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Master's Thesis
Academic Year 2018

Heart Signal: Design of Automatically Taking Photos Based on Real-Time Heart Rate

Keio University
Graduate School of Media Design

Yao Jicheng

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

Yao Jicheng

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Abstract of Master's Thesis of Academic Year 2018

Heart Signal: Design of Automatically Taking Photos Based on Real-Time Heart Rate

Category: Design

Summary

Recently, sharing photos and videos has become more and more popular on social platforms. I still remember the very first time when I touched my camera and the very first moment when I took a travel photo, which had become a wonderful part of my memory.

However, since I started taking photos, my smartphone's photo album has been full of photos. Photos taken with friends will be uploaded and saved to some platforms. And when I look back, the good memories of that time will come back in my mind. However, many good moments have been missed when I realized, and it had been too late when I raised my mobile phone or camera. I have one pain point that I cannot capture the existed moments when I play games as both two hands are not free.

So It will be helpful if I have one thing, which can help automatically record interesting photos to avoid missing any touchable moments. Heart signal can help record those touchable and valuable moments once missed easily by wearing intelligent gloves and glasses. Recorded images can be stored in cloud to create one tangible memory photo album, which can be used to re-experience those Special moments. With HEART SIGNAL, you can re-experience the excited game playing moments and do not need worry about missing those excited images. Beyond that, you can share the moments seamlessly with friends through social media linking with HEART SIGNAL.

Keywords:

Heart Signal, Heart Rate, Taking Photo, Game, Recorded Images, Photo Album, Re-experience, Social Share, Special Moments, Tangible Memory

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Finally, I wish to thank my parents for their support and encouragement throughout my study.

Chapter 1
Introduction

1.1. Design inspiration- memory recording and saving

Turning the meaningless into the meaningful

We record memories and keep mementos, often unconsciously, on a daily basis. We know the stories behind the photos and trinkets we keep, but to a stranger, our collection is meaningless.

For example, you may pick up a photo of yourself with friends, sitting around a table. You look fondly at the picture, chuckling to yourself, remembering all the events that occurred that night. But, let ' s say your great-granddaughter picks up this same photo 40 years from now.What would she see?

Now imagine this same photo, but with the caption: ' The gang, aged 25, the night Dan proposed to Jen ' . Not only will your great-granddaughter laugh at what you ' re all wearing, she now has context behind the image. This is not to say, however, that every trinket you keep needs its own accompanying novel. Having a record of who people are and your relationship with them, though, can turn something meaningless into something meaningful.

Why record memories?

There are lots of reasons why people want to record memories. Share them with friends and family or pass them through generations. There are lots of different methods to collect these stories. Interviews and asking questions, for example, are a great way to inspire memories. For more interview ideas read our post on: ' Questions to Inspire Memories and Life Stories ' . In this article, however, we will focus on how to inspire memories using visual cues through mementos and artifacts.

Not only is collating all your photos and mementos a nice way to stay organised but when it comes to getting a biography written it ' s also really convenient too. Professional biographer, Andrew Crofts, explains that in his experience: " The more material (clients) have, the better unless there is so much that you feel overwhelmed, in which case put it aside for later. "

Collecting Memories

1.Photographs and Films

Photographs and films are probably the most obvious visual cues for recalling memories. They literally capture the image of the person or event. A photograph may serve as the most direct method of showing what someone or something looked like. However, this doesn ' t mean the picture alone conveys the whole story, or how you experienced it. Much like any other memento, the significance of a photograph is subjective, as is the story that the image inspires. Photos can also be preserved by including them in a biography book. [1]

Andrew Crofts explains the role of the photograph when preparing for a biography:

" Photos can enliven the text but they need to be interesting, not just views. They need to feature the people who will be appearing in the story, maybe their houses if that will help to paint a picture. "

Rachel LaCour Niesen, keen photograph preservationist gives us an insight into why she is so passionate about photography, as well as ideas on how to display photographs:

"In the age of social media and instant gratification, I think families are hungry for tangible experiences. There's magic in holding printed photos in your hands, in passing them around the table. That ' s because analogue photos trigger powerful emotional responses. Most families have hundreds of analogue photos in their homes. These photos hold valuable family memories; they are passports to a place called memory. We must make an effort to rescue them from deterioration and loss. When analogue photos are in danger, family history is also in danger. "

"National Endowment for the Humanities Chairman William Adams says: "We know that America's cultural heritage isn ' t found only in libraries and museums, but in our homes, in our family histories, and the stories and objects we pass down to our children. " [2]

“ Indeed, photographs are a living, breathing archive. They are meant to be displayed and shared. Whether they ’ re displayed in frames, in an old-school slideshow, or in albums, I hope all families recognise the value of their personal photographic histories. Can you imagine never having the magical experience of discovering a box of family photos? It ’ s like finding buried treasure! I would love to guarantee that experiences like that aren ’ t lost in the future. Somehow, I can ’ t imagine sorting through old hard drives to be quite as magical as opening up a shoebox of printed photos. ” [3]

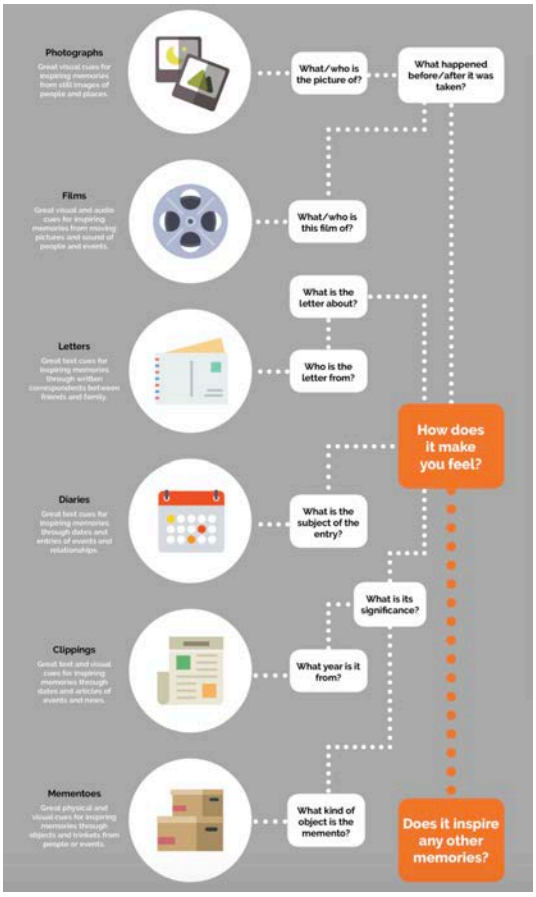

Figure 1.1 the ways of collecting memories. https://storyterrace.com/how-to-record-memories/

1.2. Design explanation

Several weeks ago, there are many game sports teams from all over the world joined the League of Legends, and it had attracted lots of audience from different countries. When players playing games, they cannot capture the excited moments as good memory and cannot share with audience immediately without delays. Though recording video can present all gaming, it is difficult to distinguish the excited moments. How can we capture and share the good impressive moments with friends or audience seamlessly ?

Not only good moment in the game is valuable, but also we can imagine some sad moments in the game could be also valuable. “ This is a general tendency for everyone,” said Clifford Nass, a professor of communication at Stanford University. “ Some people do have a more positive outlook, but almost everyone remembers negative things and in detail. ”

Figure 1.2 IG team playing League of Legends. https://lpl.qq.com

Modern life rhythm is very fast and everyday tends to be same. As busy life, people tend to forget the special moments, for example, you could not even tell one word when being asked is there any interesting things happened recently. Heart signal can help record those touchable and valuable moments once missed easily by wearing intelligent gloves and glasses. Recorded images can be stored in cloud to create one memory photo album, which can be used to re-experience

those special moments.

In summary, this design research is to trigger camera to take pictures as certain bluetooth heart beat value collected from wearing intelligent gloves, and those pictures will be uploaded to an application to ensure people can check the impressive moments or share with friends. Also, I validated if it is solid through experiment.

1.3. Paper structure

This paper consists of five chapters, and the first chapter includes the background and purpose of the research. In the next chapter, I explored that heart rate is being influenced by individual emotion and dug down related research in order to achieve better understanding of the area. In the third chapter, I did design experiments and concept design of this research, and proposed the concept of HEART SIGNAL. In Chapter 4, to validate the concept, I built a testing prototype to get testing results to determine if the proposed system is valid for the purposes of this study. Finally, in Chapter 5, I present the conclusions of this research.

Chapter 2
Literature Review

2.1. Connection between emotion and heart rate

The autonomic specificity of emotion

It is a popular belief that increased emotion/stress equates with adrenaline and hence the sympathetic nervous system. However this is an over simplification and some emotions appear to be associated with parasympathetic activity. The issue of whether different emotions are associated with different patterns of autonomic activity and different cortical representation, has been an ongoing debate since James (1884) originally proposed specificity of emotion and Cannon (1927) argued against it. Clinical studies have identified anger as the most common emotion precipitating ventricular arrhythmia (Lampert et al., 2002). For example in patients with cardioverter defibrillators (ICD), the state of anger occurred significantly more frequently in periods prior to ICD shocks than during control periods. In contrast this was not observed for the incidence of anxiety, worry, sadness, happiness, or feeling in control or being interested (Lampert et al., 2002). The greater arrhythmogenic effect of anger could be due to either engaging specific properties of the autonomic nerves, or simply due to eliciting a greater arousal response. Support for the former concept derives from studies which have demonstrated specific patterns of autonomic activity for anger and other emotions in response to emotional facial expressions (Ekman et al., 1983; Levenson et al., 1990), film clips (Christie and Friedman, 2004), and to the recall of previous emotional experiences (Rainville et al., 2006). The study by Rainville et al. (2006) incorporated Fourier analysis of the ECG RR tachogram (HRV; Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996) using the high frequency component (HF–HRV) as a measure of parasympathetic activity. They showed that anger recall was associated with

an increase n heart rate but no change in HF–HRV suggesting relative dominance of sympathetic activity, as reported previously in anger by McCraty et al. (1995). In contrast fear, happiness, and sadness were associated with an increase in heart rate but a decrease in HF–HRV (parasympathetic activity) suggesting an overall decrease in parasympathetic activity, or increase in sympathetic/parasympathetic ratio. This is in keeping with a reduction in vagal tone reported in patients with panic attacks (Friedman and Thayer, 1998). [4]

