Importance of Cooling Method in Media Art Device: Based on Galaxy Kids Interactive Media Art

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Abstract: This research focuses on an interactive media art solution that uses the children's animation, *Galaxy Kids*. It is a work that solves the interaction on the floor through direct contact with children. The devices required are motion sensors, projectors, and computers. In this solution, a computer, projector, and sensor are combined into an all-in-one product. Heat treatment is very important in the case of all-in-one products. This research included three case studies of cooling systems in universal personal computers (PCs). An optimal cooling method was used to apply the selected process to the final product.

Keywords: Media Art, All-in-one, Cooling, Temperature.

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1. Introduction

It is now common to see an exhibition of works called media art. In particular, developments in technology have a great influence on the development of media art. Therefore, media art is a field where collaboration between technology and art is very important. Major media art artists are not uncommon, but viewing access to most media art exhibitions is often limited because of frequent breakdowns. This is caused by a final work product that is incomplete and frequently modified owing to a lack of understanding of the relationship between art and technology during product development. For this reason, most media art works are not developed from a single design. Thus, most exhibitions are a hastily assembled collection of various sensors

In this study a single-design media art machine was developed to solve these problems. This is a design solution wherein a computer, projector, and sensor are assembled as an all-in-one product. In the case of all-in-one products, heat treatment is very important. In many media works cases, malfunctions are associated with high temperatures. Of course, in some cases, the breakdown is viewed as part of the work; however, more often, it makes a negative impression on the audience. This paper summarizes the study of the heat treatment process, which is very important when developing an all-in-one media art product.

2. Case Study

As the computer processing unit (CPU), graphics processing unit (GPU), random access memory (RAM), and other components used in computers for media art have increased in speed and power consumption, the amount of heat produced by these components as a side-effect of normal operation has also increased. The temperature of these components need to be kept within a specified range to prevent overheating, instability, malfunction, and damage leading to a shortened component lifespan [1] -[4].

When media art suddenly breaks down during an exhibition, the most likely reason is because the internal temperature of the system has increased owing to the tremendous amount of heat generated by the CPU. A device called a cooler is used to control this heat. The cooler cools not only the CPU, but also the graphics card, hard drive, and mainboard chipset. In this study, various types of coolers were examined and experiments were conducted with actual measurements to verify if they meet the design requirements of the solution.

A. Cooling Method using Fan

In earlier media art devices, it was possible to cool most components using natural convection; however, many modern components require more effective active cooling. To cool these components, fans are used to both move heated air away from the components and to draw cooler air over them. Fans attached to components are generally used in combination with a heatsink to increase the area of heated surface in contact with the air, thereby improving the efficiency of cooling.

In the past, in the casual IBM compatible PC market, the computer's power supply unit almost always used an exhaust fan to expel warm air. Active cooling on CPUs began to appear on the Intel 80486, and by 1997 it was standard on all desktop processors. Computer case fans, which usually had an exhaust fan to expel heated air from the rear and, optionally, an intake fan to draw cooler air in

through the front, became common with the arrival of the Pentium 4 in late 2000. A third vent fan in the side of the desktop computer, often located over the CPU, was also common. The GPU on most modern graphics cards also requires a heatsink and one or more fans. Other components such as hard drives and RAM may also be actively cooled, although, as of 2012, this remains relatively unusual. It is not uncommon to find five or more fans in a modern PC.

The problem, however, is that the media art solution in this study is not a universal computer. Therefore, a media art device requires a larger amount of fan. Also, need a universal computer fan has variable speed.

B. Cooling Method using Extruded Metal

A cooling method using extrued metal, known as passive heat-sink cooling, involves attaching a piece of conductive material to the part that needs cooling. A thermal adhesive may be used. This method is more commonly used for a computer CPU; a clamp holds the heat sink directly over the chip, with thermal grease or a thermal pad spread between the two parts. This piece of metal has fins and ridges to increase its surface area. The heat conductivity of metal is much better than that of air, and it radiates heat better than the component that it is protecting. This method is easy in that just attaching the extruded metal can remove the heat of electronic devices.

Dust buildup between the metal fins of a heat sink gradually reduces efficiency. This can be countered with a gas duster by blowing away the dust along with any other unwanted excess material. However, it is difficult to maintain because, in the case of media art, the installation location is unspecified more so than in a universal computer.

C. Cooling Method using Liquid Submersion

Liquid submersion is a routine method of cooling large power distribution components such as transformers. A media art device cooled in this manner may not require either fans or pumps, and may be cooled exclusively by passive heat exchange between the hardware and the plastic box in which it is placed. The piping also needs to be placed correctly, and a heat exchanger might still be needed. For example, extreme component density supercomputers such as the Cray 2 and T90 used additional large liquid heat exchangers for heat removal. The liquid used must have sufficiently low electrical conductivity so as not to interfere with the normal operation of the computer. The most suitable liquids are transformer oils and other specialty electrical cooling oils, such as 3M Fluorinert. Liquid submersion is the best method for removing heat from the devices.

The greatest problem with liquid submersion is evaporation. In addition, there is a liquid leaking problem. Therefore, the liquid may be required to be either regularly refilled or sealed inside the device's enclosure.

