United States Patent	12393034
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Chien; Wei-Min et al.

Wearable projection device

Abstract

A wearable projection device includes a main body, an optical-mechanical module, a waveguide module, a first thermally conductive plate, and a control module. The main body has a display portion and a support portion connected to each other. The optical-mechanical module is disposed at the display portion and includes at least one light source. The waveguide module is disposed at the display portion. The first thermally conductive plate is connected to the light source and extends from the display portion to the support portion. The control module is electrically connected to the optical-mechanical module, so that an image generated by the optical-mechanical module is displayed on the display portion by the waveguide module. The wearable projection device is able to increase a heat dissipation area through the first thermally conductive plate, so that the wearable projection device may achieve an improved heat dissipation effect and have an improved display quality.

Inventors: **Chien; Wei-Min (Hsin-Chu, TW), Hu; Tung-Chou (Hsin-Chu, TW)**

Applicant: **Coretronic Corporation** (Hsin-Chu, TW)

Family ID: **1000008766670**

Assignee: **Coretronic Corporation (Hsin-Chu, TW)**

Appl. No.: **18/537815**

Filed: **December 13, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20240219730 A1	Jul. 04, 2024

Foreign Application Priority Data

CN	202211709617.1	Dec. 29, 2022

Publication Classification

Int. Cl.: **G02B27/01** (20060101)

U.S. Cl.:

CPC **G02B27/0172** (20130101); **G02B27/0176** (20130101); G02B2027/014 (20130101)

Field of Classification Search

CPC: G02B (27/0172); G02B (27/0176); G02B (2027/014); G02B (2027/0178); G02B (27/01); G02B (27/017); G03B (21/16)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
9740023	12/2016	Ashwood	N/A	G02C 11/10
10317700	12/2018	Ashwood	N/A	G02C 5/143
10433467	12/2018	Hurbi et al.	N/A	N/A
10620439	12/2019	Zhang	N/A	G09G 3/3603
11112619	12/2020	Romano	N/A	G02C 5/008
11493763	12/2021	Lee	N/A	G02B 27/0172
11703923	12/2022	Mou	361/679.46	G06F 1/203
11768538	12/2022	Wang	345/156	G02B 27/0176
12029014	12/2023	Yoon	N/A	G06F 1/20
12111514	12/2023	Ashwood	N/A	G02C 11/10
12189421	12/2024	Lin	N/A	G06F 1/163
2012/0235900	12/2011	Border	345/156	G06F 3/017
2016/0041395	12/2015	Yajima	359/630	G02B 27/017
2016/0212888	12/2015	Nikkhoo	N/A	G02B 7/008
2018/0376626	12/2017	Hurbi	N/A	G02B 7/002
2022/0299781	12/2021	Ran	N/A	G02B 27/0172

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
215494370	12/2021	CN	N/A
216979450	12/2021	CN	N/A
113260226	12/2021	CN	N/A
202217394	12/2021	TW	N/A

Primary Examiner: Sitta; Grant

Attorney, Agent or Firm: JCIPRNET

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims the priority benefit of China application serial no. 202211709617.1, filed on Dec. 29, 2022. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND OF THE INVENTION

Field of the Invention

(2) The invention relates to a projection device and particularly relates to a wearable projection device.

Description of Related Art

(3) With the increasing development of science and technologies, types and functions of projection devices and the manner of using the same have become more and more diverse, and wearable projection devices that may be directly worn on bodies of users have also emerged accordingly. At present, the wearable projection device includes three sets of heat sources; namely, a display element, a system on a chip (SoC), and a network module. Since the wearable projection device is in direct contact with the human body, an active heat dissipation element (such as a fan) that generates vibrations and noise cannot be used, while a passive heat dissipation element may be applied to dissipate heat from the heat sources, which significantly limit the heat dissipation capability of the wearable projection device.

(4) The information disclosed in this Background section is only for enhancement of understanding of the background of the described technology and therefore it may contain information that does not form the prior art that is already known to a person of ordinary skill in the art. Further, the information disclosed in the Background section does not mean that one or more problems to be resolved by one or more embodiments of the invention was acknowledged by a person of ordinary skill in the art.

