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Motorized coil wireless charger with coil alignment mechanism

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Motorized coil wireless charger with coil alignment mechanism

ABSTRACT

The disclosure describes techniques to improve power transfer efficiency of a wireless charger through a coil alignment mechanism. A transmitter coil of a wireless charger is configured with step motors and gears, and can travel in a radial motion and towards or away from a central point to align with the receiver coil of a device across the charging surface. Further, the transmitter coil can also be moved in a direction perpendicular with respect to the charging surface which can help optimize the distance from the receiver coil. Charging efficiency and stability between the transmitter and receiver coils are measured using signal strength of packets.

KEYWORDS

- electromagnetic induction
- movable coil
- wireless charger
- inductive charging
- motorized coil
- charging efficiency
- charging mat

BACKGROUND

Devices that include wireless charging features utilize electromagnetic induction between two planar coils. The charging surface that is connected to a power supply includes a transmitter coil that generates an oscillating magnetic field. The magnetic field generated by the transmitter coil couples with the receiver coil within devices such as smartphones, smartwatches, tablets, or other devices to induce current in the receiver coil. Close spacing and alignment between the transmitter and receiver coils ensures efficient power transfer. For example, wireless charging requires alignment of the transmitter coil and the receiver coil within 10mm or less. The requirement that the transmitter coil and receiver coil be aligned places limits on where the user can place devices on the charging surface.

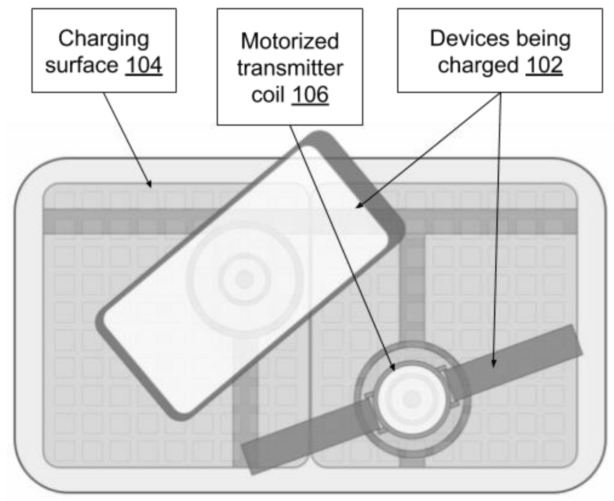

Fig. 1: Motorized coil wireless charger with traditional alignment mechanism

Fig. 1 illustrates an example of a current design wireless charger with a motorized arm with a transmitter coil. The motorized coil wireless charger locates the receiver coil using a matrix of small sensing coils in the wireless charger. When the location of the device (102) placed on a charging surface (104) is determined, the motorized arm and transmitter coil (106) travel vertically and horizontally along the charging surface to align with the receiver coil housed within the device. For example, when a smartphone is placed on a charging surface, sensing coils in the wireless charger locate the receiver coil in the smartphone at position (X_{Rx}, Y_{Rx}). The motorized arm aligns the transmitter coil to the location of the receiver coil. The orthogonal movement of the motorized arm and coil limits the charging surface to a rectangular shape.

DESCRIPTION

Transmitter coil alignment

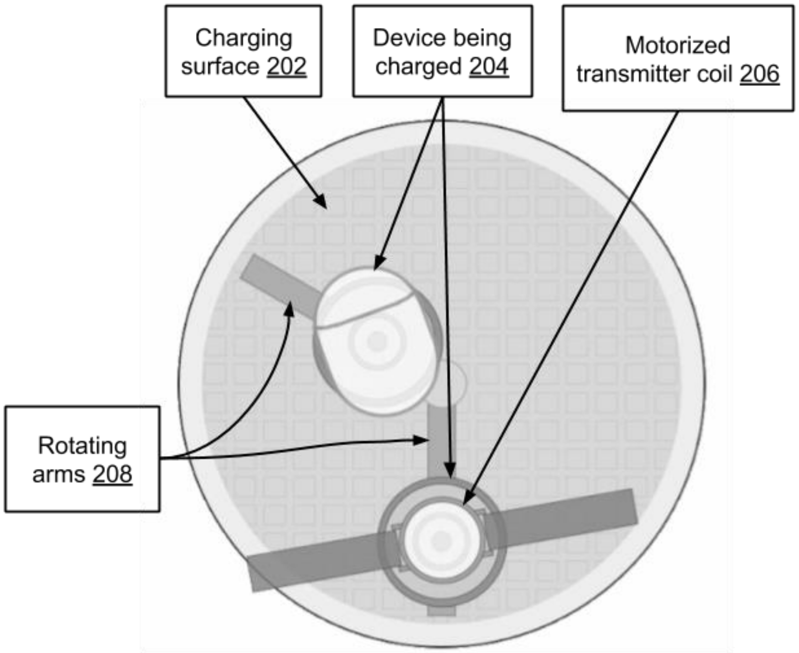

Fig. 2: Motorized coil wireless charger with novel alignment mechanism

Fig 2 illustrates an example of a circular wireless charger with an alignment mechanism in which the motorized arm (208) travel in a radial motion within a circular charging surface (202), per techniques of this disclosure. When devices such as smartphones, smartwatches, tablets, etc. (204) are placed on a charging surface, the motorized arms rotate around the center point of the charging surface. The motorized arms rotate in a direction that results in the shortest delay to align a device placed on the charging surface with a receiver coil housed within the device. The motorized transmitter coils (206) travel along the motorized arm to align with the receiver coil.

For example, the wireless charger detects a smartwatch placed at polar coordinate (r_{watch}, $\boldsymbol{\theta}_{watch}$). The motorized arm rotates to angle $\boldsymbol{\theta}_{watch}$ in the direction that results in the shortest delay to align to the device. The motorized transmitter coil travels to reach length r_{watch} from the center point of the circular charging surface to align with the receiver coil housed within the smartwatch.

Further, the motorized transmitter coil can also travel in a direction perpendicular to the charging surface. Charging efficiency and stability between the transmitter and receiver coil can be measured by techniques such as packet signal strength. Movement of the transmitter coil, including the perpendicular movement, can be implemented with step motors and mechanical structures, e.g., gear sets. For example, if the signal strength packet indicates that the stability and power transfer efficiency for charging a device is not optimal, the transmitter coil is moved perpendicular to the charging surface till the power efficiency reaches the optimal level.

Transmitter coil design

The energy captured by the receiver coil is proportional to the ratio between the coil diameter between the transmitter and receiver coils. A transmitter coil with identical dimensions as the receiver coil improves the magnetic flux captured by the receiver coil, thus maximizing charging efficiency. The design of motorized transmitter coils is optimized to provide high charging efficiency even for receiver coils with different specifications. Design parameters of the transmitter coils include inductance, inner diameter, outer diameter, number of turns, etc. For example, large devices such as smartphones, tablets, etc. and small devices such as wireless headsets, smartwatches, etc. house wireless power charging receiver coils with different specifications. Optimum transmitter coils designed for each device increases coupling factor with the receiver coils for efficient power transfer.

CONCLUSION

The disclosure describes techniques to improve power transfer efficiency of a wireless charger through a coil alignment mechanism. A transmitter coil of a wireless charger is configured with step motors and gears, and can travel in a radial motion and towards or away from a central point to align with the receiver coil of a device across the charging surface. Further, the transmitter coil can also be moved in a direction perpendicular with respect to the charging surface which can help optimize the distance from the receiver coil. Charging efficiency and stability between the transmitter and receiver coils are measured using signal strength of packets.

REFERENCES

1. https://www.youtube.com/watch?v=LZwR19n6EGM