University of Science &Technology of China

Course: Design Innovation Course

Title: Smart Gadget and Technologies
For Personal Safety

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Content

● Background

This section describes the implicit requirements of our topic, **Smart Gadget and Technologies for Personal Safety**, and our understanding of them.

■ Project Instruction

The purpose of this project is to develop gadgets and technologies to achieve goals like:

1. Predict and detect dangerous situations users may be faced with and give appropriate warnings to users.
2. Automatically notify trusted people and report to the police when users are in danger.
3. Guide users to safe places.

■ Project Analysis

1. Personal safety is a problem for all human beings and is even more serious when it comes to vulnerable groups that usually refer to children, the elder and women.
2. According to another key word "Smart", it is easy for us, on the one hand, to associate this project to the recently popular smart wearable devices like Google Glasses and Smart Band. On the other hand, to make a mobile APP to implement some functions based on existing high-quality performance of smart phones.
3. Considering the requirements of our project, we thought out several basic functions of this gadget including orientation, alarming, reminding, etc. Moreover, by thinking about this gadget is supposed to be useful under dangerous conditions, we assume it should be easily carried and unnoticeable, which contributes to our selection of wearable devices as well.

● Needfinding & Benchmarking

This section contains the result of Needfinding & Benchmarking . Our survey in this step can be divided into two parts, a general survey of wearable devices and a survey on needs of different groups.

■ **Survey Plan**

Based on our project analysis above, we made a plan for our surveys that involve general survey of wearable devices, needfinding & benchmarking.

1. General survey of wearable devices

The first survey we made is the general survey for those wearable devices and mobile APPs that have emerged already. The goal of this survey is to make us clear about some common forms of smart gadgets and technologies.

2. Needfinding & Benchmarking

We adopted several methods to conduct our needfinding & benchmarking including making interviews with different people for essential needs, using preferences and searching data online for available technologies, etc.

The target of our surveys:

✓ Needfinding

■ Problems of children and their parents' expectation

■ Problems of women and what can be useful for them

■ Problems of the elder and what can help them

✓ Benchmarking

■ Search for some products that designed for children

■ Find some products that can meet required functions

■ Look for some existing products or some useful concepts that can be used to solve women's safety problems.

■ **Survey Results of Wearable Devices**

We need to search for some existing products to have a general knowledge of their functions and forms which can be usefully referenced when we design our gadget. Though these functions might be designed for personal health or entertainment and these forms may have some limitations, we will be inspired by these products as well.

Table I: Wearable Devices

Product	Function	Brand

Smart Glass	Based on hardware platform that contains CPU, camera, touch tablet, displayer and microphone and Android operating system Can integrate a lot of functions	Google Glass
Wearable Camera	Can take photos continuously, supplied by APP, stand-by time can be a few days	Autographer
	Can take high quality photos continuously, supplied by APP, Automatically take pictures and then get them classified, cloud storage, stand-by time is about 30 hours	Narrative Clip
Smart Wristband	Detect heart rate and blood pressure, measure steps, calculate energy consumption, monitor sleep quality	
Smart Cap	Track heart rate, stride and step number, calculate calorie consumption, give advice to improve people' health	LifeBeam
Wearable Necklace	Can be used to listen music and make calls, support for voice-to-text import	Gear Circle
Smart Head Band	Detect the head impact's acceleration	Triax
	Adjust state of brain	Muse
Smart Ring	Control other intelligent devices	Logbar

■ **Survey Results of Needfinding & Benchmarking**

◆ **Children**

We conducted interviews with classmates, parents playing with their kids beside the pool in front of Library, West Campus of USTC, online talks with parents having used some existing products specially designed for children.

a) Needs

Some of the needs are concluded inversely from the functions of the

products. And from the surveys we realize that the most important function for devices used by children is precise location, which is also what the parents require most.

b) User's Feedback

From our investigation of the user experience towards existing products, we find that it is usual for parents to be disappointed with the low accuracy rate of location of 360 Children Defender, but some of them say the location of Bangbang Bear is much better. What's more, parents think the color of these devices are too bright that they are easily to be noticed and then taken away by criminals to avoid being located, therefore, parents think the hidden ability of devices is supposed to improve one step further. For LG Children's Smart Wristband and Bugua Parent-Child Smart Watches, there are not any valuable evaluating information for now. Let's wait and see.

c) Conclusion

Primarily, the devices for children are well designed and have been considered in detail, there is not much space for us to extend.

