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ELECTROMAGNET INPLEMENTATION IN NOTEBOOKS FOR CONTROLLED OPENING STATES

HP INC

Electromagnet Implementation in Notebooks for Controlled Opening States

Abstract: Replacing some permanent magnets with electromagnets in clamshell and convertible notebook computer devices provides a better and more intuitive clamshell opening action and stay-open state.

This disclosure relates to the field of electronic clamshell products such as notebook computers.

A technique is disclosed that uses electromagnets to provide a better and more intuitive opening action and stay-open state with reduced mechanical system impact on clamshell and convertible platforms.

Many notebook computer systems use a set of magnets to fix the orientation of the lid (containing the display) and the base (containing the keyboard and processor) in certain ergonomic use cases. X360 designs have a double magnet design to support holding the device in both clamshell (0 degree) mode and tablet (360 degree) mode. Currently these are permanent magnets - such as permanent N52 rare earth magnets - which have their magnetic field strength governed by physical volume and magnet grade. These permanent magnets are not switchable.

According to the present disclosure, and as understood with reference to the Figure, the use of electromagnets results in space and weight savings on the system, and also grants the system a degree of control over the magnetic profile of the case. An electromagnet solution can control the presence, strength, and vector of a magnetic field via a hardware solution with minimal software or firmware support required.

An electromagnet is a switchable magnet to support the target operation mode. It comprises a metal core wrapped with a coil of insulated wire. When an electric current is present in the coiled wire, a magnetic field is induced in the axis of the metal core. The strength of the magnetic field is dependent on the current through the wire, as well as geometrical properties of the assembly. It can work in both directions, creating attractive or repulsive forces on a permanent magnet. The magnetic force applied is dependent on current, so the user experience can be fine-tuned by changing the electrical control circuit, rather than only via the mechanical design. When magnetic force is not needed (e.g. when the system is open and running), the electromagnet can be turned off to save on power consumption.

In a conventional notebook device 10, permanent magnets 20 are typically placed on each side of the hinged assembly (base side 4 and display side 2). These magnets 20 attract each other when in proximity, usually when the lid 2 is closed or the device 10 is in a tablet orientation (360 mode). Magnets 20 are usually placed in the front corners of the base 4 and display 2, as far from the hinge as possible to counteract the torsional resistance from friction in the hinge.

In a notebook device 30 according to the disclosed technique, the permanent magnets in the base 4 are replaced with electromagnets 40 with a ferrous core, while leaving the permanent magnets 20 on the display side 2. When the electromagnets 40 are left unpowered, the magnets 20 on the panel side will be attracted to the core of the electromagnet and provide a similar experience as current solutions. Then, when the user intends to open the device, a current passes through the electromagnets 40 to induce an opposing magnetic field to pop open the lid 2. Various methods can be used as triggers for the device 30 to identify an opening event. This same assisted opening solution can be applied on a tablet-style device with a kickstand.

In x360 systems, an additional set of magnets is typically used to attract the external housing covers of the device to each other. These magnets are frequently larger than the aforementioned magnets because a larger distance exists between the two, so a stronger magnetic field is required.

The disclosed electromagnetic technique allows the polarity of the electromagnets 40 to be switched and the strength increased. Current switching is controlled by an H-bridge, similar to reversing an electric motor. As a result, the electromagnet configuration has smaller dimensions than the permanent magnets that it replaces, providing more room in the base 4 for other system components. Power is applied to the electromagnets 40 only when the magnetic force is needed. A Hall Effect sensor identifies the angle of the hinge, and the electromagnet is controlled by the output of that sensor.

A simple control system manages the electromagnets. The inputs are the lid angle and a listener for an opening event, and the output is the current to the magnet. The magnet can be connected to the motherboard and controlled via the IC.

A number of techniques can be used to indicate when the user plans to open the lid. An electrical input, such as a button press or capacitive sensor, could provide user intent information to the system and activate the magnetic assisted opening. Providing a system for assisted opening advantageously allows industrial designers to remove the notch in the clamshell lid intended to assist with opening the device, which in turn improves the aesthetics of the device as well.

Alternatively, the electromagnets could be used as an additional layer of security, clamping the lid closed until a positive fingerprint match is provided from a fingerprint sensor on the external surface of the notebook.

