or groups of remote controls within a home.

In one aspect, the IR bridge module may include several components for functionality, including a microprocessor component (logic), a memory component (DRAM, NAND, NOR, etc), an IR blaster (transmitter), and IR reader (receiver), and a transceiver (wi-fi, ethernet, Bluetooth ®, etc.) to communicate with a voice-recognizing personal assistant. The IR bridge module functions in two primary modes, a "training" mode and an "active" mode. A block diagram of basic components of the IR bridge module are represented in Fig. 2 below:

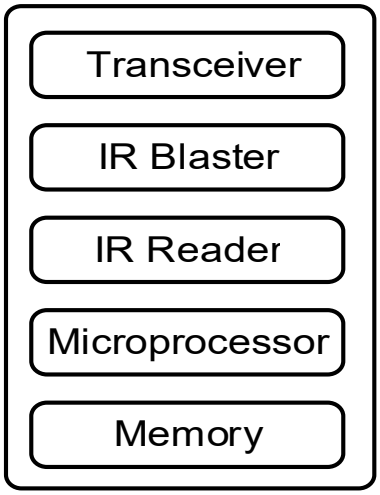

Fig. 2

In the training mode, data necessary for IR communication with a specific device (such as a television) is instilled in the IR bridge module. Such information, similar to "pairing" a remote control with a specific device, may include IR communication parameters such as frequency, modulation, or protocols, as well as device identification information (make, model, serial number, etc.) The data may be instilled by any combination events, including the IR bridge module sending IR signals (via the IR blaster) to and receiving IR signals (via the IR receiver) from) a device which it is trying to learn. While in training mode, audible commands may also be "mapped" between the voice-recognizing personal assistant and the IR bridge module, where an audible command may be correlated with a specific IR command.

Data may also be instilled in whole, or in part, based on data downloaded to the IR bridge module from a cloud-based service or from the voice-recognizing personal assistant. Multiples of devices may be learned by the IR bridge module, allowing the IR bridge module to support more than one device as part of home automation.

A use of a voice-recognizing personal assistant, in combination with an IR bridge module, is illustrated in Fig. 3 below:

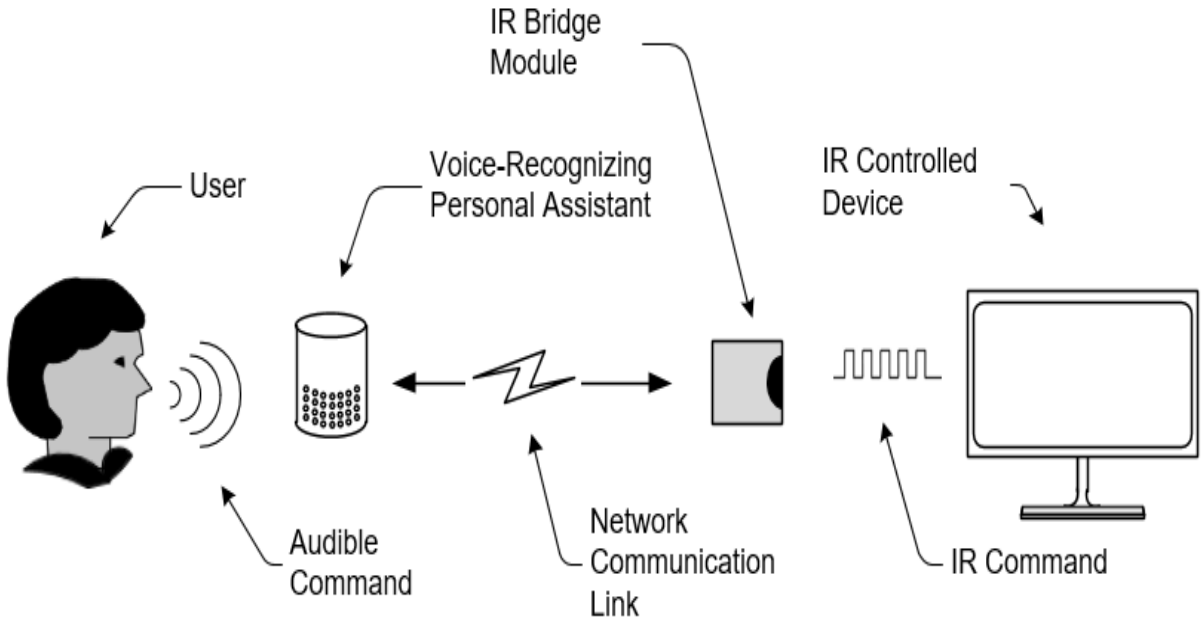

Fig. 3

The voice-recognizing personal assistant can be a dedicated device, such as a smart speaker, or integrated into another device, such as a smart phone or a smart watch. As displayed in Fig. 3, a user issues an audible command to a voice-recognizing personal assistant. The voice-recognizing personal assistant then recognizes, either via a method that is completely local to the voice-recognizing personal assistant or via a method that relies on a cloud-based service, the audible command. The voice-recognizing personal assistant then sends, over a network communication link, a signal to the IR bridge module. The signal sent to the IR bridge module indicates the IR command the IR bridge module is to communicate to the IR controlled device. For example, the command could be “turn on”, “turn off”, “turn to my favorite station”, etc. After

receiving the signal, the IR bridge module then transmits the indicated IR command to the IR controlled device.

Additional techniques may be incorporated part of audible-to-infrared bridging. For example, a cloud-based service may maintain a library of IR communication parameters necessary for a variety of devices, enabling a user to download parameters of an IR controlled device directly to an IR bridge module and skip training parameters. Protocols may be implemented on behalf of the cloud-based service provider, managing access to parameters necessary for communication between the IR bridge module and the voice-recognizing personal assistant. Additionally, audible-to-infrared bridging might be limited to specific devices that have been licensed for use with services provided by the voice-recognizing personal assistant.

Audible commands may also be linked, either directly by the voice-recognizing personal assistant or indirectly via a cloud-based services, to preferences or traits of the user. For example, a user may suggest "turn to my favorite station", and based on the user's viewing history or profile, the IR bridge module may be caused to send an IR command to a television or set-top box that changes a station of the television to that of the user's favorite station.

Although the aforementioned material is described in the context of bridging vocal commands to an IR bridge module in order to control an entertainment device, additional permutations of using a voice-recognizing personal assistant to control devices exist. For example, one permutation may integrate a voice-recognizing personal assistant directly with components of an IR bridge module for more direct control of the IR bridge module. Other example permutations may include, for example, use voice-recognizing personal assistant to bridge to devices relying on other communication technologies, such as a ceiling fan or fireplace relying on radio frequency (RF) communications.