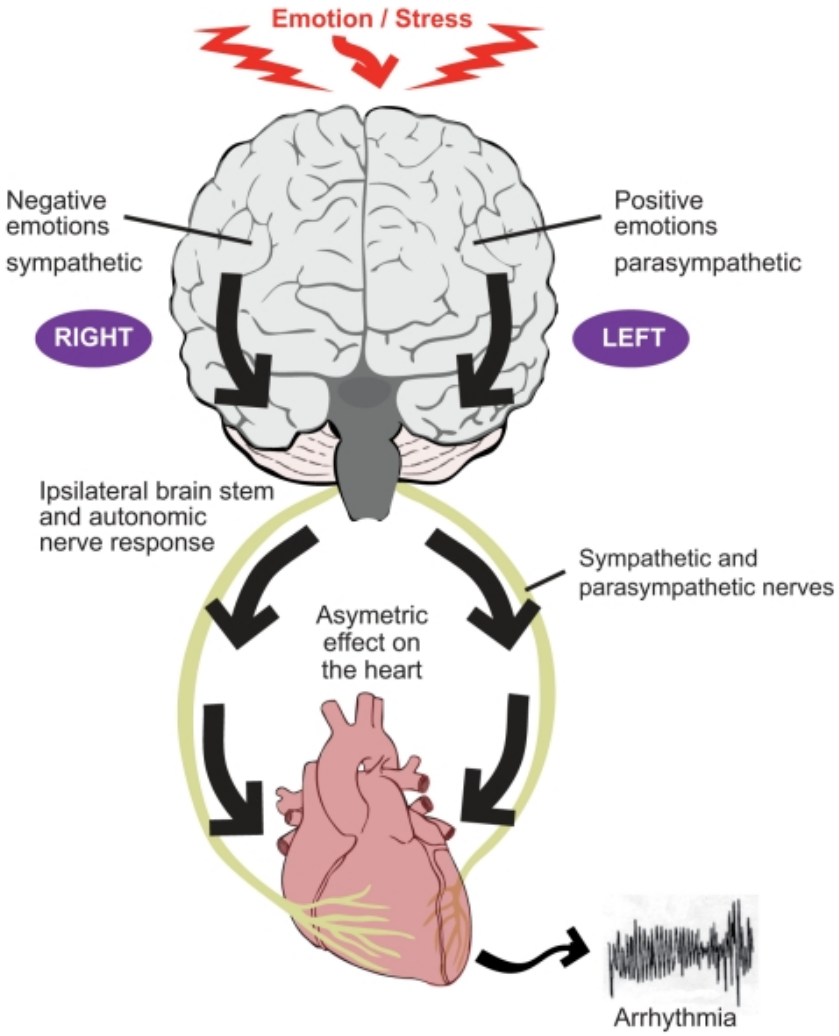

Figure 2.1 The two components of the autonomic nervous system. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3196868/

2.2. Related Works

2.2.1 Snapchat video camera “Spectacles” research

Snapchat (snap chat) where the number of users exceeds 150 million people worldwide. The Snapchat company released a spectacular video camera ”Spectacles ” for popular application official formula.

Spectacles (Spectacle: meaning eyeglasses) ”has a camera lens with a viewing angle of 115 degrees and you can shoot and save up to 30 seconds of movies. If you connect with an application using Bluetooth or Wifi, you can post directly to ”Memories” in Snapchat.

Since it is a glasses type, it has the feature that you can record the experiences the user sees as a movie as it is, and you can relive yourself and friends' happy memories from the user's point of view.

Another major feature is a new image format called circular. With Spectacles, the movie itself is shot and saved in a circular shape. Therefore, when watching on a smartphone, the concept of vertical / horizontal type is eliminated and it becomes possible to watch the movie at an angle that is in line with the tilt of the smartphone. [5]

Design and colors

- Stylish Sunglasses first, a camera second
- Comes in three colors: black, coral and teal
- UV protection, durable and comfortable to wear

The most important decision Snap made when creating Spectacles was to design them as fairly fashionable sunglasses with a camera, not a camera first that tries to be sunglasses second.

Figure 2.2 Snapchat Spectacles https://www.spectacles.com

2.2.2 Nikon “Heartography” research

This is the latest development of Nikon Asia to create a new device that activates the camera shooting function according to the heart rate, which means that anyone, even an animal with the heart rate may also be able capturing it. In this, they mounted a test equipment into a dog and obtained very unexpected shots. [6]

Basically, it’s a heart rate tracking device when increased heart rate, increased number of BPM (BPM: number of heart beats in a minute), it will automatically trigger the camera’s shutter function.

The design consists of a bracelet with a heart rate monitor function, is associated with an accessory called Heartography Smart Case and the heartbeat of the person or animal that wore it surpassed the level is to be set up before it will send signals via Bluetooth. This time, a Pro Trinket microcontroller will control the trigger inside the Smart Case accessories, helping it hit the shutter button of the camera can focus and shoot.

This new technology will be published together with the Nikon Coolpix L31

camera, we can see in the images that is mounted inside Heartography Smart Case accessories.

Figure 2.3 Nikon “ Heartography ” http://heartography.nikon-asia.com/

Here’s how it works: A brace dubbed the Heartography SmartCase holds a digital Nikon camera, the Coolpix L31, and attaches to the dog. Enabled with Bluetooth, the case is connected to an included heart-rate monitor. When the pooch gets excited and its heart rate exceeds a predetermined baseline (usually about 120 bpm), a servo contained in the Heartography SmartCase is triggered, depressing the camera’s shutter, autofocusing the L31 in the process and snapping the photo when everything is crystal clear.

Although there’s no app that frees up 93.6 percent of the Coolpix’s SD card by automatically deleting close-ups of dog butts, that technology is hopefully forthcoming.

Figure 2.4 Nikon “ Heartography ” working principle diagram 1 http://heartography.nikon-asia.com/

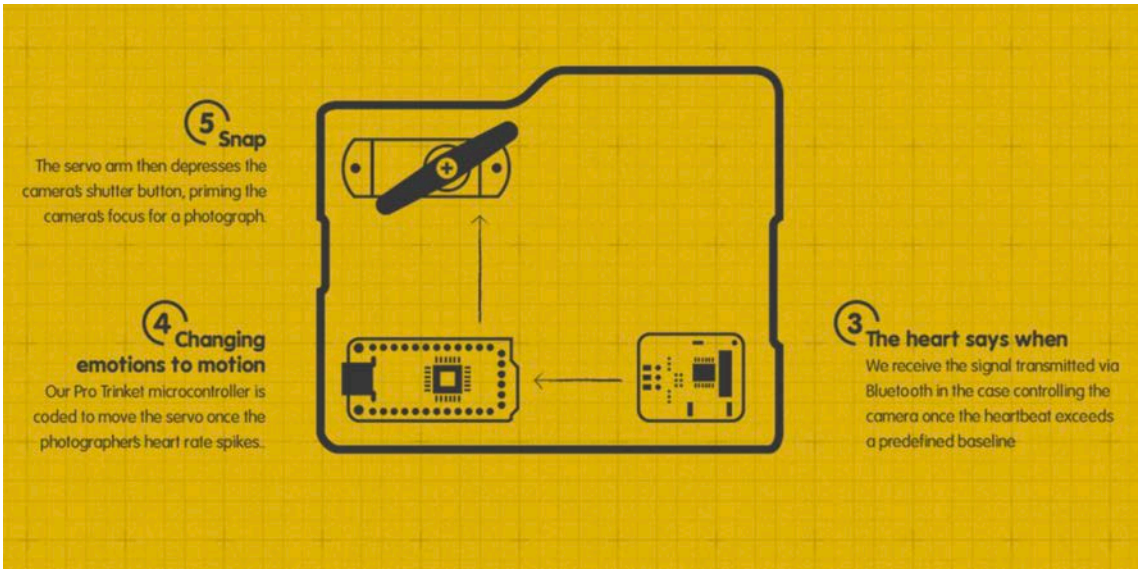

Figure 2.5 Nikon “ Heartography ” working principle diagram 2 http://heartography.nikon-asia.com/

If the dog's heart rate spikes, indicating that it's excited, a microcontroller activates a servo hidden inside the case that punches the shutter, which focuses the shot then takes it.

Figure 2.6 the photo taken by Nikon "Heartography" http://heartography.nikon-asia.com/

2.2.3 Lenovo Mirage Camera research

The unique Lenovo Mirage Camera records 180-degree video for a super-wide and 3D view of the world. Its simplicity compared to the many 360-degree cameras out now gives it more mainstream appeal than a full 360 video for both the shooter and the watcher, though it's a little too simple without a screen on the back and YouTube's lousy compression is easy to spot.

The Lenovo Mirage Camera eschews the idea of capturing 360-degree video and, instead, focuses on recording sometimes brilliant-looking, though far-too-inconsistent, 180-degree footage in 3D. [7]

Daydream VR- and Lenovo Mirage Solo-supported camera and can firmly say that '180' doesn't always mean it's half as good as the best 360 cameras available. In fact, for a lot of people, it's going to be simpler to use and better than a 360-degree camera.

This compact, point-and-shoot style camera has two 13MP fisheye lenses on the front, and although it's very easy to get your fingertips in the shot, they give you a whole new way to capture the broad world in front of you. Creators have a new tool to differentiate their normally flat-looking videos.

Lenovo and YouTube are out to prove that there's room in between normal 2D video and 360-degree video. But VR180 isn't for everyone – or even most people. There's no screen on back and it's still as expensive as many 360-degree cameras, many of which can shoot 180-degree video with a simple settings switch.

