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Proactive Prevention and Mitigation of Saltwater Damage for Portable Devices

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ABSTRACT

This disclosure describes techniques to mitigate the effects of fluid submersion on electronic devices such as mobile phones. Per techniques of this disclosure, with user permission and express consent, user context data is utilized to determine a likelihood of a user device being proximate to a saltwater body. Mitigating actions such as disabling the charging port of the device are automatically performed. If fluid submersion is detected, the duration of submersion is determined and a duration of time before the device undergoes damage is determined. Additional information, such as information about repair shops, may be provided to the user based on the extent of damage to the device. The device may be put in a low-power mode in order to extend the battery life of the device while the charging port is disabled.

KEYWORDS

- Water damage
- Fluid damage
- Ionic fluid
- Salinity
- Corrosion
- Saltwater
- Reverse bias
- Waterproof device
- Water submersion
- Charging port

BACKGROUND

Many portable electronic devices are designed to withstand some extent of submersion of the device into fluids such as water. The devices are designed such that a submersed device can continue to function effectively, so long as the device is dried and water is effectively removed from the device, e.g., via a drying method like pat-drying with a towel.

However, many designs that protect a device from water damage are mainly effective under freshwater exposure. The chemical reactivity (e.g., thermodynamic and kinetic) can be greater if the device (including its charging port and/or other ports) is exposed to salt-water or other ionic fluids. When submerged in an ionic fluid (e.g., ocean water), exposed electrodes of a device can be irreversibly rusted at a faster rate when compared to submersion in freshwater (e.g., a lake).

When a device has been exposed to water, it is feasible for a user to allow the device to air dry before using a device port. While this may be effective for freshwater submersion, it may not mitigate corrosion damage due to ionic fluid ingress. For example, when saltwater dries, salt can remain deposited onto the electrode surface and can recombine with the humidity in the air to further continue the corrosion process.

DESCRIPTION

This disclosure describes techniques to mitigate the effects of fluid submersion on electronic devices such as mobile phones. Per techniques of this disclosure, with user permission and express consent, user information obtained from a mobile phone is utilized to determine a likelihood of the user being proximate to a saltwater body. Mitigating actions are undertaken based on determination of the user context.

Fluid submersion is detected based on voltage measurement on the configuration channel (CC) lines of the USB port of the device. In the event that fluid submersion is detected, a warning is provided along with a determination of the duration of submersion. Additional information may be provided to the user based on user context and the estimated extent of damage to the device.