SUMMARY OF THE INVENTION

(5) One or more embodiments of the invention provide a wearable projection device with an improved heat dissipation effect and an improved heat dissipation quality.

(6) Other objectives and advantages of the invention may be further understood from the technical features disclosed in the invention.

(7) In order to achieve one, some, or all of the aforementioned objectives or other objectives, an embodiment of the invention provides a wearable projection device that includes a main body, an optical-mechanical module, a waveguide module, a first thermally conductive plate, and a control module. The main body has a display portion and a support portion connected to each other. The optical-mechanical module is disposed at the display portion and includes at least one light source. The waveguide module is disposed at the display portion. The first thermally conductive plate is connected to the light source and extends from the display portion to the support portion. The control module is electrically connected to the optical-mechanical module, so that an image generated by the optical-mechanical module is displayed on the display portion by the waveguide module.

(8) In view of the above, the wearable projection device provided in one or more embodiments of the invention has at least one of the following advantages or achieves at least one of the following effects. In the wearable projection device provided in one or more embodiments of the invention, the first thermally conductive plate is connected to the light source and extends from the display portion to the support portion. Namely, an area occupied by the first thermally conductive plate is relatively large, whereby a heat dissipation area may be increased. As such, the wearable projection device provided in one or more embodiments of the invention may achieve with an improved heat dissipation effect and have an improved heat dissipation quality.

(9) Other objectives, features and advantages of the present invention will be further understood from the further technological features disclosed by the embodiments of the present invention

wherein there are shown and described preferred embodiments of this invention, simply by way of illustration of modes best suited to carry out the invention.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

(2) FIG. **1**A is a schematic three-dimensional view illustrating a wearable projection device according to a first embodiment of the invention.

(3) FIG. **1**B is a partial perspective top view illustrating a display portion of the wearable projection device depicted in FIG. **1**A.

(4) FIG. **1**C is a partial perspective top view illustrating a support portion of the wearable projection device depicted in FIG. **1**A.

(5) FIG. **1**D is a schematic view illustrating an optical-mechanical module and a waveguide module of the wearable projection device depicted in FIG. **1**A.

(6) FIG. **2**A is a schematic partial perspective top view illustrating the wearable projection device depicted in FIG. **1**A.

(7) FIG. **2**B is a schematic partial perspective front view illustrating the wearable projection device depicted in FIG. **1**A.

(8) FIG. **2**C is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **1**A.

(9) FIG. **3**A is a schematic partial perspective top view illustrating a wearable projection device according to a second embodiment of the invention.

(10) FIG. **3**B is a schematic partial perspective front view illustrating the wearable projection device depicted in FIG. **3**A.

(11) FIG. **3**C is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **3**A.

(12) FIG. **4**A is a schematic partial perspective top view illustrating a wearable projection device according to a third embodiment of the invention.

(13) FIG. **4**B is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **4**A.

(14) FIG. **5**A is a schematic partial perspective top view illustrating a wearable projection device according to a fourth embodiment of the invention.

(15) FIG. **5**B is a schematic partial perspective front view illustrating the wearable projection device depicted in FIG. **5**A.

(16) FIG. **5**C is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **5**A.

DESCRIPTION OF THE EMBODIMENTS

(17) In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings which form a part hereof, and in which are shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as “top,” “bottom,” “front,” “back,” etc., is used with reference to the orientation of the Figure(s) being described. The components of the present invention can be positioned in a number of different orientations. As such, the directional terminology is used for purposes of illustration and is in no way limiting. On the other hand, the drawings are only schematic and the sizes of components may be exaggerated for clarity. It is to be understood that other embodiments

may be utilized and structural changes may be made without departing from the scope of the present invention. Also, it is to be understood that the phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless limited otherwise, the terms "connected," "coupled," and "mounted" and variations thereof herein are used broadly and encompass direct and indirect connections, couplings, and mountings. Similarly, the terms "facing," "faces" and variations thereof herein are used broadly and encompass direct and indirect facing, and "adjacent to" and variations thereof herein are used broadly and encompass directly and indirectly "adjacent to". Therefore, the description of "A" component facing "B" component herein may contain the situations that "A" component directly faces "B" component or one or more additional components are between "A" component and "B" component. Also, the description of "A" component "adjacent to" "B" component herein may contain the situations that "A" component is directly "adjacent to" "B" component or one or more additional components are between "A" component and "B" component. Accordingly, the drawings and descriptions will be regarded as illustrative in nature and not as restrictive.

