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USB POWER MANAGEMENT

Alec Berg

Vincent Palatin

Todd Broch

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ABSTRACT

A power management system identifies a power source and a power recipient between a first device and a second device based on their respective states. The system identifies that the first device and the second device are connected using a universal serial bus (USB) type-C connectors. The system further determines a respective state for the first device and the second device, e.g., tilt or orientation of the devices. Based on the respective states, the system identifies the power source and the power recipient between the first device and the second device, e.g., using pre-stored information from a database. Further, the system causes energy to be transferred from the power source to the power recipient.

PROBLEM STATEMENT

The Universal Serial Bus (USB) standard is utilized to connect two electronic devices for power exchange and communication. There are three families of USB connectors: type A, B, and C.[1] Traditionally, USB power delivery is determined by the connector family. For example, a USB type-B connector draws power from the device it is connected to and the USB type-A connector provides power to a host device. USB type-C is a universal connector that is reversible and is identical on both ends of the cable[2]. The USB type-C connectors as described in USB power delivery (PD) specification can support both the power delivery roles for the electronic device, i.e., power provider and power consumer. USB type-C connectors under USB PD

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[1] *See generally* Dong Ngo, "USB Type-C: One cable to connect them all," CNET, 08/22/2014, available at http://www.cnet.com/news/usb-type-c-one-cable-to-connect-them-all/.

[2] See generally "USB 3.0 Promoter Group Announces USB Type-C Connector Ready for Production," USB.org Press Release, 08/12/2014, available at http://www.usb.org/press/USB_Type-C_Specification_Announcement_Final.pdf.

specification have no physical characteristics that distinguish the "host" or "device" ends and therefore do not designate which device is the power source or power recipient. Therefore, when two devices, both capable of being a power provider and power consumer, e.g., a laptop or a phone, are connected using USB type-C connectors, the power roles of the devices can be initially unknown or random. For example, if two phones are connected together using USB type-C connectors, it may be random which phone is charged and which phone provides the power. A method and system that identifies a power role, power source or power recipient, for two devices connected using USB type-C connector, is described.

USB POWER MANAGEMENT SYSTEM

The system and techniques described in this disclosure relate to a power management system that identifies a power source and a power recipient between two connected devices based on the state of the devices. The power management system can be or include program instructions implemented locally on a client device or implemented across a network, e.g., an Internet, an intranet, or another client device and server environment. The client device can be any electronic device such as a mobile device, a smartphone, a tablet, a handheld electronic device, a wearable device, laptop, etc.

Fig. 1 illustrates an example method 100 for identifying a power source and a power recipient between a first device and a second device based on their respective states. Method 100 can be performed by a system that determines the respective power roles of devices and causes the transfer of power between the devices, e.g., a power management system.

As shown in Fig. 1, the system identifies that a first device and a second device are connected (block 110). The first and second device may be connected together with a cable. The cable can comprise of USB type-C connectors on both ends to connect the first and second devices. Fig. 2, block 210, illustrates device A connected to device B by a USB cable with type-C connectors.

The system further determines a respective state for the first device and the second device (block 120). The state of a device can refer to any condition of the device. The system can analyze the outputs from sensors, e.g., accelerometers, gyroscopes, altimeters, proximity and touch sensors, in the device to determine the device’s state. One such state is the spatial orientation of the device. For example, in one implementation, the system can determine a tilting level of the device. The system may use the device’s gyroscope to measure the device’s degree of tilt with respect to a horizontal and/or vertical axis of the device. For example, the first device may be placed flat on a table and the second device may propped at a certain angle with respect to the horizontal axis. The system therefore determines that the second device has a greater level of tilting than the first device. Alternatively or additionally, the system may determine the relative heights of the devices. For example, the system may use the device’s accelerometer to determine if the device has been lifted. For example, the second device may be lifted from the floor and placed on a table whereas the first device is left on the floor. The system therefore determines that the second device is at a greater height compared to the first device.

