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## COOLING FAN WITH MULTI-PIEZO ELEMENTS FOR WIRELESS CONTROL

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### Cooling fan with multi-piezo elements for wireless control

A cooling fan works by acquiring voltage supply, receiving PWM signal from controller, and providing speed feedback back to control for monitor. Traditionally, this connection in a PC system is achieved by using solid wires and connector to link cooling fan and main board controller. In slim form factor PC system, the space is limited so only small connector and thinner wires could be used. This constrain of component selection leads to several problems such as

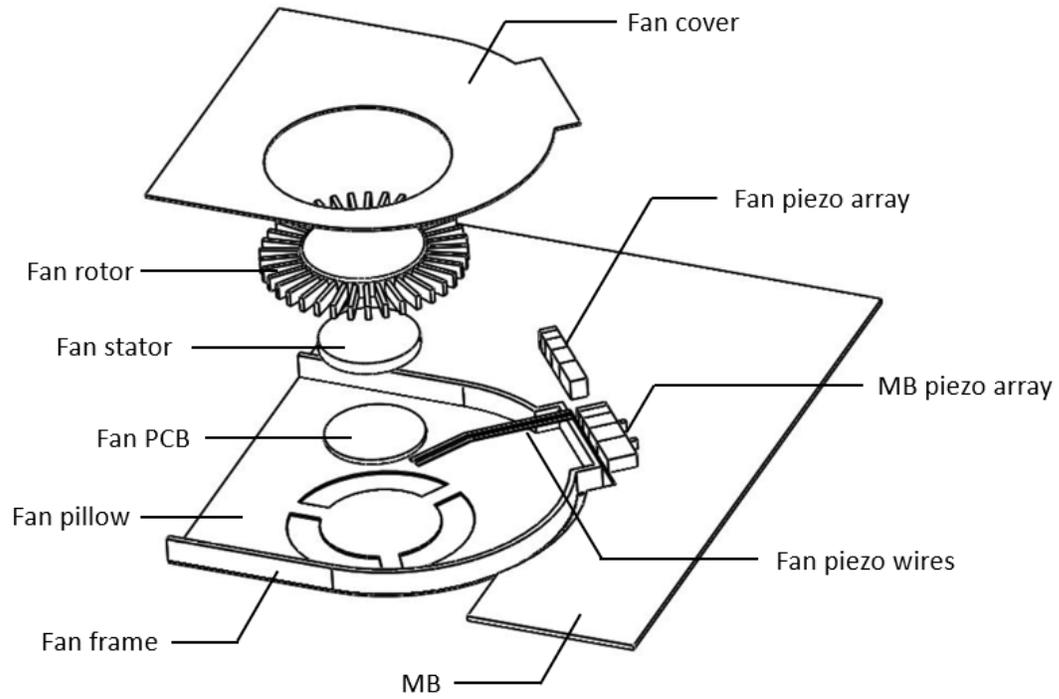
- A) Small gauge wires are easy to be damaged during assembly.
- B) Difficult fan assembly process due to limited operating space.
- C) Unstable fan operation due to bad connector engagement.

A new cooling fan system is disclosed that a piezoelectric array is utilized to eliminate the traditional physical connection. Detail construction is illustrated in below figure and the operation principle is explained as follows

- A) The cooling system includes a cooling fan and a control circuit. The cooling fan consists of fan cover, fan rotor, fan stator, fan PCB, fan pillow, fan frame, fan piezo array, and fan piezo wires. The control circuit consists of a MB piezo array and a MB.
- B) Both the fan piezo array and the MB piezo array consist of multiple piezoelectric elements, each element has difference size with its own resonance frequency. Those piezoelectric elements are connected in series to form the array. Fan piezo array is placed inside fan frame.
- C) To active the fan to 1<sup>st</sup> level speed, signal with frequency of 1<sup>st</sup> MB piezo array element is used to trigger 1<sup>st</sup> MB piezo array element to vibrates. 1<sup>st</sup> MB piezo array element vibration energy is transmitted to fan piezo array through acoustic waveform.
- D) The 1<sup>st</sup> fan piezo array element receives the energy and vibrates accordingly, this vibration generates electric power due to piezoelectric effect, the power is then transmitted through fan piezo wire to fan PCB. Fan rotor is driven by this electric power and then reach to 1<sup>st</sup> level speed.
- E) To active the fan to 2<sup>nd</sup> level speed, signal with combined frequency of 1<sup>st</sup> and 2<sup>nd</sup> MB piezo array elements is used. Step (C) to Step (D) is repeated and the electric power is doubled because 1<sup>st</sup> fan piezo element and 2<sup>nd</sup> fan piezo element is connected in series.
- F) 3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup> level fan speed could be obtained by following Step (C) and Step (D). The same procedure could also be applied to reduce fan speed from high speed level down to low speed level, and the fan could be stopped by cut off voltage supply to MB piezo array.

This idea leads to advantages including

- A) Solve the hard-to-assembly issue on production line for fan WTB connector plug.
- B) Solve the unstable fan operation risk caused by improper fan installation.
- C) Eliminate wire soldering on fan control board process, this process change reduces cooling fan manufacture time and increases the manufacture yield rate.
- D) Eliminate fan connector installation process, and this action helps to simplify the fan assembly and disassembly process complexity.



***Disclosed by Owen Chang, Wade Huang and Al-Tsung Li, HP Inc.***