(18) FIG. **1**A is a schematic three-dimensional view illustrating a wearable projection device according to a first embodiment of the invention. FIG. **1**B is a partial perspective top view illustrating a display portion of the wearable projection device depicted in FIG. **1**A. FIG. **1**C is a partial perspective top view illustrating a support portion of the wearable projection device depicted in FIG. **1**A. FIG. **1**D is a schematic view illustrating an optical-mechanical module and a waveguide module of the wearable projection device depicted in FIG. **1**A. FIG. **2**A is a schematic partial perspective top view illustrating the wearable projection device depicted in FIG. **1**A. FIG. **2**B is a schematic partial perspective front view illustrating the wearable projection device depicted in FIG. **1**A. FIG. **2**C is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **1**A.

(19) With reference to FIG. **1**A, FIG. **1**D, and FIG. **2**A, in the present embodiment, the wearable projection device **100***a* includes a main body **110**, an optical-mechanical module **120***a*, a waveguide module **130**, a first thermally conductive plate **140**, and a control module **150***a*. The main body **110** has a display portion **112** and a support portion **114** connected to each other. The optical-mechanical module **120***a* is disposed at the display portion **112** of the main body **110** and includes at least one light source **122** (one light source **122** is schematically shown). The optical-mechanical module **120***a* is, for instance, a projection device. The at least one light source **122** of the optical-mechanical module **120***a* is, for instance, a laser light source, a light emitting diode (LED), or an organic light emitting diode (OLED). The waveguide module **130** is disposed at the display portion **112** of the main body **110**. The first thermally conductive plate **140** is connected to the at least one light source **122** and extends from the display portion **112** to the support portion **114**. The control module **150***a* is electrically connected to the optical-mechanical module **120***a*, so that an image generated by the optical-mechanical module **120***a* is displayed on the display portion **112** by the waveguide module **130**. The waveguide module **130** is, for instance, a light transmissive waveguide sheet configured to receive an image beam L**2**, which allows a user to watch an image generated by the image beam L**2**. The control module **150***a* includes, for instance, a microprocessor, an image processor, and so on, which should however not be construed as a limitation in the disclosure.

(20) Specifically, with reference to FIG. **1**B, the display portion **112** of the main body **110** has a contact surface **112***a* and an appearance surface **112***b* opposite to each other. Here, the contact surface **112***a* is a surface that contacts the skin of the user when the user wears the wearable projection device **100***a*, while the appearance surface **112***b* is not in contact with the user. An inner side S**1** of the appearance surface **112***b* is located between the contact surface **112***a* and an outer side S**2** of the appearance surface **112***b*. The optical-mechanical module **120***a* is located between

the contact surface **112***a* and the inner side S**1** of the appearance surface **112***b*. In order to ensure heat energy at a high temperature is not transmitted out through the contact surface **112***a* to discomfort the user, the wearable projection device **100***a* provided in this embodiment further includes a heat insulation structure **160**, where the heat insulation structure **160** is disposed between the optical-mechanical module **120***a* and the contact surface **112***a*. The heat insulation structure **160** includes a structural layer **162** and an air layer **164**, where the air layer **164** is located between the contact surface **112***a* and the structural layer **162**, and the structural layer **162** is located between the optical-mechanical module **120***a* and the contact surface **112***a*. It should be further explained that the structural layer **162** is formed between the appearance surface **112***b* and the contact surface **112***a* by extending the display portion **112**, and the structural layer **162** may completely overlap one side of the optical-mechanical module **120***a* corresponding to the contact surface **112***a*. A heat insulation principle of the air layer **164** is to form a closed space between the structural layer **162** and the contact surface **112***a*, so as to achieve the maximum heat insulation effect by not allowing the air to flow. Preferably, a thermal conductivity coefficient of the structural layer **162** is, for instance, less than or equal to 0.3 W/mK, and a thickness of the air layer **164** is, for instance, greater than or equal to 0.2 mm. In an embodiment, a material of the contact surface **112***a* of the display portion **112** may be different from a material of the appearance surface **112***b* of the display portion **112**, where a thermal conductivity coefficient of the contact surface **112***a* is, for instance, less than or equal to 0.3 W/mK, and a thermal conductivity coefficient of the appearance surface **112***b* is, for instance, greater than or equal to 1 W/mK.