The VR180 format – although inconsistent – is what helps set the Lenovo Mirage Camera apart from the competition. It's the right idea for cutting-edge creators seeking a simple, pocketable camera that adds more depth to their content, but it's also very much a 'Generation 1.0' product.

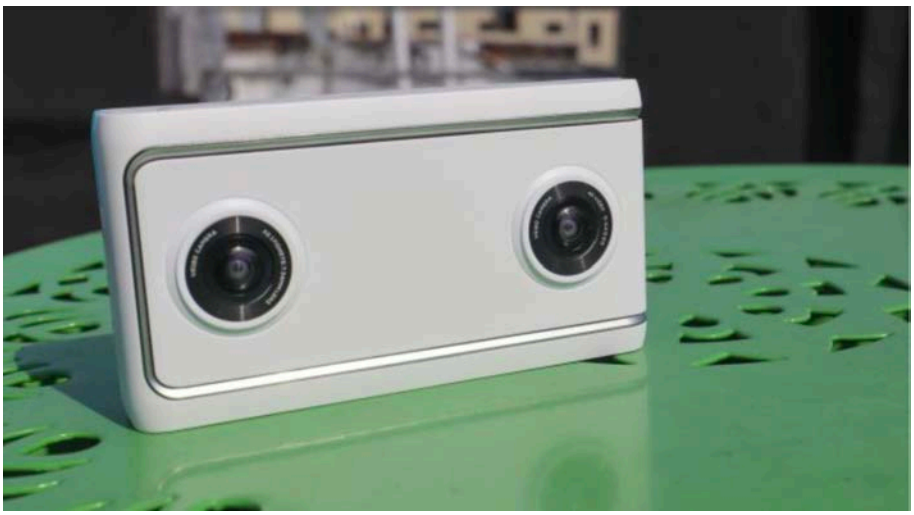

Figure 2.7 Lenovo Mirage Camera https://japanese.engadget.com/2018/05/15/vr-lenovo-vr180/

Design

The Mirage Camera is shaped like a compact and lightweight point-and-shoot digital camera that you gave up buying years ago – but one without a display on back and two 13MP camera lenses in front. They look very much like beady eyes, but that's the magic behind being able to shoot super-wide 3D photos and video in a literal snap.

It's also easier for your viewers to understand where you want them to look. 360-degree video can be a bit complex to shoot, edit (file sizes are huge) and watch.

There's a familiar shutter button on the top right and a 1/4-inch screw hole for a tripod on the bottom. The removable battery that lasts two hours and charges via USB-C. It'll fit right in your pocket, unlike Samsung's bulbously first-generation 360-degree camera, for example. We didn't need a microSD card right away, much to our delight. There's 16GB of internal storage and the ability to add up to 128GB of additional space via a hidden microSD card slot.

if you forget your microSD card at home, you can still snap ultra-wide photos and 180-degree video with the camera due to its internal storage. You won't see a "No microSD card" message. How many times has that happened to you? Even once is too much.

Verdict about Mirage Camera

The Lenovo Mirage Camera captures 180-degree video in a 360-degree world – and in a world where there are so many 360 cameras. The fact that these rival cameras can record 180-degree video doesn't help Lenovo's case.

However, we see the appeal behind the simplicity of the Mirage Camera. It's small, lightweight and acts like a point-and-shoot camera with powerful fisheye lenses. The results give you super-wide 3D video and photos in the new VR180 format.

The Mirage Camera makes it easier for every day content creators to capture wider video, and for a mainstream audience to watch it. But it's not perfect. We find YouTube's video quality compression and the lack of a built-in screen on the camera troubling. It's very much for early adopters who are willing to go through these pain points simply because the idea, not always the execution, is great.

Figure 2.8 Lenovo Mirage Camera https://japanese.engadget.com/2018/05/15/vr-lenovo-vr180/

2.3. Literature review summary

In this chapter, we have introduced reference cases and previous studies for the purposes of this study.

We compared some of the products currently on the market.

- Snapchat video camera
- Nikon “Heartography”
- Lenovo Mirage Camera

First, like Snapchat video camera you can only take videos with the glasses, not photos (particularly odd given that Snap calls itself a “camera company”). And while the ability to rotate the phone and see more of the scene is fun, you can only do that in the Snapchat app. In fact, the videos lose a lot of their charm once you download them and share them through a regular old text message. That doesn’t seem like an easy problem to fix. Presumably, Apple, Samsung , and other smartphone makers would have to build that rotating, “360°” functionality into their software, which I can’t imagine is something they’d be inclined to do without getting something in return.

second, Mirage camera and mirage solo provide a very good Google Daydream experience without the need for an expensive flagship smartphone.And the Lenovo Mirage Camera eschews the idea of capturing 360-degree video.But due to its plastic construct, it ' s tough to fit into a bag for travel. As one heavy device, it can not be taken out easily and can not fit into daily life very well.

And to the Nikon "Heartography", It is the closest to the heart signal design, but it is also not easy to carry and is currently used on pets.

Chapter 3
HEART SIGNAL supporting gaming

3.1. Design exploration

3.1.1 Design experiment

Different ways have been explored, like using a watch to measure heartbeats, using acamera to recognize smiles, testing brain waves, and so on. In the beginning, an experiment was operated to identify people ' s smiling faces [8], but the result was not ideal.For example, it was difficult to distinguish between one photo and one face, and the photo taken at the smiling moment was very strange. So, smile recognition is not the right direction.

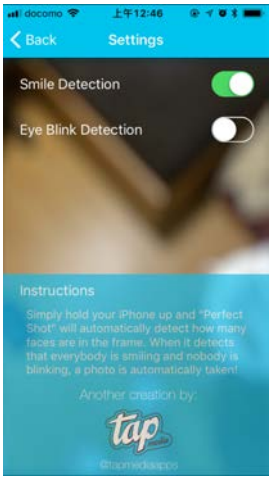

Figure 3.1 the settings of application " TapMedia "

Then a different experiment way was operated : Putting a 360-degree camera on top of the head, while another devices constantly measures heartbeat. We can experiment in the city, camera will be activated to capture the impressive moments if a high heartbeat is found. Brain wave was also used to detect the happy or moving moment.

Here ' s the testing result from attached 360 ° camera and smart wristband.

Asked participants to put a THETA(360 camera brand) on their heads andwear wristband, and they start walking in campus. Meanwhile, the whole process was recorded with a normal camera. Afterwards, I analysed the timing of heart-beat and recorded videos.

Based on experiment, high heartbeat can help tell the impressive moment. For example, when participant meet friend or good view, heartbeat tend to be high.and Compare between 360 ° video and 180 ° video, 180 ° video is morelike Human ' s eye view , more natural and more comfortable.

Therefore, ' camera glasses ' is the better option to help you record your happymoments by utilizing heartbeat to trigger video recording.

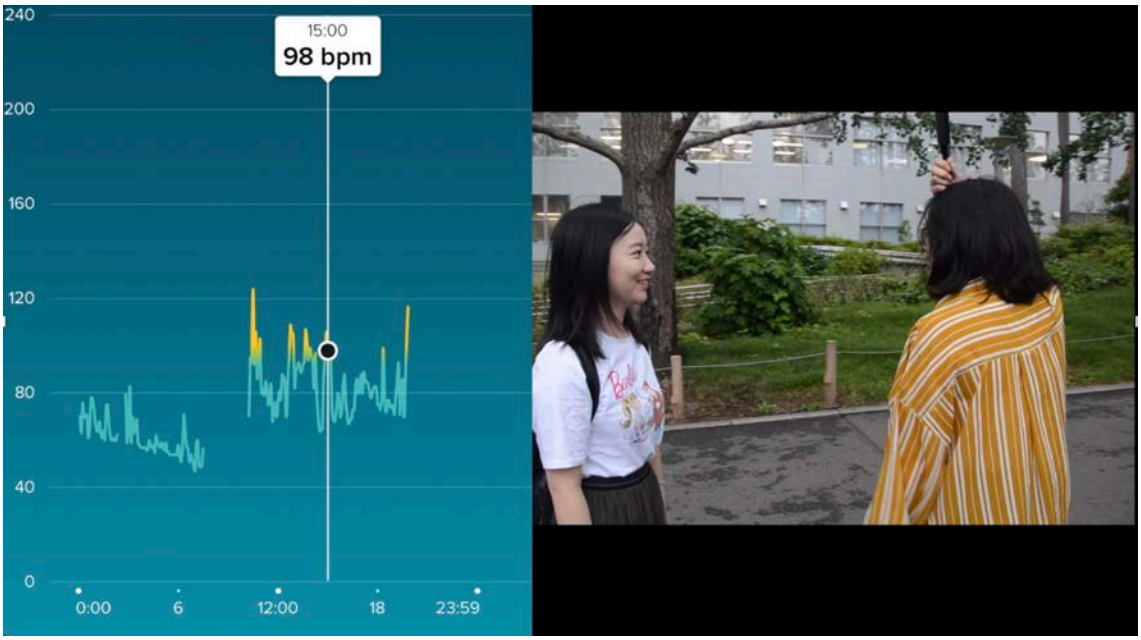

Figure 3.2 The impressive moment when participant meet friend

Figure 3.3 Photo compare between 360 ° video and 180 ° video

3.1.2 Concept - Heart signal

As my literature review and exploration, new technologies of the new cameras we can see in the market are more about the shooting technology and photography quality, but they cannot help capture the short moment which is easily missed, and even with awareness people have no time to take out camera during the short moment as human beings ' natural reaction is not real-time but always somehow delayed.

Heart rate monitors currently on the market generally come in two types — either a wireless chest strap that sends data to a monitor worn on the wrist, or pulse monitor worn on the wrist that requires you to put your finger on a certain spot to take your pulse.Both provide real-time input on how hard and how efficiently you are exercising. Heart rate monitors are typically used for cardiovascular exercise, such as walking, running, hiking, climbing and skiing.But they just measure the average heartbeat within a few minutes, and can't display your heartbeat in real time. When playing some games or watching fireworks, the heartbeat changes often in a matter of seconds.