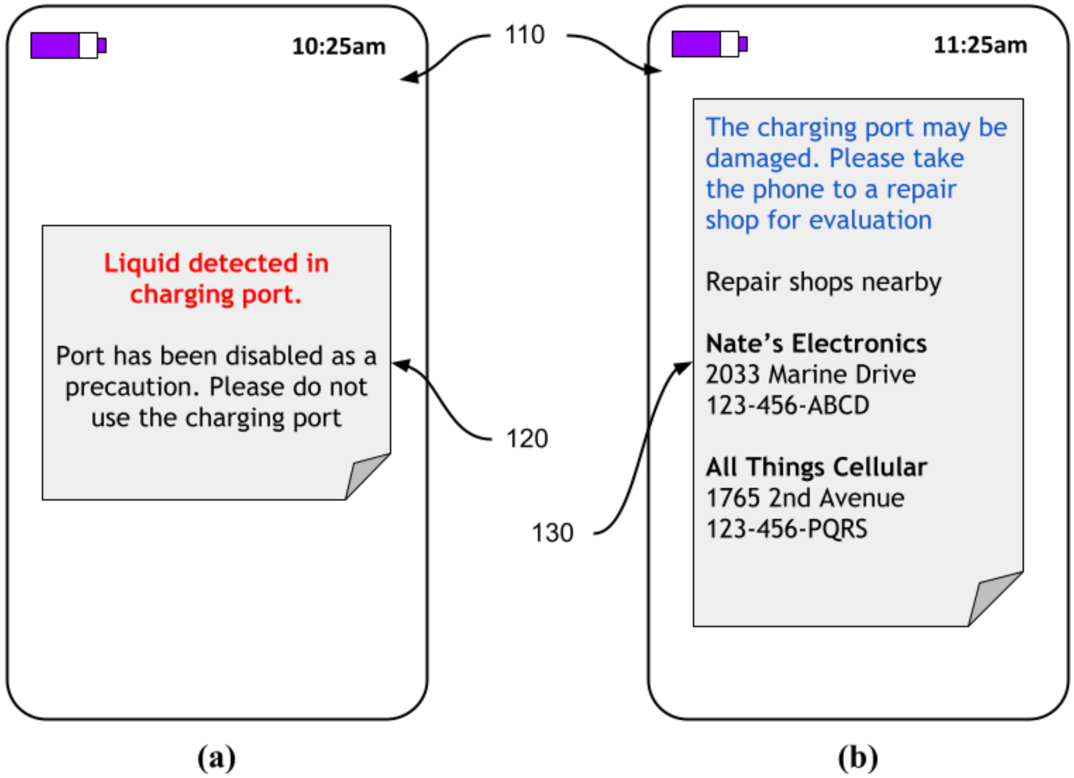

Fig. 1: Notifications provided to a user based on submersion detection

Fig. 1 depicts an example of notifications provided to a user upon detection of fluid submersion, per techniques of this disclosure. As depicted in Fig. 1(a), a notification is provided to a user when device submersion is detected. Mitigating actions such as disabling a charging port, e.g., USB port, are also performed. Fig. 1(b) depicts an example notification provided to the user subsequent to determination that the device is no longer submersed in fluid, but that a risk of corrosive damage remains high. Optionally, based on the device location, a list of repair shops that are nearby may be provided to the user. The notifications may be provided in a low power mode in order to preserve the device battery while the charging port is disabled.