(21) Next, with reference to FIG. **1**C and FIG. **2**A, the support portion **114** of the main body **110** has a contact surface **114***a* and an appearance surface **114***b* opposite to each other. Here, the contact surface **114***a* is a surface that contacts the skin of the user when the user wears the wearable projection device **100***a*, while the appearance surface **114***b* is not in contact with the user. An inner side S**3** of the appearance surface **114***b* is located between the contact surface **114***a* and an outer side S**4** of the appearance surface **114***b*. The first thermally conductive plate **140** is located between the contact surface **114***a* and the inner side S**3** of the appearance surface **114***b*. In order to ensure heat energy at a high temperature is not transmitted out through the contact surface **114***a* to discomfort the user, the wearable projection device **100***a* provided in this embodiment further includes a heat insulation structure **165** that is disposed between the contact surface **114***a* and the inner side S**3** of the appearance surface **114***b* and includes a structural layer **167** and an air layer **169**. The air layer **169** is located between the contact surface **114***a* and the structural layer **167**, and the structural layer **167** is located between the air layer **169** and the first thermally conductive plate **140**. It should be further explained that the structural layer **167** is formed between the appearance surface **114***b* and the contact surface **114***a* by extending the support portion **114**. A heat insulation principle of the air layer **169** is to form a closed space between the structural layer **167** and the contact surface **114***a*, so as to achieve the maximum heat insulation effect by not allowing the air to flow. Preferably, a thermal conductivity coefficient of the structural layer **167** is, for instance, less than or equal to 0.3 W/mK, and a thickness of the air layer **169** is, for instance, greater than or equal to 0.2 mm. In an embodiment, a material of the contact surface **114***a* of the support portion **114** may be different from a material of the appearance surface **114***b* of the support portion **114**, where a thermal conductivity coefficient of the contact surface **114***a* is, for instance, less than or equal to 0.3 W/mK, and a thermal conductivity coefficient of the appearance surface **114***b* is, for instance, greater than or equal to 1 W/mK.

(22) Next, as shown in FIG. **1**D, in the present embodiment, the at least one light source **122** of the optical-mechanical module **120***a* is adapted to emit an illumination beam L**1**, and the optical-mechanical module **120***a* further includes an imaging module **125** and a lens module **128**. The imaging module **125** is disposed on a transmission path of the illumination beam L**1** and configured to convert the illumination beam L**1** into the image beam L**2**. The lens module **128** is disposed on a transmission path of the image beam L**2** and configured to project the image beam L**2** toward the

waveguide module **130**. The imaging module **125** includes at least one lens and an imaging device. The at least one lens is configured to transmit the illumination beam L**1**, and the imaging device is, for instance, a light valve configured to convert the illumination beam L**1** into the image beam L**2**. The lens module **128** has at least one lens configured to project the image beam L**2** to the waveguide module **130**, for instance.