So in order to show a heartbeat change between a few seconds, we need a device that can monitor the heartbeat in real time.

Therefore, by utilizing real-time heart rate initiating photo shooting, I proposed to use HEART SIGNAL to replace camera or mobile at certain scenarios to take photos during fleeting moments to avoid time difference as user initiating shooting with natural delay. By utilizing glasses and gloves, the shooting equipment is becoming lighter than traditional camera. Beyond that, as shooting with HEART SIGNAL is totally hand off, therefore you can enjoy all the life moments and do not need to worry about missing important moments. Also HEART SIGNAL can be linked with social media to share photos at the most excited moment easily.

Afterwards, the shooting photos initiated by HEART SIGNAL can be uploaded to APP or shared through social media seamlessly. Eventually, you can go back to check each special moment or share those moments with friends more easily by the concept of HEART SIGNAL.

Below is the logo design for HEART SIGNAL.

Figure 3.4 The HEART SIGNAL ‘ s logo

3.1.3 Final design - HEART SIGNAL supporting gaming

HEART SIGNAL cannot replace mobile or camera in many scenarios, especially for those users who want to do high quality photography. However, HEART SIGNAL can replace camera or mobile at certain scenarios to take photos during fleeting moments to avoid time difference as user initiating shooting with natural delay. Gaming is a good scenario- When playing games, both two hands are used for gaming and are not available for shooting; When playing games, players tend to be very focused on gaming, and cannot give any focus to recording excited moments; When playing games, player's heart beat is changing a lot, which is suitable for HEART SIGNAL monitoring; Real time capturing and real time sharing is becoming more and more important for gaming especially electronic sports game, which has been accepted as one of formal sports.

With HEART SIGNAL, regular individual player can record and show off excited moments with friends, for example HEART SIGNAL can help record and share a good picture when you capture one Pokemon when playing with Pokemon Go Plus. With HEART SIGNAL, electronic sports game players can record real time excited moments and share with audience immediately without any delays.

My goal is to verify whether HEART SIGNAL can capture instant moments that make the user feel meaningful while the user is playing a game or other short-term heartbeat changes.And in the next chapter, I will do experiments to verify this purpose.

3.2. System design

This model consists of two parts: input and output. The input uses the module that detects the heartbeat to detect the heartbeat in real time and display the value on the LCD screen. After reaching a certain value, the camera is controlled by the Bluetooth module to take pictures and upload. Figure 3.5 is a conceptual diagram of the entire model.

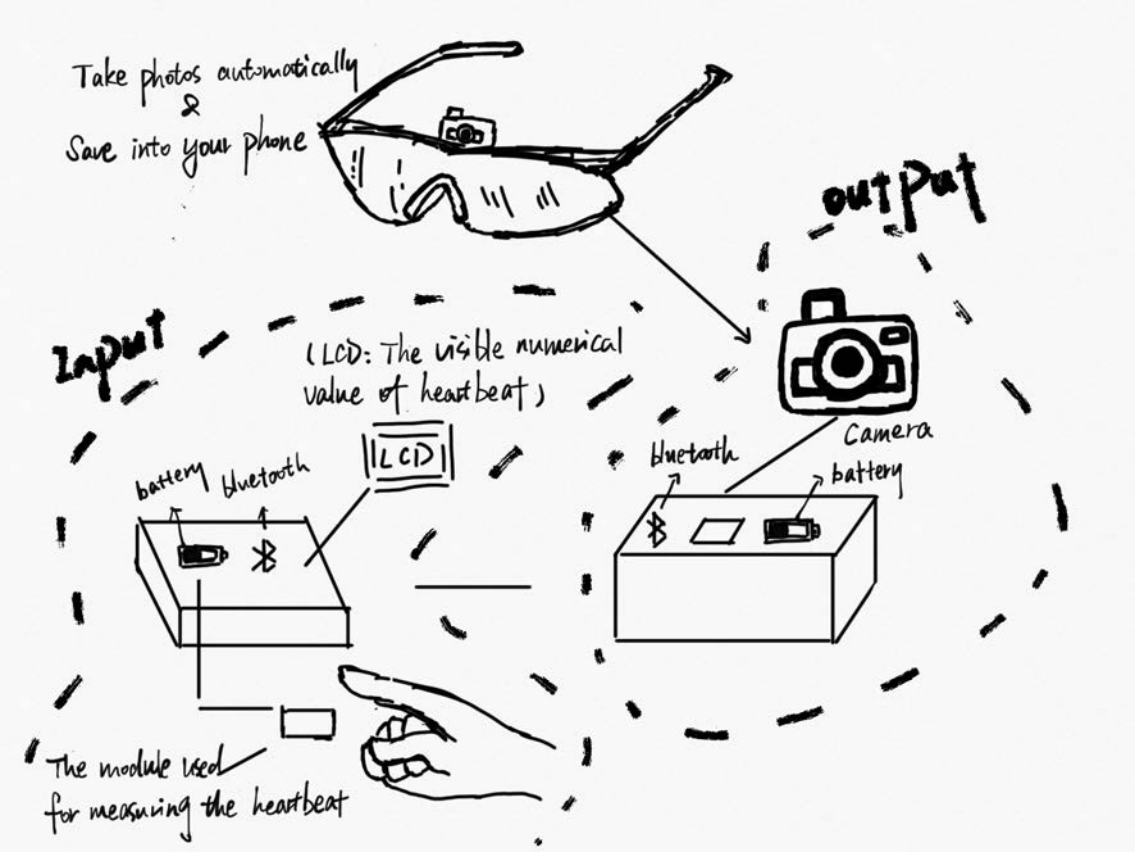

Figure 3.5 System context diagram

3.2.1 input

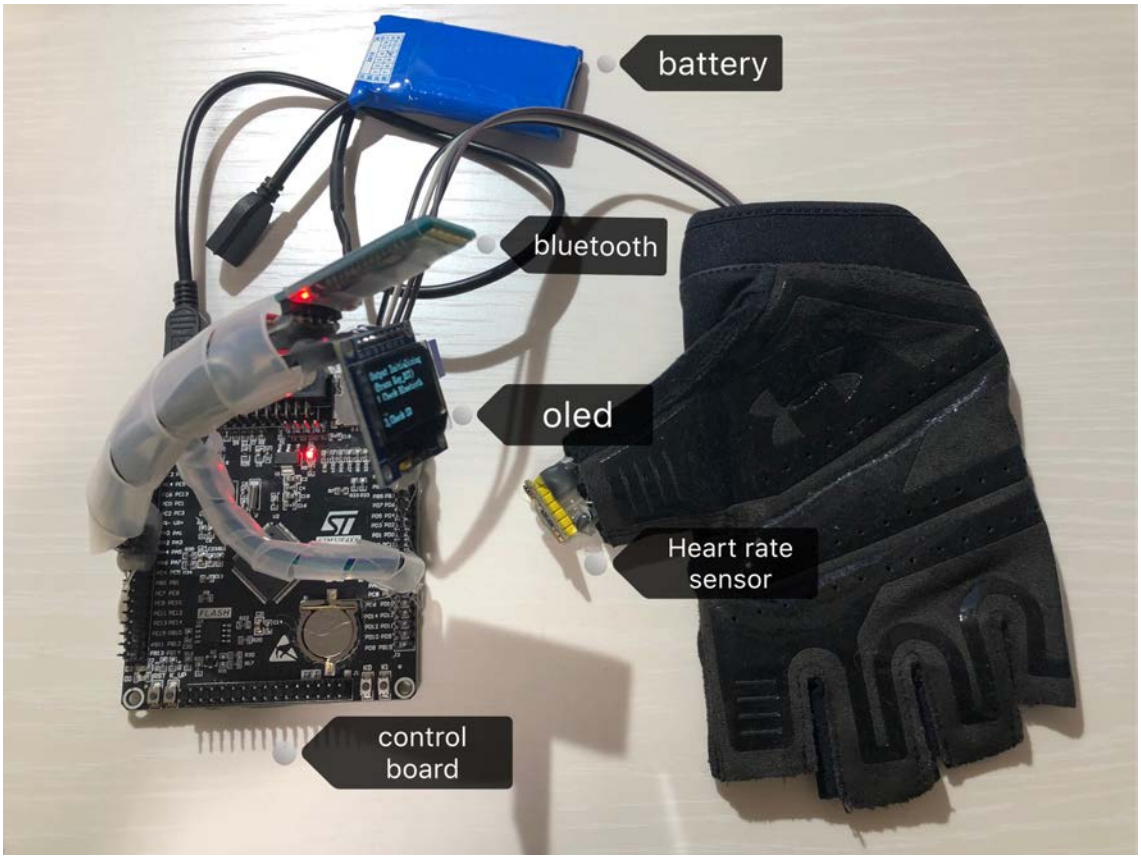

Figure 3.6 Input model structure

The input module consists of one battery, bluetooth, oled, control board and heart rate sensor.