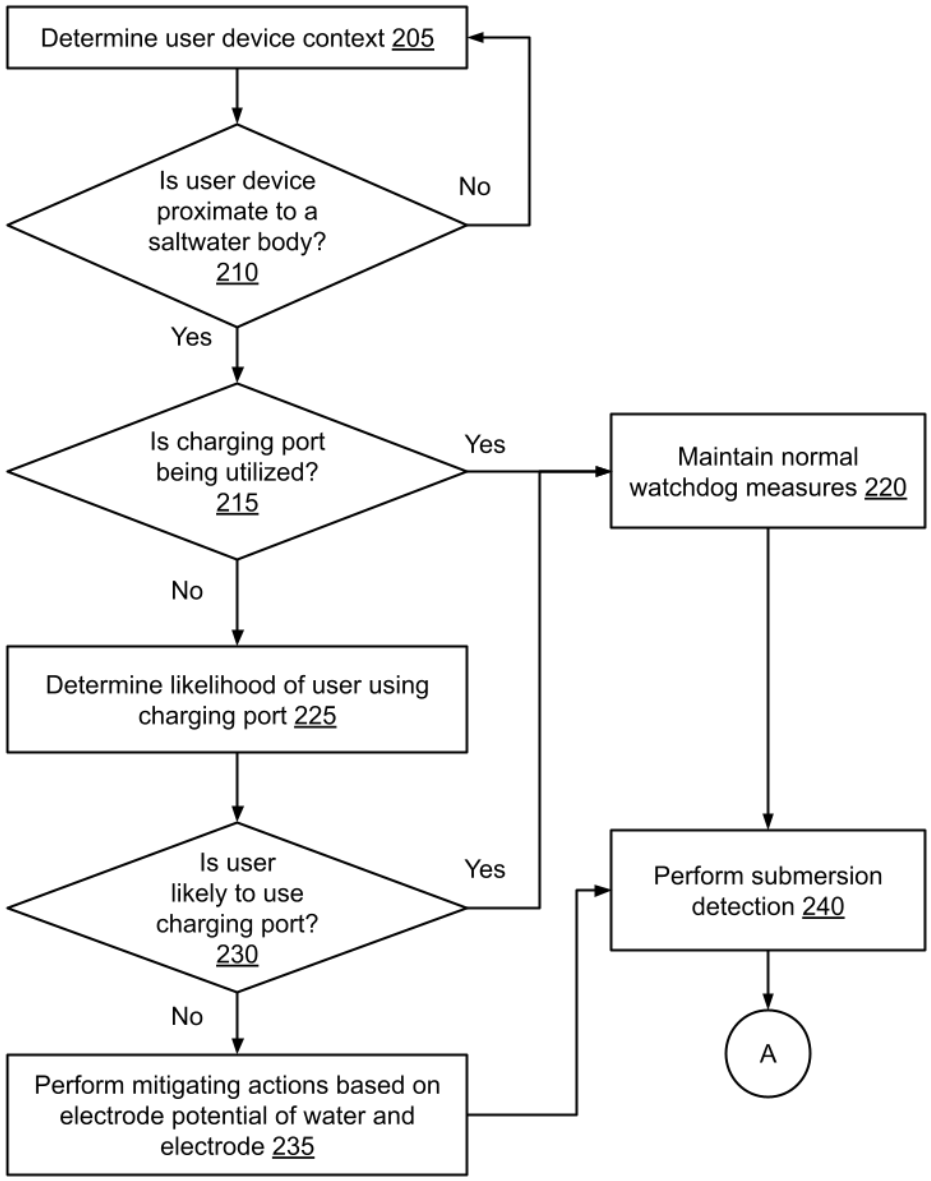

Fig. 2A: Contextual mitigation of damage from device submersion

Fig. 2A depicts an example workflow to perform context-based monitoring of device submersion, per techniques of this disclosure. With user permission and express consent, the user device context is determined (205). For example, location information of the user device is utilized to determine whether the user device is proximate to a saltwater body (210). If it is determined that the device is not proximate to a saltwater body at the time, the determination may be repeated periodically, until the user device moves away from the location.

If it is determined that the user device is proximate to a saltwater body such as an ocean, it is determined whether the charging port of the device is being utilized (215). If it is determined that the charging port of the device is being utilized, watchdog measures are maintained (220), and submersion detection is performed (240) based on moisture detection.

If it is determined that the charging port of the device is not being utilized, a likelihood of use of the charging port is determined (225) based on the user context, obtained with user permission. For example, device battery trends, current software application (app) usage, user location (e.g., a user located on a beach may be unlikely to utilize a charging port), etc. are utilized to determine the likelihood of use of the charging port.

If it is determined that the user is unlikely to use the device charging port, mitigating actions are performed (235). The electrodes of the device charging port can be preemptively reverse biased based on the electrode potential of the water body. The electrode potentials can be determined based on the salinity of the water body, which can be obtained via online databases.