(23) With reference to FIG. **2**A, FIG. **2**B, and FIG. **2**C, in the present embodiment, the at least one light source **122** of the optical-mechanical module **120***a* may be fixed to the first thermally conductive plate **140** through a thermally conductive material **170**. Here, one light source **122** is schematically shown, which means that the wearable projection device **100***a* is embodied to perform a display function in a monochromic manner. To be specific, the wearable projection device **100***a* provided in this embodiment further includes a thermally conductive material **172**, where the first thermally conductive plate **140** is fixed to the inner side S**3** of the appearance surface **114***b* by the thermally conductive material **172**, and the first thermally conductive plate **140** is not in contact with the contact surface **114***a*. The first thermally conductive plate **140** is embodied in form of extending from the display portion **112** of the main body **110** to the support portion **114**; that is, the area occupied by the first thermally conductive plate **140** is relatively large, thereby increasing the heat dissipation area. Athermal conductivity coefficient of the thermally conductive materials **170** and **172** is, for instance, greater than or equal to 0.5 W/mK. The at least one light source **122** is the main heat source in the display portion **112** of the main body **110**, and the lower the temperature of the at least one light source **122**, the higher the brightness output by the at least one light source **122**. Since the first thermally conductive plate **140** provided in this embodiment extends from the display portion **112** to the support portion **114**, and the at least one light source **122** may be fixed to the first thermally conductive plate **140** by the thermally conductive material **170**, the heat energy generated by the at least one light source **122** may be transmitted from the display portion **112** to the support portion **114** through the first thermally conductive plate **140**, so that the heat energy may be transmitted to the appearance surface **114***b* for heat dissipation more effectively. As such, the wearable projection device **100***a* provided in this embodiment may achieve an improved heat dissipation effect and have an improved display quality.

(24) Moreover, the control module **150***a* provided in this embodiment is disposed at the support portion **114** of the main body **110**, where the control module **150***a* is configured to drive the optical-mechanical module **120***a* and may simultaneously process input image data, user's commands, data obtained from network transmission, or the like. In this embodiment, the control module **150***a* further includes a temperature sensing element **152** and a predetermined temperature. The temperature sensing element **152** senses the optical-mechanical module **120***a* to generate a sensed temperature. When the sensed temperature is greater than the predetermined temperature, the control module **150***a* drives the optical-mechanical module **120***a* to reduce the brightness of the at least one light source **122**, so as to prevent the contact surface **114***a* from having an excessively high temperature and causing discomfort to the user. As shown in FIG. **2**A and FIG. **2**C, the wearable projection device **100***a* provided in this embodiment further includes thermally conductive materials **174** and **175** and a third thermally conductive plate **148**, where the control module **150***a* is connected to the third thermally conductive plate **148** by the thermally conductive material **174**, the third thermally conductive plate **148** is fixed to the inner side S**3** of the appearance surface **114***b* by the thermally conductive material **175**, and the third thermally conductive plate **148** is not in contact with the contact surface **114***a*. Here, the third thermally conductive plate **148** is not in contact with the first thermally conductive plate **140**, so as to prevent the heat dissipation effect from being reduced by mutual transfer of heat.

(25) With reference to FIG. **1**A and FIG. **1**C, the support portion **114** of the main body **110** is a region for placing the wearable projection device **100***a* on the user's ears. In view of the different body sizes of each user, the support portion **114** is required to have an adjustable mechanism or a

bendable design. Hence, the wearable projection device **100***a* provided in this embodiment further includes two sleeves **180** and a soft belt **185**, each of the sleeves **180** may connect the structures of the corresponding support portion **114** and display portion **112**, two ends of the soft belt **185** are respectively connected to the two sleeves **180**, and the soft belt **185** is in contact with the back of the user's head. The user may adjust a length of the soft belt **185**, so that the support portion **114** is bent to different angles to match the head shapes of respective users. Since the support portion **114** may be bent to different angles, the first thermal guide plate **140** that is in contact with the support portion **114** is preferably bendable or flexible and may be restored to the original shape even after the shape of the support portion **114** is changed.

(26) In short, in the wearable projection device **100***a* provided in this embodiment, the first thermally conductive plate **140** is connected to the at least one light source **122** and extends from the display portion **112** to the support portion **114**; that is, the area occupied by the first thermally conductive plate **140** is relatively large, thereby increasing the heat dissipation area and ensuring the wearable projection device **100***a* provided in this embodiment to achieve the improved heat dissipation effect and have the improved display quality.

(27) Other embodiments are provided below for explanation. Note that the reference numbers and some content provided in the following embodiments follows are derived from the reference numbers and the content provided in the previous embodiment, the same reference numbers serve to denote the same or similar element, and the description of the same technical content is omitted hereinafter. The omitted description may be referred to as the description provided in the previous embodiment and will not be repeated in the following embodiments.