The state of a device can also be a movement of the device. The user of the device can perform a physical movement of the device to establish the device’s state. Example movements include turning the first device face down while the second device is face up, shaking the first device while the second device is stationary, raising the first device higher than the second device, and rotating one device relative to the other device. For example, the user of the devices may place both devices on a table parallel to each other, and then rotate the top of one device 30-50 degrees towards the other device. The state of a device can also be a user gesture at the device. Example gestures include swiping the screen of the first device towards the screen of the second device, moving the user's hand from the first device toward the second device, and covering the second device. Other examples of the state of the device may include device in a sleep mode, device in an active mode, device with a closed lid or flap, or device having lid open, etc. In some implementations, the system determines the state of a device from a combination of one or more of: the spatial orientation of the device, movement of the device, and user gesture at the device.

Based on the respective states of the devices, the system identifies a power source and a power recipient between the first device and the second device (block 130). The power recipient refers to the device that receives the energy transferred from the power source. The power source refers to the device that transfers its power to the power recipient. The state of a device can be mapped to a designation of whether the device is the power source or the power recipient. For example, the system can determine a device's power role from a lookup table or other database that associates device states with a power role, i.e., power source or power recipient. The lookup table or database can include possible spatial orientations (e.g., tilt and height), device movements (e.g., raising, turning, shaking), and user gestures at the device (e.g., swiping) mapped to a power role. For example, a tilted device state, an elevated device state, and a device that is raised, turned, or shaken can be mapped to the power source role or the power recipient role.

The assignment of the power role to the various possible device states may be determined automatically by the system. For example, the system can be provided with the possible device states and the system assigns a power role to each of the possible device states. The system can assign the power roles randomly or algorithmically based on signals that indicate the likelihood that the device is to assume a power recipient or power source role. Alternatively, the power role for the various possible device can be set by the user. For example, the user can provide a list of possible device states and their associated power roles as identified by the user. In one implementation, the power management system of each device attempts to determine a power role for its respective device. After a power role is determined for one device, the other device automatically assumes the other role.

The system causes energy to be transferred from the power source to the power recipient (block 140). Energy from the power source is transferred to the power recipient. The energy transfer can take place until a state of one of the devices changes, e.g., a battery charge level state, a spatial or positional state, etc. The state of the first and second devices can also be changed so that their power roles are reversed. For example, the first device which is acting as the power source for the second device is moved lower than the second device. The second device becomes the power source and the first device becomes the power recipient, thereby reversing the flow of energy to the first device.

Fig. 2 illustrates example device states and the power roles assigned to the devices. In Block 220, device A is placed horizontally and the device B is tilted or rotated a certain angle with respect to the device A. The system identifies device B as the power source and device A as the power recipient based on their respective orientation states, as described above, and causes energy to be transferred from device B to device A. In Block 230, a user lifts device A higher that device B. The system identifies device A as the power source and device B as the power recipient based on their respective movement states, as described above, and causes energy to be transferred from device A to device B. In Block 240, a the user places device A upside down and device B right side up. The system identifies device A as the power source and device B as the power recipient based on their respective movement states, as described above, and causes energy to be transferred from device A to device B. Alternatively, device A may be identified as the power recipient and device B as the power source.

The subject matter described in this disclosure can be implemented in software and/or hardware (for example, computers, circuits, or processors). The subject matter can be implemented on a single device or across multiple devices (for example, a client device and a server device, or multiple peer devices). Devices implementing the subject matter can be connected through a wired and/or wireless network. Such devices can receive inputs from a user (for example, from a mouse, keyboard, or touchscreen) and produce an output to a user (for example, through a display). Specific examples disclosed are provided for illustrative purposes and do not limit the scope of the disclosure.