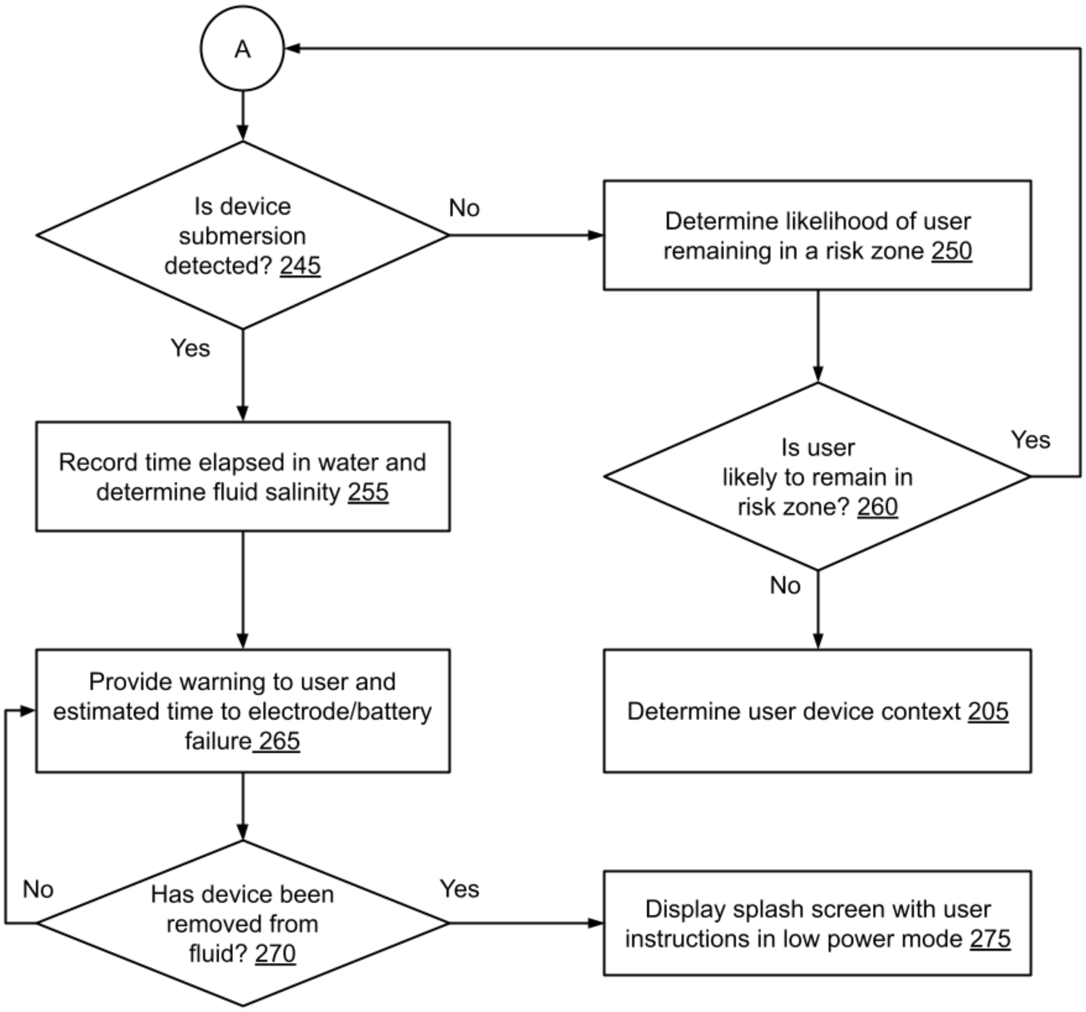

Fig. 2B: Actions are undertaken subsequent to detection of device submersion

Fig. 2B depicts an example workflow for actions undertaken subsequent to detection of device submersion, per techniques of this disclosure. If device submersion is not detected (at 240 of Fig. 2A), the likelihood of the user remaining in a zone associated with submersion risk is determined (250). If it is determined that a likelihood of the user remaining in a zone associated with submersion risk meets a threshold risk (260), submersion detection is performed periodically. If it is determined that a likelihood of the user remaining in a zone associated with submersion risk is low, block 260 is followed by block 205 and the user context is determined.

If device submersion is detected (245), the charging port is disconnected from the main circuit. A timer is started to determine the duration of submersion. Based on the salinity of the water, a duration of time before the device possibly undergoes irreversible damage is determined (255). A warning is provided to the user (265) via the user device along with an estimate of time to electrode/battery failure.

It is further determined (270) whether the device has been removed from its submersed state. This can be performed using the capacitive touch display, sound pressure feedback from the change in impedance of a speaker, or other techniques. If it is determined that the device is no longer submersed, a splash screen is displayed on the user device (275). In some implementations, based on the remaining battery life of the device, the device can be placed in low power mode and a simplified user interface (UI) can be provided. The splash screen can include the following information:

- Predicted duration of time before the electrodes are fully damaged. This can enable the user to make a decision about next steps.
- A list of repair shops available in the area with their opening hours and phone number to enable the user to record this information separately in the event of the device running out of battery.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs, or features described herein may enable the collection of user information (e.g., information about a user’s devices, device submersion status, battery level, a user’s preferences, or a user’s current location), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used so that personally identifiable information is removed.

For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level) so that a particular location of a user cannot be determined. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques to mitigate the effects of fluid submersion on electronic devices such as mobile phones. Per techniques of this disclosure, with user permission and express consent, user information obtained from a mobile phone is utilized to determine a likelihood of the user being proximate to a saltwater body. Mitigative actions such as disabling a charging port are undertaken based on the determination of user context. The device is monitored for fluid submersion. If fluid submersion is detected in the device, a duration of submersion is determined and a duration of time before the device undergoes irreversible damage is determined. Additional information may be provided to the user based on user context and a determination of an extent of damage to the device. The notifications may be provided in a low-power mode in order to extend the battery life of the device.

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