3.2.2 output

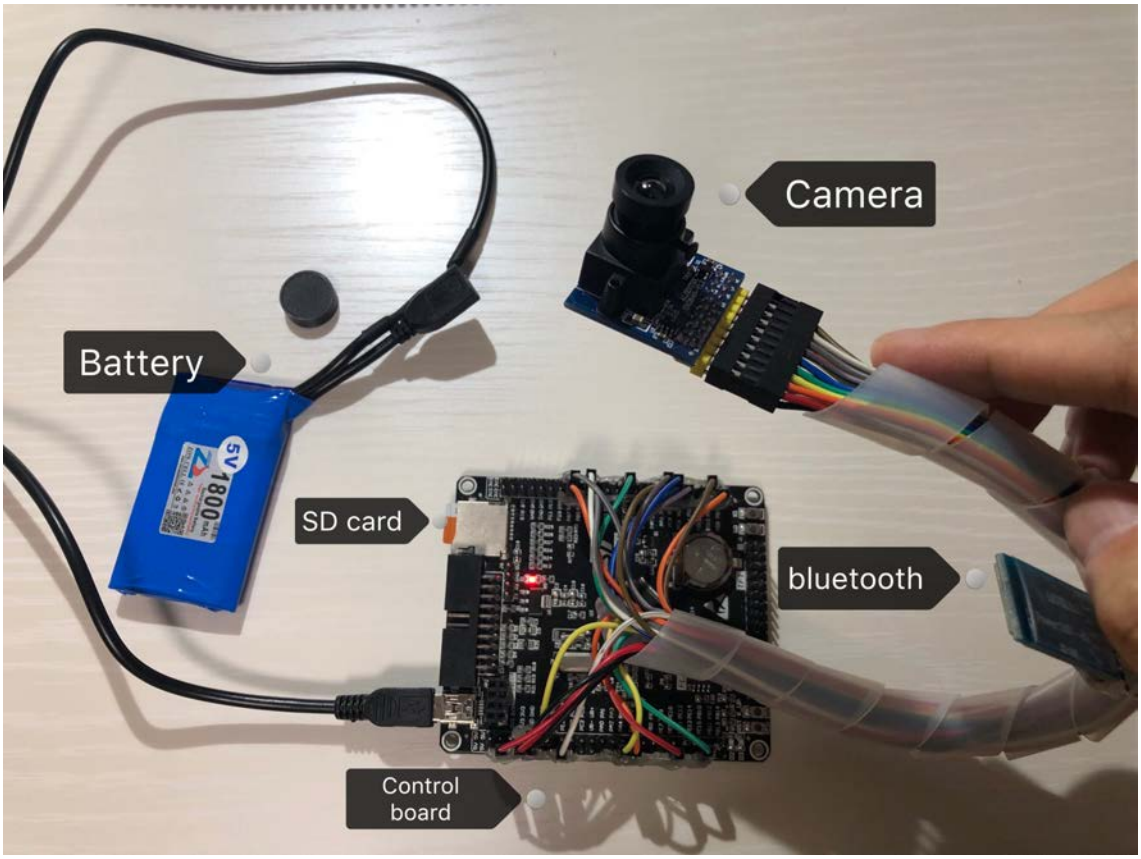

Figure 3.7 Output model structure

The output module consists of one battery, bluetooth, sd card, control board and camera.

Chapter 4
Proof of Concept

In this chapter, we will describe the implemented system based on the design described in Chapter 3. In addition, the effectiveness of the system will be verified by demonstration experiment and the results will be described.

4.1. Prototype

4.1.1 HEART SIGNAL components

There are many ways to measure heartbeats on the market today. Because I want to achieve my ideas by wearing gloves, so I chose the finger pressure heartbeat module.

The MAX30100 is a module with integrated pulse oximeter and heart rate monitoring sensor that integrates two LEDs, a photodetector, optimized optics and a low-noise analog signal processor to detect pulse oximetry and heart rate signal. The MAX30100 uses 1.8V and 3.3V supply voltages. The power can be turned off by software, and the current consumption in standby mode is negligible, so the power connection can be maintained at all times. Typical applications include fitness aids, medical monitoring equipment, and wearables.

Used Equipment

1.Heart rate sensor

General Description

The MAX30100 is an integrated pulse oximetry and heart- rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. [9]

The MAX30100 operates from 1.8V and 3.3V power sup- plies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

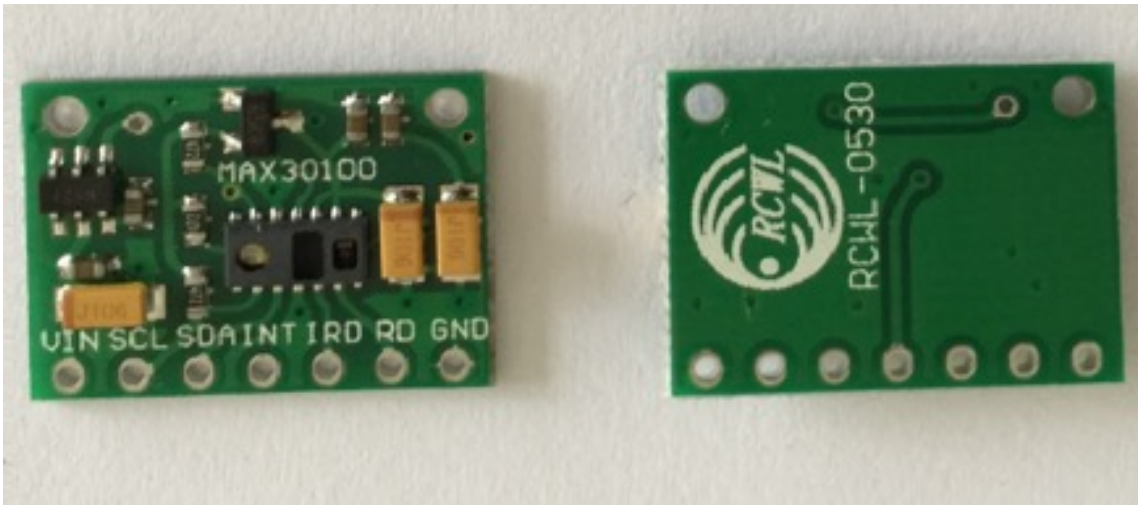

Figure 4.1 MAX30100

Applications

- Wearable Devices
- Fitness Assistant Devices
- Medical Monitoring Devices

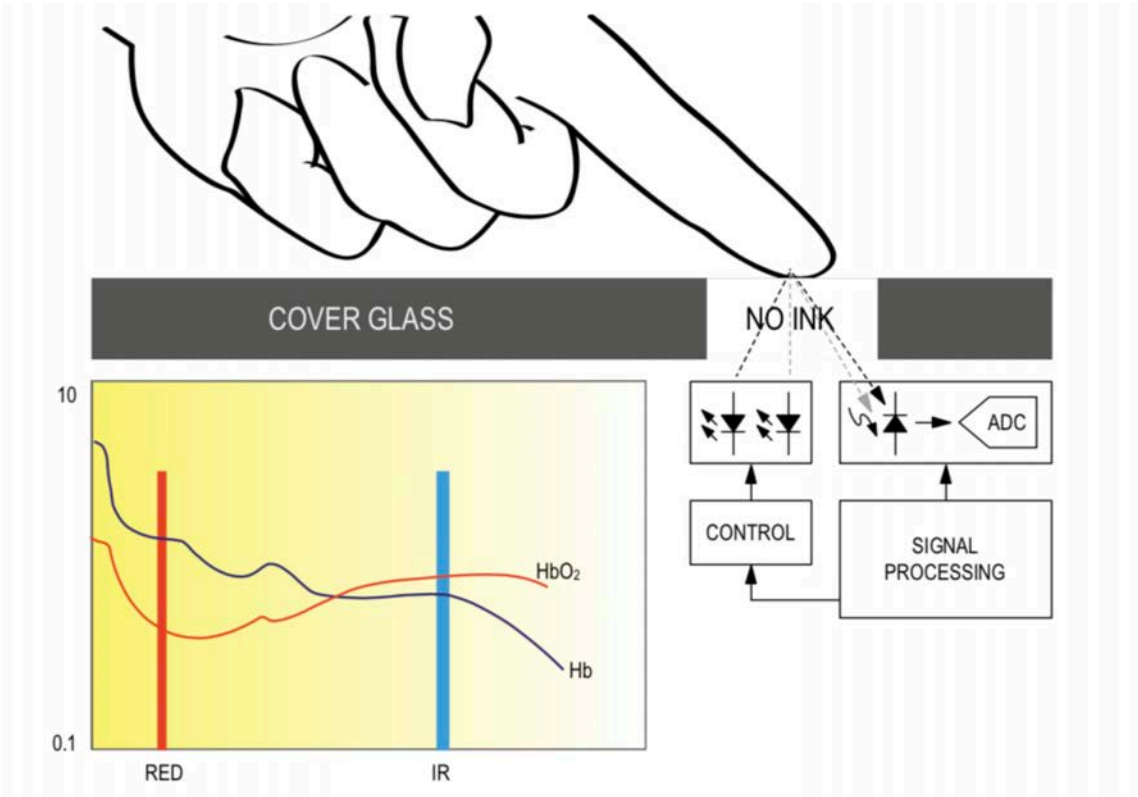

Figure 4.2 System Block Diagram

Benefits and Features

- Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design

  1.Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End

  2.Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package

- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices

  1.Programmable Sample Rate and LED Current for Power Savings

  2.Ultra-Low Shutdown Current (0.7 μ A, typ)

- Advanced Functionality Improves Measurement Performance

  1.High SNR Provides Robust Motion Artifact Resil- ience

  2.Integrated Ambient Light Cancellation

  3.High Sample Rate Capability

  4.Fast Data Output Capability

2.Control board — STM32

STM32 is a family of 32-bit microcontroller integrated circuits by STMicroelectronics. The STM32 chips are grouped into related series that are based around the same 32-bit ARM processor core, such as the Cortex-M7F, Cortex-M4F, Cortex-M3, Cortex-M0+, or Cortex-M0. Internally, each microcontroller consists of the processor core, static RAM memory, flash memory, debugging interface, and various peripherals. [10]

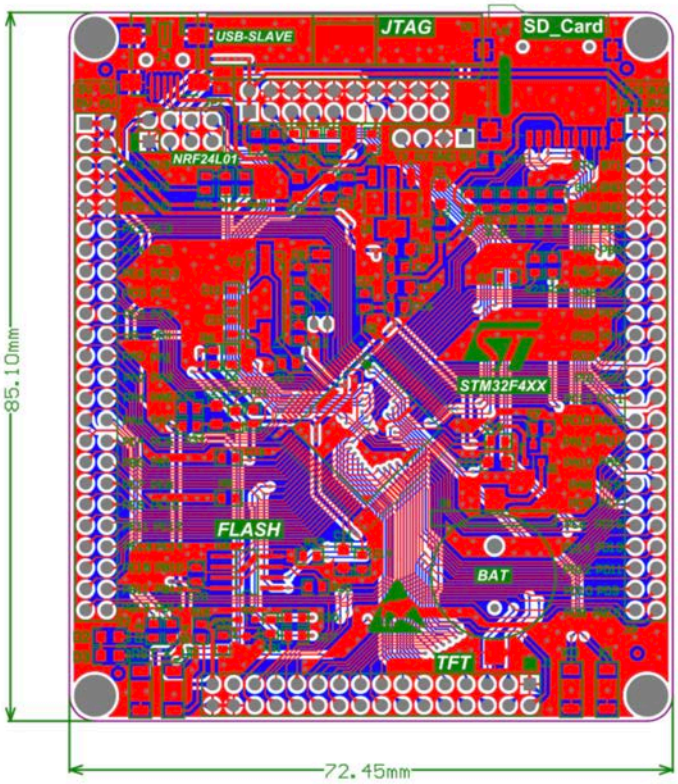

Figure 4.3 Control board-stm32

The STM32 is a family of microcontroller ICs based on the 32-bit RISC ARM Cortex-M7F, Cortex-M4F, Cortex-M3, Cortex-M0+, and Cortex-M0 cores.[1] STMicroelectronics licenses the ARM Processor IP from ARM Holdings. The ARM core designs have numerous configurable options, and ST chooses the individual configuration to use for each design. ST attaches their own peripherals to the core before converting the design into a silicon die. The following tables summarize the STM32 microcontroller families.