DRAWINGS

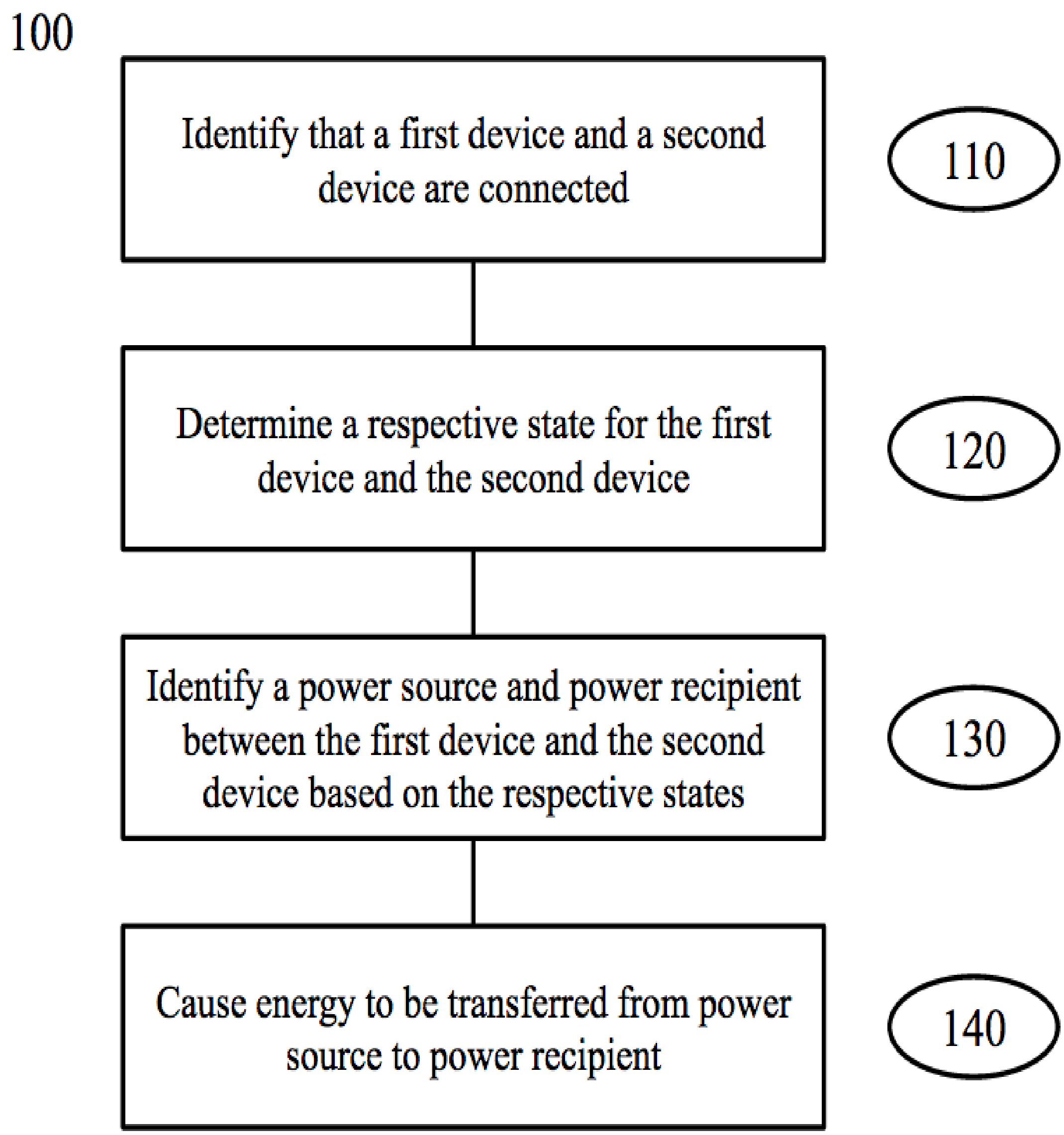

Fig. 1

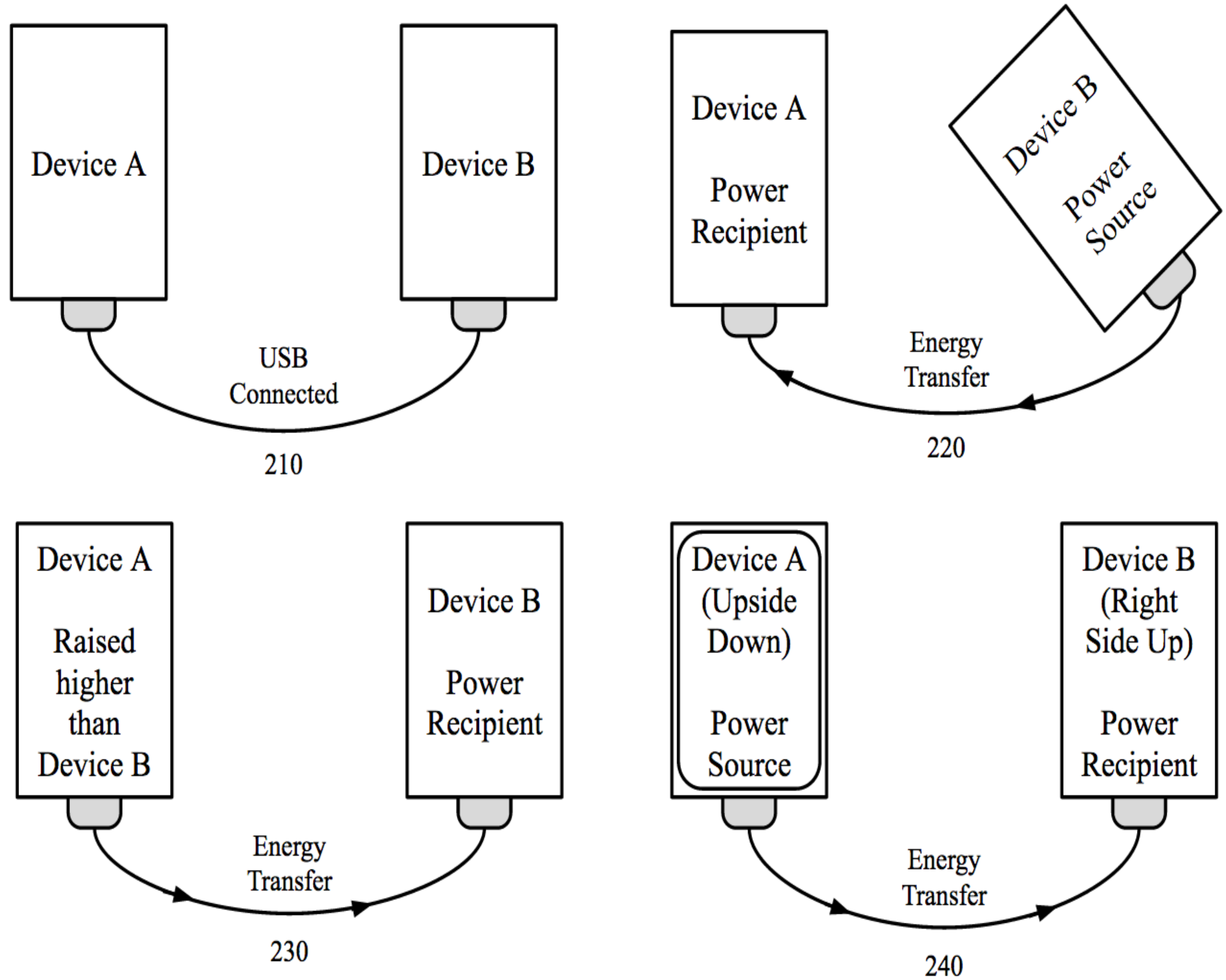
Device A
Device B
USB
Connected
210
Device A
Power
Recipient
Device B
Power
Source
Energy
Transfer
220
Device A
Raised
higher
than
Device B
Device B
Power
Recipient
Energy
Transfer
230
Device A
(Upside
Down)
Power
Source
Device B
(Right
Side Up)
Power
Recipient
Energy
Transfer
240

Fig. 2