Table II: Children part

Need/Product		360 Children Defender（Watch）	Bangbang Bear	LG Children's Smart Wristband	Bugua Parent-Child Smart Watches
GPS	Real-time Location	GPS,WIFI,Base Station,Gravity Sensor	GPS,WIFI,Base Station, Inertial Navigation, Trace Logger	GPS,WIFI,Base Station, Inertial Navigation, Timing Query	GPS, AGPS, Base Station
	Parents' Checking				
Accompanying distance detecting		Safe Distance setted by parents	×	×	Safe Distance setted by parents
One-Touch SOS		Appropriative Button	Multiple Contacts, the same button for recording(3s for recording, 15s for SOS)	√	Mutiple Contacts(with a max of 8)

Electronic Fence		√	√	×	√
Communication	Audio	Parents require to record by the gadget for 10s, one-way	Pressing the button for 3s to record or parents require	Two-way timing calls	Two-way timing calls and parents require
	Message	×	Parents send to gadget, one-way	×	×
Social		×	×	×	3 partners to talk with
Step number Detecting		√	√	√	×
Bonus for using		√	√	×	×
Grade of Waterproof		IP65	IP65	×	IP65
Hardware Requirement	Communication Block	GSM 900/1800, GPRS, Bluetooth 4.0 BLE	Built-in SIM card, CDMA network	Built-in 2G SIM card, CDMA network	GPS、AGPS、Base Station
	System Supported	Android 2.2 and above iOS 5 and above	Android 2.2 and above iOS 5 and above	×	Android 4.0 and above iOS 7.0 and above

◆ **The elder**

Based on the information collected from the internet and conversations with our classmates, we classified the needs of the elder into nine aspects and provided two representative products.

a) Important aspects:

1) Tumble or motionless detection

Most important for the elder.

2) Sudden health problems detection

According to a survey done by Xiaoyu Liu, pulse signal detection seems to be of little feasibility. Until breakthroughs in pulse or other physical signal detection happen, innovations in this direction may not be

promising.

3) Collection, arrangement and analysis of health information

    Sense-U: check health information of relatives

b) Conclusion

    Since the marketing time of Sense-U is Aug. 2014 and most of the major needs can be met with this product, space left for us to make improvements may be small. What's more, the founder of Sense-U Corporation is an alumni of USTC and we don't want to compete with him in this field. So we decided to change our target consumers.

Table III: The elder part

Need/ Product	e-Peiban (Not On the Market)	Sense-U (On the Market)
Tumble or motionless detection	APP, SMS, Phone call	√
Sudden attack of health problems	×	×
Emergency alarm button	√	×
Sleep quality	×	√
Daily activity detection	Daily exercise information detection	Detect daily exercise intelligently
Collection, arrangement and analysis of health information	√	Online account, check the health information of other family members
Real time position detection	√	×
Bi-direction audio communication	√	×
Water-proof	√	×

◆ **Women**

a) Internet

Based on the information from Internet and our simple analysis, we can figure out that the function of GPS location should be provided in our prototype definitely.

b) Interview

Interviewees: 13 young ladies (female undergraduates mostly)

2 police officers

1 taxi driver

(Every interview has a voice recording of 30 minutes on average)

After having interviews with above people, we can conclude:

1) Through talking with female undergraduates, we could find that most of them or their parents hope to record the vehicle information once upon they get on a vehicle, especially by simple ways.

2) After talking with 2 police officers, the prototype we design should be helpful in case of emergency. Besides, we notice that in some cases female are threatened to hand in their cell phones, which should be taken into consideration.