4.1.2 HEART SIGNAL prototype

Use C programming language to trigger camera to take pictures as certain bluetooth heart beat value collected from the MAX30100, and those pictures will be stored in SD card.As the below shows.

```
  u8 str[100];
  OLED_ShowString(0,0,"Input Initializing",12);
  OLED_ShowString(0,52," (Temp_Set)",12);
  OLED_ShowString(90,20,"K1:+",12);
  OLED_ShowString(90,34,"K0:-",12);
  OLED_ShowString(90,48,"UP:OK",12);
  OLED_Refresh_Gram();
  while(!Set_OK)
  {
    sprintf((char *)str,"TEMP=%2d ",T_Temp);
    OLED_ShowString(10,32,str,16);
    OLED_Refresh_Gram();
    delay_ms(100);
  }
  OLED_Clear();
  OLED_ShowString(20,28,"Temp Set OK",16);
  OLED_Refresh_Gram();
  delay_ms(1000);
  Set_OK=0;
  OLED_Clear();
  OLED_Refresh_Gram();
  return T_Temp;
}

u8 HR_Photo_Set(void)
{
  u8 str[100];
  OLED_ShowString(0,0,"Input Initializing",12);
  OLED_ShowString(0,52,"Value to photo",12);
  OLED_ShowString(90,20,"K1:+",12);
  OLED_ShowString(90,34,"K0:-",12);
  OLED_ShowString(90,48,"UP:OK",12);
  OLED_Refresh_Gram();
  while(!Set_OK)
  {
```

Figure 4.4 Input Text Setting

Initialization process

First step

Insert camera and SD card to Output module without power connecting, and the camera is installed as shown.

Figure 4.5 camera

Second step

With switcher on, the LCD on input module can open. Meanwhile, click reset button on output module when power is on to make sure that the LCD, bluetooth, camera and SD card on input module can work well.

Figure 4.6 OLED screen1

third step

Afterwards, set certain parameters, for example set critical number for temperature(if real temperature is higher than particular number, shooting will not be triggered), and set certain critical number for heart rate to make sure shooting can be triggered at certain heart rate range.

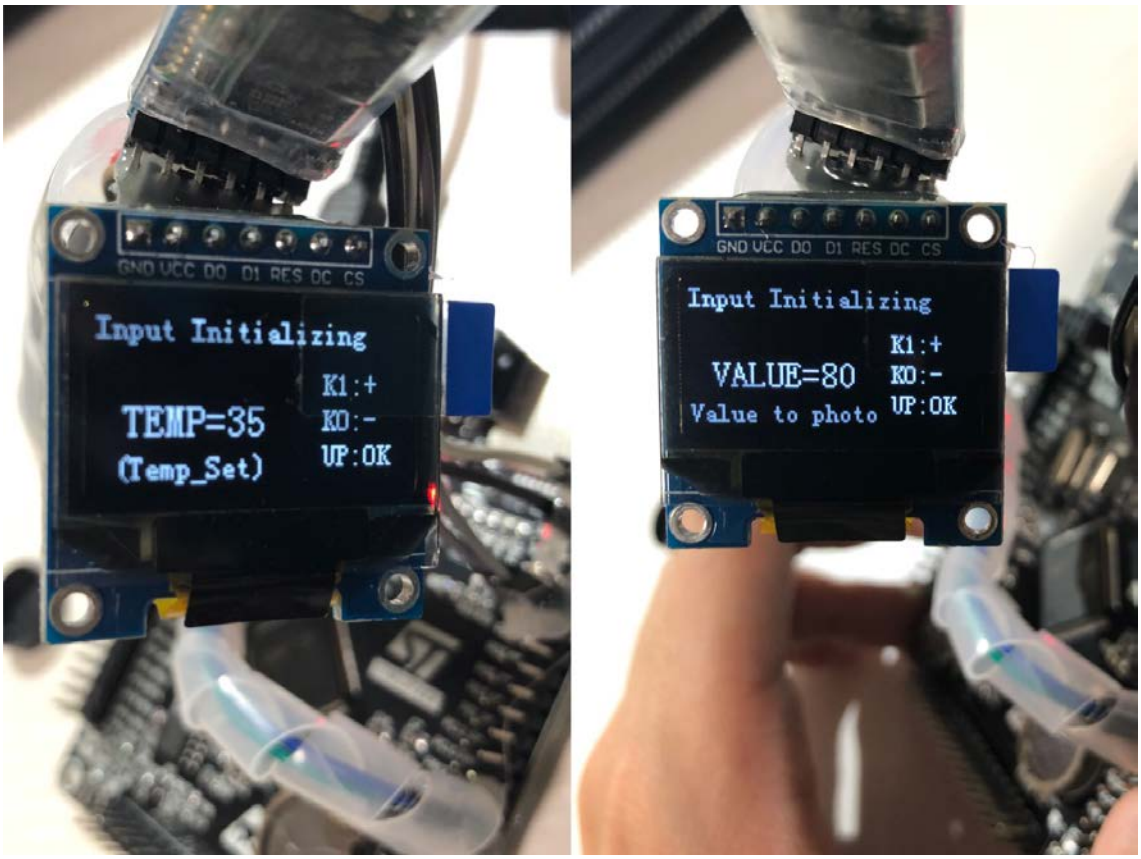

Figure 4.7 OLED screen2

the fourth step

When start detecting heart rate, the real-time heartbeat value at the moment will be displayed on the screen. Detecting the real-time heart rate value with HEART SIGNAL is very different with wristband watch or mobile sports applications, which is just detecting average data within certain period. Because of the real-time data, it can ensure the instant picture capture ability. If real-time heart rate value can meet setting requirements, it will take photos and store them on the SD card.

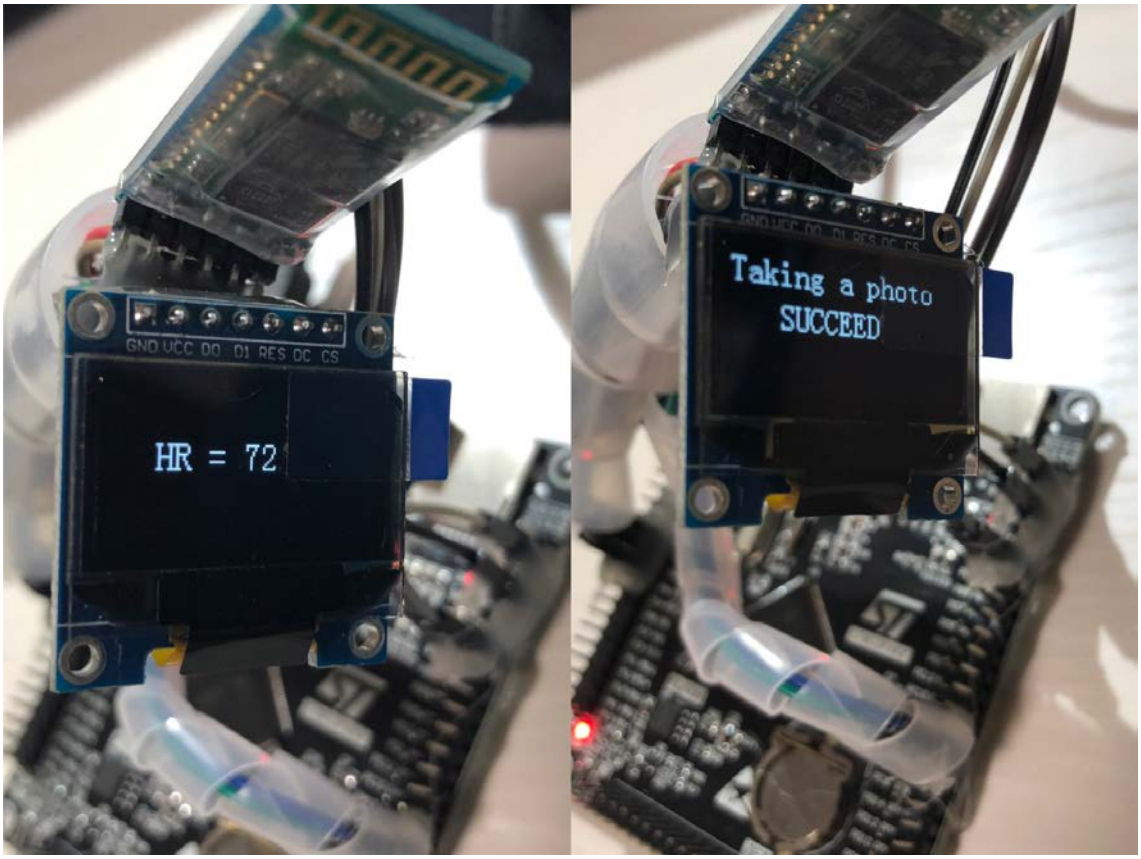

Figure 4.8 OLED screen3

4.1.3 Prototype overall review

4.2. Testing

Based on the above model, I designed two experiments to verify the functionality of HEART SIGNAL. One of the experiment is to compare the advantages and disadvantages of HEART SIGNAL and ordinary cameras. And the other experiment is to test whether HEART SIGNAL can record some special moments when playing games, such as Pokemon Let's Go with Switch.