(28) FIG. **3**A is a schematic partial perspective top view illustrating a wearable projection device according to a second embodiment of the invention. FIG. **3**B is a schematic partial perspective front view illustrating the wearable projection device depicted in FIG. **3**A. FIG. **3**C is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **3**A. With reference to FIG. **2**A, FIG. **3**A, FIG. **3**B, and FIG. **3**C, a wearable projection device **100***b* provided in this embodiment is similar to the wearable projection device **100***a* depicted in FIG. **2**A, while one of the differences between the wearable projection device **100***b* and the wearable projection device **100***a* lies in that the wearable projection device **100***b* provided in this embodiment further includes a second thermally conductive plate **144** that is disposed at the display portion **112** of the main body **110**, and the second thermally conductive plate **144** is directly connected to the first thermally conductive plate **140**. The at least one light source **122** is fixed to the second thermally conductive plate **144** through a thermally conductive material **176**, while the second thermally conductive plate **144** is fixed to the display portion **112** through a thermally conductive material **177**.

(29) In short, the at least one light source **122** provided in this embodiment is fixed to the second thermally conductive plate **144** by the thermally conductive material **176**, and the second thermally conductive plate **144** is directly connected to the first thermally conductive plate **140** and is fixed to the display portion **112** by the thermally conductive material **177**. The first thermally conductive plate **140** and the second thermally conductive plate **144** are disposed to increase the heat dissipation area, so that the heat generated by the at least one light source **122** may be dissipated through the first thermally conductive plate **140** which occupies a relatively large area, and the second thermally conductive plate **140** may serve as a means of auxiliary heat dissipation. Accordingly, the wearable projection device **100***b* provided in this embodiment may achieve the improved heat dissipation effect and have the improved display quality.

(30) FIG. **4**A is a schematic partial perspective top view illustrating a wearable projection device according to a third embodiment of the invention. FIG. **4**B is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **4**A. With reference to FIG. **3**A, FIG. **4**A, and FIG. **4**B, a wearable projection device **100***c* provided in this embodiment is similar to the wearable projection device **100***b* depicted in FIG. **3**A, while one of the differences between the

wearable projection device **100***c* and the wearable projection device **100***b* lies in that the optical-mechanical module **120***b* provided in this embodiment includes a light source **122** (i.e., a first light source) and a light source **124** (i.e., a second light source). The light source **122** is connected to the first thermally conductive plate **140** by the thermally conductive material **170**, and the light source **124** is connected to the second thermally conductive plate **145** by the thermally conductive material **178**, where the first thermally conductive plate **140** is not connected to the second thermally conductive plate **145**, so as to prevent the heat dissipation effect from being reduced by mutual transfer of heat. Here, the third thermally conductive plate **148** is not in contact the first thermally conductive plate **140** and the second thermally conductive plate **145**, so as to prevent the heat dissipation effect from being reduced by mutual transfer of heat. Since the optical-mechanical module **120***b* provided in this embodiment includes the light source **122** and the light source **124** which may serve to generate color beams, e.g., red, green, and blue color beams, the wearable projection device **100***c* may perform the display function in a full-color manner.

(31) FIG. **5**A is a schematic partial perspective top view illustrating a wearable projection device according to a fourth embodiment of the invention. FIG. **5**B is a schematic partial perspective front view illustrating the wearable projection device depicted in FIG. **5**A. FIG. **5**C is a schematic partial perspective side view illustrating the wearable projection device depicted in FIG. **5**A. With reference to FIG. **4**A, FIG. **5**A, FIG. **5**B, and FIG. **5**C, a wearable projection device **100***d* provided in this embodiment is similar to the wearable projection device **100***c* depicted in FIG. **4**A, while one of the differences between the wearable projection device **100***d* and the wearable projection device **100***c* lies in that the control module **150***b* provided in this embodiment is the display portion **112** disposed at the main body **110**, where the control module **150***b* is connected to the third thermally conductive plate **149** through a thermally conductive material **179**, and the third thermally conductive plate **149** is fixed to the display portion **112** of the main body **110** through a thermally conductive material **173**. Here, the third thermally conductive plate **148** is not in contact with the first thermally conductive plate **140** and the second thermally conductive plate **145**, so as to prevent the heat dissipation effect from being reduced by mutual transfer of heat.