Lastly, an electromagnet toggle can be implemented in software to allow the user to fasten the device to a ferrous surface such as a monitor mount or a refrigerator. This avoids the use of any hardware, preserving system aesthetics. A dock / mount for a tablet system can use an NFC tag to notify the system of the presence of a dock.

The disclosed technique advantageously reduces the magnet impact on notebook system-side mechanical layout, since fewer magnets are needed, and the magnets have smaller footprints. It adds functionality for assisted lid opening, or security clamp locking.
As the electromagnets have controllable magnetic field strengths, the same design can be leveraged on multiple product sizes.

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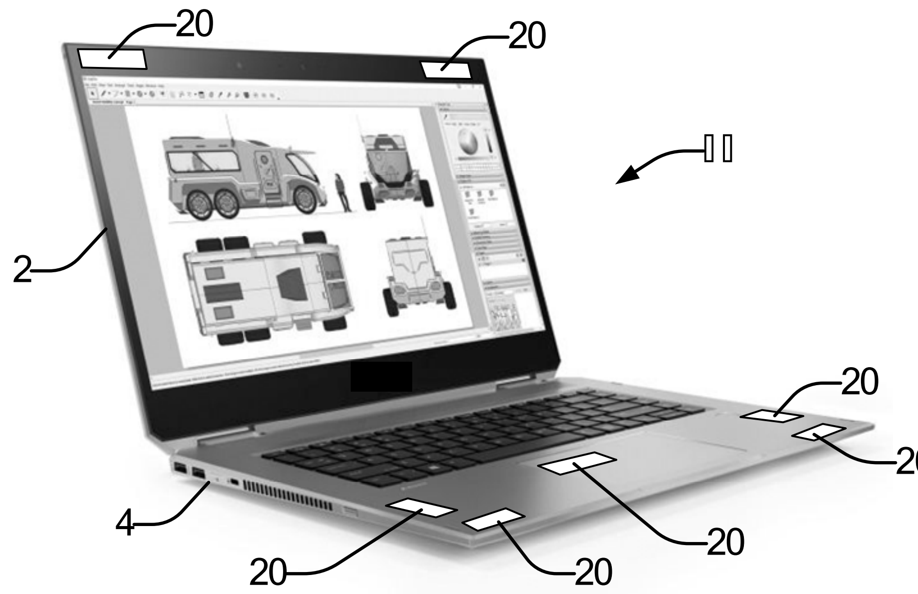
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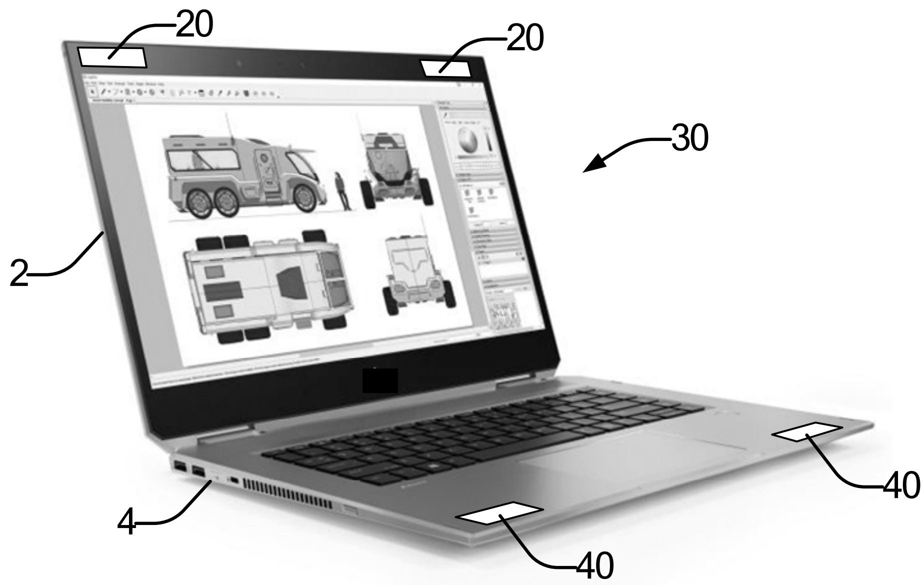
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