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Low Power State To Avoid Battery Damage Due To Excessive Drain

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ABSTRACT

Rechargeable batteries in portable devices can be damaged permanently and become unrecoverable when completely drained. Such a situation arises when a device is left idle for a long period of time. This disclosure describes techniques to prevent battery damage during extended idle periods. When an idle state is detected, a low power state is selected for the computing device based upon a battery state of charge. The selection of the state is based on a comparison of the measured remaining battery capacity with a predetermined threshold. If the battery state of charge meets the threshold, the computing device is placed into a hibernation state and an embedded controller (EC) is shut down to conserve battery power. If the battery state of charge does not meet the threshold, the computing device is placed into a sleep state. In the sleep state, the embedded controller periodically monitors the battery state of charge, and disconnects the battery if the battery state of charge falls below a critical level.

KEYWORDS

- Rechargeable battery
- Battery management
- Idle state
- Hibernate
- Battery life
- Embedded controller
- Sleep state
- State of charge (SOC)

BACKGROUND

Rechargeable batteries in portable computing devices such as laptops, mobile phones, etc. can be damaged permanently and become unrecoverable when completely drained. In some idle states, computing devices are set to a state wherein an embedded controller (EC) monitors a battery state of charge. Commonly, controllers are utilized in the computing devices to disconnect a battery upon detection of a battery charge state that is critically low to prevent permanent battery damage. However, in some idle states, computing devices are placed in a state of hibernation in which hardware components including the EC are shut down to conserve power and prolong battery life. Hibernation states are effective for computing devices that are in relatively frequent use, e.g., at least once a day, at least once a week, etc.

However, some computing devices can remain in a state of hibernation for a relatively long period. For example, laptop computers used in schools can be placed in hibernate mode at the beginning of the summer break and can stay in that state until the school reopens. Continuous battery discharge during a state of hibernation, even if occurring at a slow rate, can lead to permanent battery damage. This occurs since in a state of hibernation, the EC is shut down and the battery crossing a critical battery level state goes undetected without the battery being disconnected.

DESCRIPTION

This disclosure describes techniques to prevent battery damage in computing devices that experience extended periods of disuse while also providing power conservation during idle states.

When an idle state is detected in a computing device, one of a hibernation state and a sleep (deep sleep) state is selected based upon a measured remaining battery capacity (battery

state of charge). The selection of the state is based on a comparison of the measured remaining battery capacity with a predetermined threshold that is indicative of discharge characteristics of the battery.

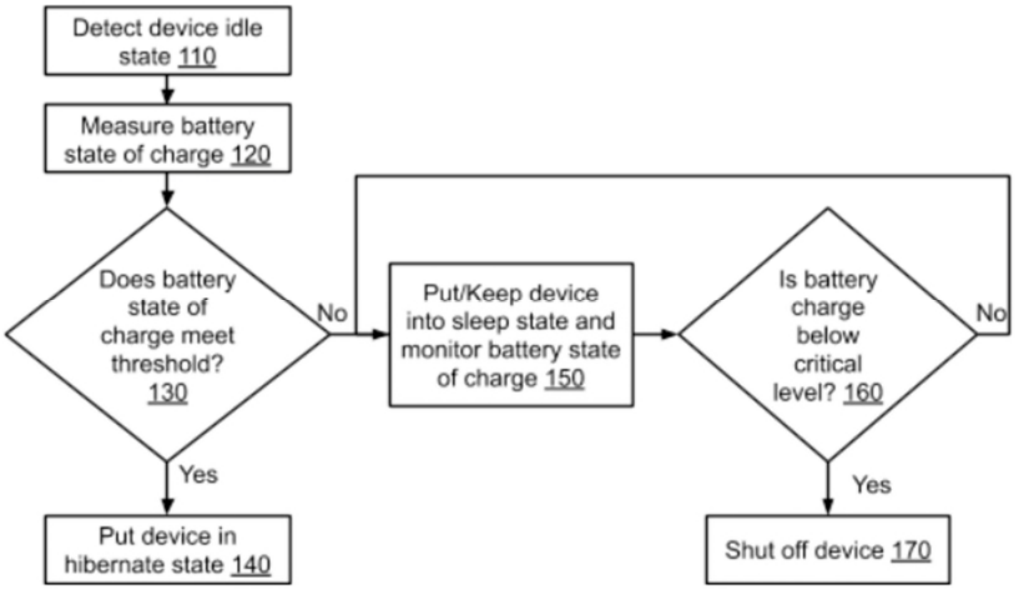

Fig. 1: A low power state is selected based on a battery state of charge

Fig. 1 illustrates a flowchart of an example selection of a low power state, per techniques of this disclosure. A computing device that enters an idle state is detected (110). A battery state of charge is measured (120). The battery state of charge is compared (130) to a predetermined threshold. The threshold is selected based on the discharge characteristics of the battery over an expected period of disuse of the computing device, e.g., a summer break of 90 days. For example, if it takes 90 days for the battery to discharge from a 25% state of charge to a critical battery level of 3%, the threshold is set to 25%.

Based on the comparison, if the battery state of charge meets the threshold (exceeds 25%), the computing device is placed in a hibernate state (140). The EC is shut down. The

battery state of charge exceeding 25% enables the battery charge to remain above the critical battery level for the duration of the period of disuse, without any intervention by the EC.

If the battery state of charge does not meet the first threshold (is less than or equal to 25%), the computing device is placed into a sleep state (150). In the sleep state, the battery state of charge is monitored by the EC, e.g., activated by an internal or external timer . Periodically, the battery state of charge is compared to a battery critical level (160). If the battery state of charge falls below the battery critical level, the battery is disconnected and the computing device is shut off (170) to prevent permanent to the battery damage.

Alternative to the described techniques, a battery level gauge can be configured to automatically cut off the battery when it is measured to be below the critical level. However, this requires that battery level gauge be able to either cut off the battery itself, or instruct the EC to cut off the battery. Further, when there is a current spike, the battery gauge may measure the charge level incorrectly and take premature action to cut off the battery, which can result in unnecessary sudden shutdown of the computing device. Still alternatively, hibernation mode can be disabled and the device can be turned off upon detecting that the battery is below the battery critical level. However, doing so can lead to the device consuming more power and therefore, needing to be turned off earlier than if the device were configured to use the hibernate mode.

The described techniques can be implemented in any computing device that includes a battery, e.g., laptop, tablet, etc. The techniques are suitable in contexts where devices are left idle for long periods of time, e.g., during school holidays, or other long breaks.

CONCLUSION

This disclosure describes techniques to prevent battery damage during extended idle periods. When an idle state is detected, a low power state is selected for the computing device based upon a battery state of charge. The selection of the state is based on a comparison of the measured remaining battery capacity with a predetermined threshold. If the battery state of charge meets the threshold, the computing device is placed into a hibernation state and an embedded controller (EC) is shut down to conserve battery power. If the battery state of charge does not meet the threshold, the computing device is placed into a sleep state. In the sleep state, the embedded controller periodically monitors the battery state of charge, and disconnects the battery if the battery state of charge falls below a critical level.