(32) To sum up, one or more embodiments of the invention may have at least one of the following advantages or achieve at least one of the following effects. In the wearable projection device provided in one or more embodiments of the invention, the first thermally conductive plate is connected to the at least one light source and extends from the display portion to the support portion. In addition, the second thermally conductive plate may be further disposed at the display portion disposed. When there is only one single light source, the second thermally conductive plate may be connected to the first thermally conductive plate, when there are two light sources, the first thermally conductive plate and the second thermally conductive plate may be connected to the first light source and the second light source, respectively. Besides, according to the location where the control module is disposed, the third thermally conductive plate may be correspondingly connected to the control module located at the support portion or the display portion. Accordingly, the first thermally conductive plate, the second thermally conductive plate, the third thermally conductive plate, or a combination thereof is arranged to increase the heat dissipation area, so that the wearable projection device provided in one or more embodiments of the invention may achieve the improved heat dissipation effect and have the improved display quality.

(33) The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form or to exemplary embodiments disclosed. Accordingly, the foregoing description should be regarded as illustrative rather than restrictive. Obviously, many modifications and variations will be apparent to practitioners skilled in this art. The embodiments are chosen and described in order to best explain the principles of the invention and its best mode practical application, thereby to enable persons skilled in the art to understand the invention for various embodiments and with various modifications as are suited to the particular use or implementation

contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents in which all terms are meant in their broadest reasonable sense unless otherwise indicated. Therefore, the term “the invention”, “the present invention” or the like does not necessarily limit the claim scope to a specific embodiment, and the reference to particularly preferred exemplary embodiments of the invention does not imply a limitation on the invention, and no such limitation is to be inferred. The invention is limited only by the spirit and scope of the appended claims. Moreover, these claims may refer to use “first”, “second”, etc. following with noun or element. Such terms should be understood as a nomenclature and should not be construed as giving the limitation on the number of the elements modified by such nomenclature unless specific number has been given. The abstract of the disclosure is provided to comply with the rules requiring an abstract, which will allow a searcher to quickly ascertain the subject matter of the technical disclosure of any patent issued from this invention. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. Any advantages and benefits described may not apply to all embodiments of the invention. It should be appreciated that variations may be made in the embodiments described by persons skilled in the art without departing from the scope of the present invention as defined by the following claims. Moreover, no element and component in the present disclosure is intended to be dedicated to the public regardless of whether the element or component is explicitly recited in the following claims.

Claims

1. A wearable projection device, comprising: a main body, having a display portion and a support portion connected to each other; an optical-mechanical module, disposed at the display portion, and including at least one light source; a waveguide module, disposed at the display portion; a first thermally conductive plate, connected to the at least one light source and extending from the display portion to the support portion; a thermally conductive material, disposed between the optical-mechanical module and the first thermally conductive plate, wherein the optical-mechanical module, the thermally conductive material and the first thermally conductive plate are sequentially arranged along an arranging direction, wherein an orthographic projection of the optical-mechanical module and an orthographic projection of the thermally conductive material along the arranging direction on the first thermally conductive plate are overlapped with the first thermally conductive plate at the display portion, and the orthographic projection of the optical-mechanical module and the orthographic projection of the thermally conductive material along the arranging direction on the first thermally conductive plate are not overlapped with the first thermally conductive plate at the support portion; and a control module, electrically connected to the optical-mechanical module, so that an image generated by the optical-mechanical module is displayed on the display portion by the waveguide module.
2. The wearable projection device according to claim 1, wherein the display portion has a contact surface and an appearance surface opposite to each other, an inner side of the appearance surface is located between the contact surface and an outer side of the appearance surface, and the optical-mechanical module is located between the contact surface and the inner side of the appearance surface.
3. The wearable projection device according to claim 2, further comprising: a heat insulation structure, disposed between the optical-mechanical module and the contact surface, and the heat insulation structure comprising a structural layer and an air layer, wherein the air layer is located between the contact surface and the structural layer, and the structural layer is located between the optical-mechanical module and the contact surface.
4. The wearable projection device according to claim 3, wherein a thermal conductivity coefficient of the structural layer is less than or equal to 0.3 W/mK, and a thickness of the air layer is greater than or equal to 0.2 mm.