Experiment 1

The first experiment was i designed a control experiment.I chose a horrifying movie (including a number of scary pictures) to validate HEART SIGNAL. The reason for choosing a thriller movie is that it can generate strong emotions in a short period of time, making the experiment even more obvious than real life.

Let users wear the HEART SIGNAL to automatically capture impressive scary photos, meanwhile they can also use mobile to take photos at the moment feeling scary. The movie cannot be played back or paused during the experiment as the time in the real life will not be paused.

Then compare the photos taken with the mobile with the photos recorded by HEART SIGNAL and finally let the user complete a questionnaire.

User test

Figure 4.9 User test

- 1 Wear HEART SIGNAL
- 2 Tell the users to take some unforgettable pictures with the phone in advance, and notify that movie cannot play back and pause.
- 3 After the video is played, Compare the two sets of photos to let the user share the feeling.

photos

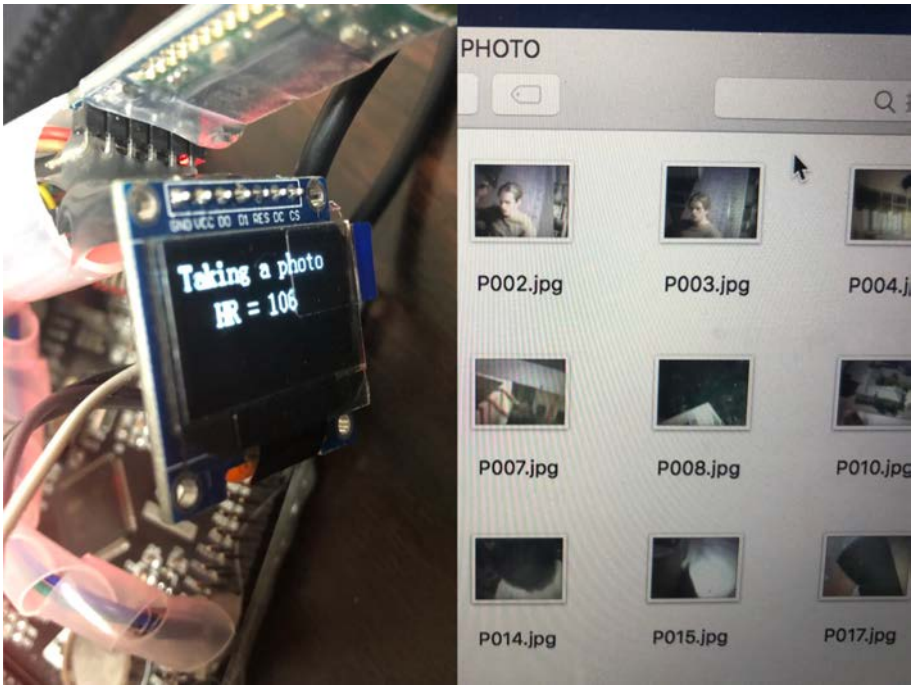

Figure 4.10 The photos taken by HEART SIGNAL

Figure 4.11 The photos taken by the mobile phone

Questionnaire

weizhu, 28, Seller

What kind of moments are you impressed in that video?

There are a lot of extreme sports inside, like the action of rolling around the tall building,

Do you have opportunity to take pictures during those impressive moments?

Yes,but sometimes I am fascinated by the content in the video, and I haven ' t had time to take pictures.

Are there similar situations in the daily life ? (Try to record some unexpected impressive moments, but cannot record as limitations)

Yes

Do you often use mobile phones and other camera equipment to record life ?

Not often, but most of times are taking pictures with mobile phones

How do you feel about the photos taken by HEART SIGNAL and photos taken by the mobile phone?

The picture taken by HEART SIGNAL is much more than i shoot. And the picture is a little bit fuzzy. Although some of them are not really the impressive moment I think, but it also took a lot of pictures that my mobile phone didn't have time to shoot.

Overall Feedback

- 1 The photos taken by HEART SIGNAL are not very clear due to module problems.
- 2 HEART SIGNAL can capture some impressive photos in the first time.
- 3 People have no time to take out camera during the short moment as human beings ' natural reaction is not real-time but always somehow delayed.
- 4 In addition to professional camera enthusiasts, most people choose to use their mobile phones to record their lives, mainly taking pictures of landscapes and food and some personal photos.

Experiment 2

As talked, gaming can be one the most suitable usage scenarios for HEART SIGNAL, and I chose Pokémon Let's go(role-playing video games developed by Game Freak and published by The Pokémon Company and Nintendo for the Nintendo Switch) as an example to validate if HEART SIGNAL can capture the excited gaming moments and if it can empower players with capturing and sharing gaming pictures.

- 1 Wear HEART SIGNAL
- 2 Let the participants play the Pokémon Let's go.
- 3 Check the collected photos （ test whether HEART SIGNAL can record some special moments in gaming）

Figure 4.12 User test

Questionnaire

Wenxi Li, 25, Engineer

What kind of moments are you impressed in that game?

There are a lot of impressive moments when I play the game, and especially I felt very excited when I captured one cute Pokemon.

Do you want to take pictures to record the impressive moments when playing games?

Yes,but there was no way to take a picture when playing games previously.

Do you often use mobile phones and other camera equipment to record games to share with friends or audience ?

Yes, but not often. Recording all the gaming will take long time and it will also take long time to distinguish the most impressive moments to share.

How do you feel about the photos taken by HEART SIGNAL?

The picture taken by HEART SIGNAL can match my impressive moments, and that's very surprise for me. Though the picture is not clear enough, it can catch the impressive moment at least. I would like to share with my friends!

4.3. Utilizing the Application

Based on the original prototype, the project wants to present these recorded photos on the application.

The shooting photos initiated by HEART SIGNAL can be uploaded to APP and can also be shared through social medias. Eventually, you can go back to re-experience each special moment by HEART SIGNAL, and share impressive moments with friends or audiences seamlessly without delay.