Table. 1
Methods of cooling

Method	Details
Fan	Most common method Needs a large amount of pen Needs variable speed
Extruded Metal	Easy to use Dust buildup between the metal fins of a heat sink Periodic maintenance is needed
Liquid Submersion	Effective Evaporation problem Liquid leaking problem Periodic maintenance is needed

3. Device Design

This research is focusing on an interactive media art solution using children's animation Galaxy Kids. It is a work that solves the situation on the floor through direct contact of children. The devices required are motion sensors, projectors, and computers.

First, liquid submersion was selected for cooling the all-in-one solution. This is because the temperature of the device exposed to heat for a long time can be easily lowered.

However, there are problems with this method. The first problem is that the installation location is not the floor, but the ceiling. Therefore, a continuous supply of cooling water is very difficult to obtain. In addition, the liquid submersion method is not used for projectors.

The second case study, a cooling method using extruded metal, is inefficient to do all this. Because it is common to use a fan and liquid rather than a extruded metal in the case of a lot of heat treatment.

Finally, a fan-type cooling system was selected.

The Optoma HT29 was selected for the projection. The HT29 uses 195 W of stable power and has good performance. This means that the problem of heat from the projector can be solved easily.

Fig. 1. The Optoma HT29 is designed with a ventilation system that has exhaust vents on the sides.

However, when the HT29 is produced as an all-in-one for a work, it becomes ineffective because the projector must be assembled with a computer and other sensors in one body. Heat from the projector and each device will remain in the body, and the temperature will rise.

In this situation, if a Kinect motion sensor is installed, there will be a problem. Therefore, all tools and sensors in the body have a space between them of 1–2 cm. The fan cooler blows cool air through the spaces and blows out hot air. Of course, in addition to the design of the cooling-air circulation path, the number of fans is increased to eight to increase the input/output pressure.

Fig. 2. Our final ventilation system (left is input, right is output).

PC components should also be of equivalent or superior performance to those in existing desktop PCs, and should be small in size and well ventilated. Small-sized PC standards include mini-ITX and barebones. The components purchased for this study were the smallest, simplest, and had the highest quality. Intel Core i7-6700, Geforce GTX-1050, and 16GB DDR4 RAM is the specified hardware. Even a desktop PC needs two or three extra fans. In particular, in this project, the three main heating components are located in proximity.

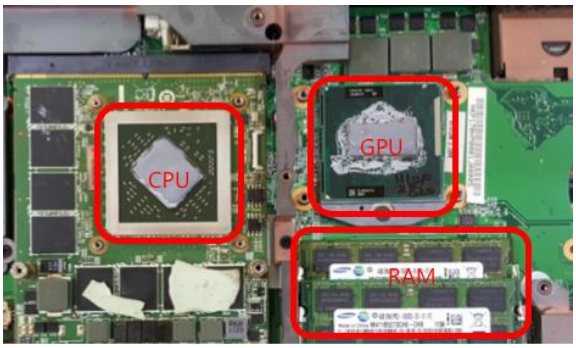

Fig. 3. CPU, GPU, and RAM are located in proximity.

The process selected is a mix of fans and extruded metal, which are often used in notebook PCs.

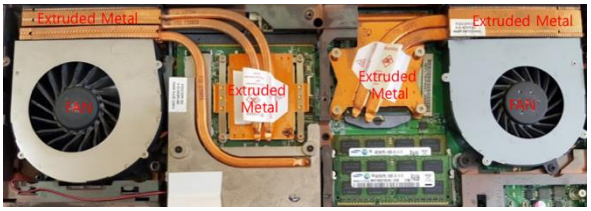

Fig. 4. Two fans and four pieces of extruded metal were used in the computer part.

The air discharged by two fans in this part is blown out through four fans in the case. The other four fans continuously inject fresh air to keep the temperature of the metal low.

4. Implementation

Table. 2
Temperature change (unit: °C)

Part	Universal PC	All-in-one without cooler	All-in-one with cooler
CPU	40–70	Over 105 (speed instability)	60–90
GPU	85–100	Over 100 (error occurred)	75–90
Body	66	Over 90	85–90 *

*The temperature of the body was difficult to lower owing to the temperature of the projector.

Table 2 shows experiment results. The temperature of the same specification was first measured with a laser thermometer. Next, the temperature of the all-in-one device was measured. The method was divided into two cases: with cooler and without cooler. When the cooler was not applied, a fatal error occurred and the system went down after a sudden temperature rise. These system downs did not happen immediately; they occurred after an unspecified time or after two or three test runs.

After the cooler was applied, the temperature fell, of course. However, this method showed a relatively high temperature compared to the Universal PC. There are a variety of causes, but it can be noted that the projector was very hot. In addition, although the GPU's temperature increased owing to graphics processing, it also continued to operate.

5. Conclusion

There were no problems purchasing and using ready-made computer products for this study; however, it is necessary that computers used for media art be custom-made for special circumstances. The focus of this study was limited to the combination of a projector, computer, and various sensors. The authors would like to research other problems related to this study and various art works in the future.

The media art work in this study will be exhibited at the Art & Technology Exhibition at the end of 2017, and will be used as a final result of the CFT program of the Graduate School of Advanced Science and Multimedia Chung-Ang University.

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