5. The wearable projection device according to claim 2, wherein a material of the contact surface of the display portion is different from a material of the appearance surface of the display portion.
6. The wearable projection device according to claim 5, wherein a thermal conductivity coefficient of the contact surface is less than or equal to 0.3 W/mK, and a thermal conductivity coefficient of the appearance surface is greater than or equal to 1 W/mK.
7. The wearable projection device according to claim 1, wherein the support portion has a contact surface and an appearance surface opposite to each other, an inner side of the appearance surface is located between the contact surface and an outer side of the appearance surface, and the first thermally conductive plate is located between the contact surface and the inner side of the appearance surface.
8. The wearable projection device according to claim 7, wherein the first thermally conductive plate is fixed to the inner side of the appearance surface by the thermally conductive material, and the first thermally conductive plate is not in contact with the contact surface.
9. The wearable projection device according to claim 8, wherein a thermal conductivity coefficient of the thermally conductive material is greater than or equal to 0.5 W/mK.
10. The wearable projection device according to claim 8, further comprising: a heat insulation structure, disposed between the contact surface and the inner side of the appearance surface and the heat insulation structure comprising a structural layer and an air layer, wherein the air layer is located between the contact surface and the structural layer, and the structural layer is located between the air layer and the first thermally conductive plate.
11. The wearable projection device according to claim 10, wherein a thermal conductivity coefficient of the structural layer is less than or equal to 0.3 W/mK, and a thickness of the air layer is greater than or equal to 0.2 mm.
12. The wearable projection device according to claim 7, wherein a material of the contact surface of the support portion is different from a material of the appearance surface of the support portion.
13. The wearable projection device according to claim 12, wherein a thermal conductivity coefficient of the contact surface is less than or equal to 0.3 W/mK, and a thermal conductivity coefficient of the appearance surface is greater than or equal to 1 W/mK.
14. The wearable projection device according to claim 1, wherein the first thermally conductive plate is flexible.
15. The wearable projection device according to claim 1, further comprising: a second thermally conductive plate, disposed at the display portion, wherein the second thermally conductive plate is connected to the at least one light source or both of the at least one light source and the first thermally conductive plate.
16. The wearable projection device according to claim 15, wherein the at least one light source comprises a first light source and a second light source, the first light source is connected to the first thermally conductive plate, the second light source is connected to the second thermally conductive plate, and the first thermally conductive plate is not connected to the second thermally conductive plate.
17. The wearable projection device according to claim 15, further comprising: a third thermally conductive plate, wherein the control module is connected to the third thermally conductive plate by the thermally conductive material.
18. The wearable projection device according to claim 17, wherein the third thermally conductive plate is not in contact with the first thermally conductive plate and the second thermally conductive plate.
19. The wearable projection device according to claim 1, further comprising: a third thermally conductive plate, wherein the control module is connected to the third thermally conductive plate by the thermally conductive material.
20. The wearable projection device according to claim 19, wherein the third thermally conductive plate is not in contact with the first thermally conductive plate.

21. The wearable projection device according to claim 1, wherein the control module further comprises a temperature sensing element.
22. The wearable projection device according to claim 21, wherein the control module further comprises a predetermined temperature, the temperature sensing element senses the optical-mechanical module to generate a sensed temperature, and when the sensed temperature is greater than the predetermined temperature, the control module drives the optical-mechanical module to reduce a brightness of the at least one light source.
23. The wearable projection device according to claim 1, wherein the at least one light source is adapted to emit an illumination beam, and the optical-mechanical module further comprises: an imaging module, disposed on a transmission path of the illumination beam and configured to convert the illumination beam into an image beam; and a lens module, disposed on a transmission path of the image beam and configured to project the image beam toward the waveguide module.
24. The wearable projection device according to claim 1, wherein the control module is disposed to the display portion or the support portion.