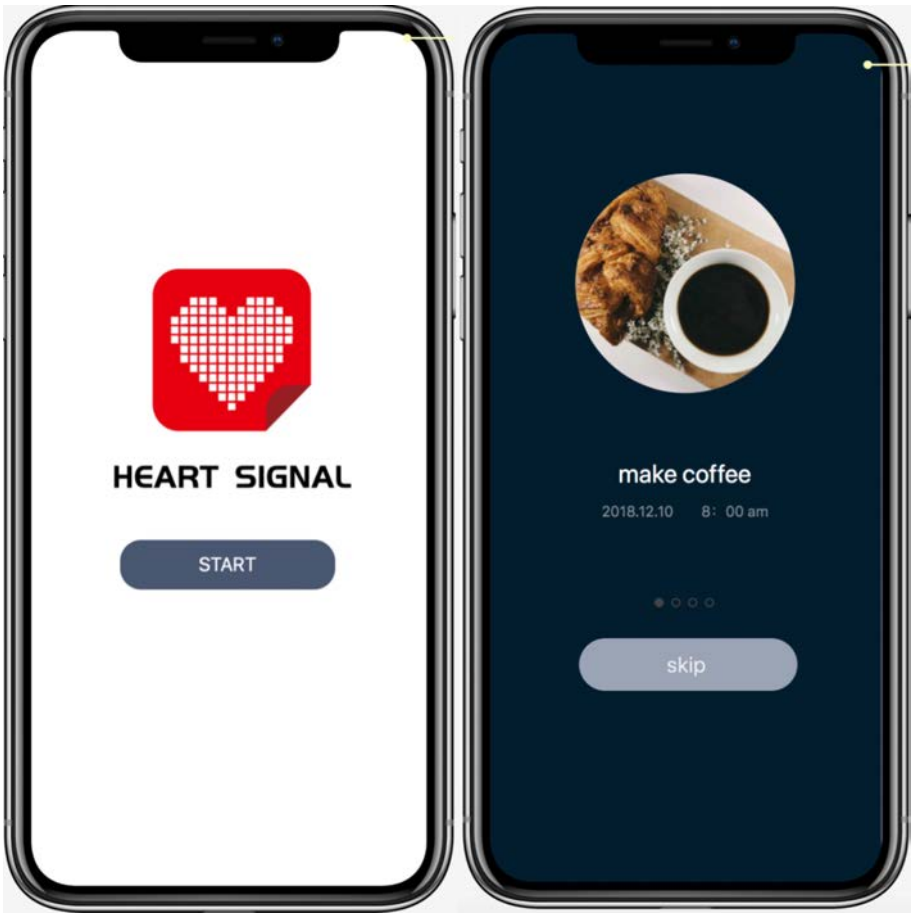

Figure 4.13 The main interface of the application

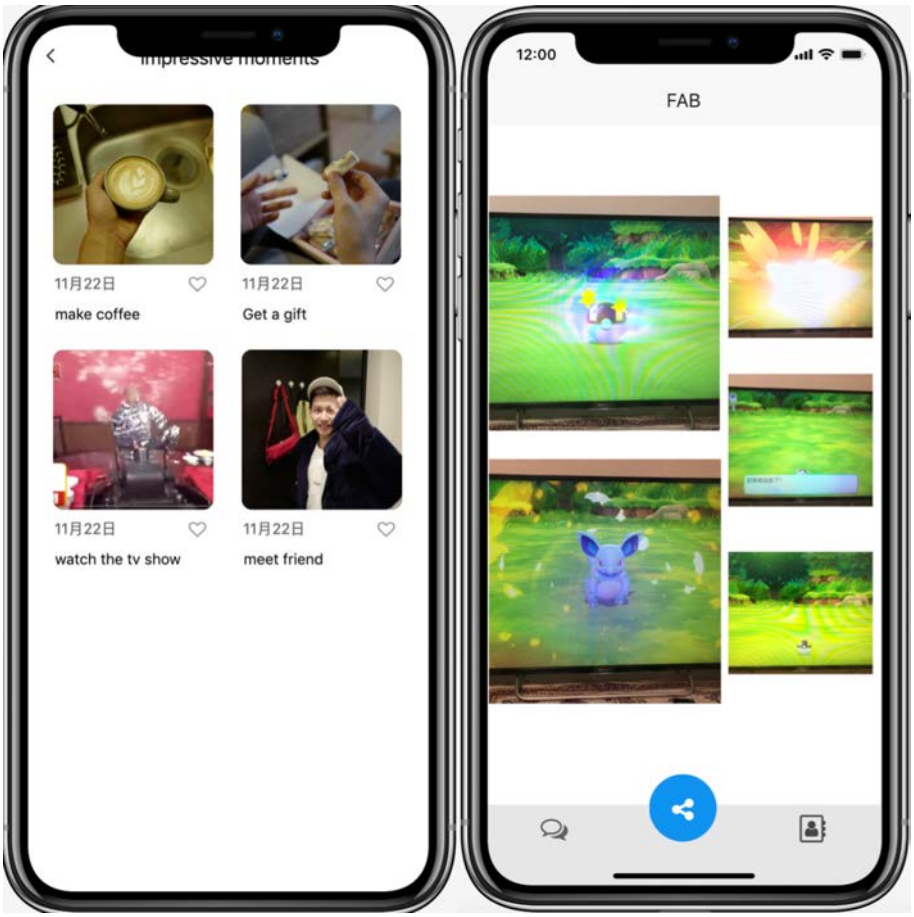

Figure 4.14 Record the classification of photos

Figure 4.15 Share recorded photos through social media

Chapter 5
Conclusion

5.1. Overview

Though new technologies of the new cameras we can see in the market can help achieve high photography quality, they cannot help capture the short moment which is easily missed in many scenarios like gaming scenario, and even with awareness people have no time to take out camera during the short moment as human beings ' natural reaction is not real-time but always somehow delayed.

This research can help automatically record interesting photos to avoid missing any touchable moments. HEART SIGNAL can help record those touchable and valuable moments once missed easily by wearing intelligent gloves and glasses. Recorded images can be stored in cloud to create one tangible photo album to share.

By utilizing real-time heart rate initiating photo shooting, HEART SIGNAL can help take photos during fleeting moments to avoid time difference as user initiating shooting with natural delay. HEART SIGNAL can help empower many usage scenarios, such as gaming scenario. By utilizing glasses and gloves, HEART SIGNAL can take photo at the impressive moment as heart beat. Beyond that, as shooting with HEART SIGNAL is totally hand free, therefore you can enjoy all the life moments and do not need to worry about missing important moments. With HEART SIGNAL, game players can capture and share impressive gaming moments without any delays in the future.

5.2. Future Plan

Because this research still has a lot of things to be perfected, it only solves the problem of taking photos with real-time measurement of heartbeat, and then can

review it on the mobile APP, but the accuracy of the photos taken by HEART SIGNAL remains to be verified. We could build a filter system, which can help analyze the pictures to filter out unrelated pictures.

Though HEART SIGNAL can take photo very silently, but it is not interactive and not fun enough for users. For the future, it could give users a hint when taking photos to remind users of the impressive moments.

Because photo quality taken by HEART SIGNAL is not good enough, therefore some testers don't want to share with friends. To encourage users to share photos taken by HEART SIGNAL, photo quality need to get improved in the future.

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[9] Roland pelayo,march 20, 2018,how to use the max30100 as arduino heart rate sensor.

[10] Turin area, italy, march 25 2016, stm32.

Appendices

```c
//
void Send_data(u16 data)
{
//  USART_SendData(USART1,data);//
//  while(USART_GetFlagStatus(USART1,USART_FLAG_TC)!=SET);//
}


/*
*/
extern void Send_Array(const u16 data1,const u16 data2,const u16 data3)
{
  u16 temp;
  Send_data(170);

  temp=data1>>8;
  Send_data(temp);
  temp=data1;
  Send_data(temp);

  temp=data2>>8;
  Send_data(temp);
  temp=data2;
  Send_data(temp);

  temp=data3>>8;
  Send_data(temp);
  temp=data3;
  Send_data(temp);

  Send_data(13);
  Send_data(10);
}

extern void Send_Array_Display(void);

u8 Temp_Set(void)
{
```

Figure .0.1 C programming language code

```
    u8 str[100];
    OLED_ShowString(0,0,"Input Initializing",12);
    OLED_ShowString(0,52," (Temp_Set)",12);
    OLED_ShowString(90,20,"K1:+",12);
    OLED_ShowString(90,34,"K0:-",12);
    OLED_ShowString(90,48,"UP:OK",12);
    OLED_Refresh_Gram();
    while(!Set_OK)
    {
      sprintf((char *)str,"TEMP=%2d ",T_Temp);
      OLED_ShowString(10,32,str,16);
      OLED_Refresh_Gram();
      delay_ms(100);
    }
    OLED_Clear();
    OLED_ShowString(20,28,"Temp Set OK",16);
    OLED_Refresh_Gram();
    delay_ms(1000);
    Set_OK=0;
    OLED_Clear();
    OLED_Refresh_Gram();
    return T_Temp;
  }

  u8 HR_Photo_Set(void)
  {
    u8 str[100];
    OLED_ShowString(0,0,"Input Initializing",12);
    OLED_ShowString(0,52,"Value to photo",12);
    OLED_ShowString(90,20,"K1:+",12);
    OLED_ShowString(90,34,"K0:-",12);
    OLED_ShowString(90,48,"UP:OK",12);
    OLED_Refresh_Gram();
    while(!Set_OK)
    {
      sprintf((char *)str,"VALUE=%2d ",H_HR_Photo);
      OLED_ShowString(10,32,str,16);
      OLED_Refresh_Gram();
      delay_ms(100);
    }
```

Figure .0.2 C programming language code

```
  }
  OLED_Clear();
  OLED_ShowString(0,28,"HR VALUE Set OK",16);
  OLED_Refresh_Gram();
  delay_ms(1000);
  Set_OK=0;
  OLED_Clear();
  OLED_Refresh_Gram();
  return H_HR_Photo;
}
void Take_Photo(void)
 {
  printf("Z");
  LED1=0;
  OLED_ShowString(0,0,"Taking a photo",16);
  OLED_Refresh_Gram();//
  delay_ms(500);
  LED1=1;
  while(!Take_OK);
  OLED_ShowString(0,20,"   SUCCEED   ",16);
  OLED_Refresh_Gram();//
  delay_ms(1000);
  Take_OK=0;
  OLED_Clear();
  OLED_Refresh_Gram();
}

void Input_Output_Init(void)
{
  u8 str[100];
  OLED_ShowString(0,0,"Output Initializing",12);
  OLED_ShowString(0,13,"(Press Key_RST)",12);
  OLED_ShowString(0,26,"1,Check Bluetooth",12);
  OLED_ShowString(0,39,"2,Check Camera",12);
  OLED_ShowString(0,52,"3,Check SD",12);
  OLED_Refresh_Gram();//
  while(!Bluetooth_OK);
  OLED_ShowString(110,26,"OK",12);
  OLED_Refresh_Gram();
  while(!Camera_OK);
```

Figure .0.3 C programming language code

```
  while(!Camera_OK);
  OLED_ShowString(110,39,"OK",12);
  OLED_Refresh_Gram();
  while(!SD_OK);
  OLED_ShowString(110,52,"OK",12);
  OLED_Refresh_Gram();
  delay_ms(2000);
  OLED_Clear();
  OLED_Refresh_Gram();


  th_temp=35;//
  th_temp = Temp_Set();
  HR_Photo = 80;
  H_HR_Photo = 80;
  HR_Photo = HR_Photo_Set();
  sprintf((char *)str,"TEMP=%2d ",th_temp);
  OLED_ShowString(10,0,str,16);
  OLED_Refresh_Gram();
  sprintf((char *)str,"VALUE=%2d ",HR_Photo);
  OLED_ShowString(10,40,str,16);
  OLED_Refresh_Gram();
  delay_ms(1000);
  OLED_Clear();
  OLED_Refresh_Gram();

}

int main(void){
  u8 str[100];
  short HR=0;
  u8 temp,TEMP_INT=0,TEMP_FRA=0;

  delay_init(168);//
  NVIC_PriorityGroupConfig(NVIC_PriorityGroup_2);//
  uart_init(38400);//
  usmart_dev.init(84);//USMART
  LED_Init();//LED
  EXTIX_Init();//
  delay_ms(100);
```

Figure .0.4 C programming language code

```
delay_ms(100);
IIC_Init();//IIC□□'□□
demo_max_init();//MAX3010□□□'□□,□□□□_□□□□□;□□□□□□□□
OLED_Init();
TIM3_Int_Init(10-1,8400-1);

Write_One_Byte(0x06,0x0A);
TIM_Cmd(TIM3,ENABLE);

Input_Output_Init();

while(1)
{
  TEMP_INT=Read_One_Byte(0X16);
  TEMP_FRA=Read_One_Byte(0X17);
  TEMP_FRA&=0X0F;
  temp=TEMP_INT+TEMP_FRA/100;
  if(temp<=th_temp)
  {
    POupdate();//□□'□□□□□□□□
    HR=getHeartRate();
    if(HR>42&&HR<150)
    {
      sprintf((char *)str,"HR = %2d ",(int)HR);
      OLED_ShowString(20,20,str,16);
      OLED_Refresh_Gram();
      if(HR > HR_Photo)
      {
        Take_Photo();
      }
      LED0=0;
    }else{
      LED0=1;
    }

  }
  else
  {
    printf("HOT\r\n");
    delay_ms(10);
```

Figure .0.5 C programming language code