3) Based on a conversation with a cab driver, we could know that if we take a picture of the license plate before we get on a vehicle, it would be offensive and impolite. Because it shows a clear message that *I do not trust you*. More or less, the driver would feel uncomfortable, although the driver we interviewed with said that it could be understood.

c) Functions that some products provide

Some functions we list in the following table are directly from some products, wearable devices and mobile apps included, like Call Security, Alert My Friends in Emergency part.

Table IV: Women part(1)

Need/Product		Wearable Device		
		First Sign Hair Clip(not on the market)	Personal Emergency Alarm	Defender(not on the market)
GPS	Safety Score Based on Location	×	×	×
Emergency	Call Security	√(Mobile App)	×	×
	Alert My Friends	√(Mobile App)	×	×
	Alarm & Flashlight	"Help is on the way, and evidence collected."	120dB & LED	√
	Cancel	Deactive any false alarms	√	×
	Pepper Spray	×	×	√
Vehicle Information	License Plate Recognition(Auto/Manul)	×	×	×
	Inform friends	×	×	×
	License Plate Verification	×	×	×
	Path planning(Remind when out of path greatly)	×	×	×
	Infrared Image	×	×	×
Cloud		×	×	Post GPS location and photos
Socialization		×	×	×

Hidden/Aesthetics	Head & Handbag	×	√

Table IV: Women part(2)

Need/Product		APP			
		Circle of 6	HelpMee	Watch me 911	SafetiPin
GPS	Safety Score Based on Location	×	×	×	Tracking &Safety Score
Emergency	Call Security	√	Trigger: Button, Shake, Headset-Trigger, etc.	√	×
	Alert My Friends	"Come and get me" & GPS location		Facebook & Twitter	×
	Alarm & Flashlight	×	Siren & Whistle	√	×
	Cancel	×	×	×	×
	Pepper Spray	×	×	×	×
Vehicle Information	License Plate Recognition(Auto/ Manul)	×	×	×	×
	Inform friends	×	×	×	×

License Plate Verification	×	×	×	×
Path planning(Remind when out of path greatly)	×	×	×	×
Infrared Image	×	×	×	×
Cloud	×	×	×	Users and professionally trained auditors
Socialization	×	×	×	Circle of interest

■ **Summary of This Step**

Considering the needs of these three groups of people and the products used to solve the corresponding problems, we concluded that we could do something to help women when they are in danger. Moreover，their problems are more complex than those of children and the elder.

The followings are some points we may improve to guarantee the personal safety of women.

1) We can compute the safety score of a certain location and remind women when they are in an unsafe place.

2) We may find a way to record and verify the information of the taxi via the license plate.

3) The separation of the alarming device and the device that sends the emergency massage may be one point we can improve. Or we may simply abandon the usage of alarming device by considering possible danger raised by it.

4) We may add path planning and reminding based on electrical map and GPS.

5) We may also expand the usage of our devices to socialization functions such as creating a group and sharing the position information within the group.

6) Taking the target consumer into consideration, we should focus more on the aesthetics of our design, or even hide it inside clothes.

● **CFP & CEP**

■ **Brainstorming**

◆ **Discussion with the whole classmates**

The following is a list of all solutions mentioned in the discussion in the class.

1) Rank the safety score of the time period, place, scenario, and record it on maps.

Explanation: By ranking the places and build up the corresponding database, users can search the safety score of a certain place.

2) Find a companion. Develop a software to achieve this. Rank the credit level of users.

Explanation: Users using this application can post their traveling information in advance and find someone to go with him/her. As for the credit level part, this can be done by other users as well as the police. In order to protect the traveling information, this information is only visible if the traveling information of the searcher corresponds with the person posted it.

3) Set starting places and destinations in advance. If the route is not reasonable, send message to the relatives and the police and remind users automatically. If it is used in a long-distance trip, take the weather condition into consideration.

Explanation: Input the APP the destination of this trip. The APP will recognize whether the route is correct and whether the taxi driver is intended to go somewhere other than the destination. If there is an abnormal circumstance, send the current position of the user and the information of the vehicle to the relatives or call the police. Monitor the weather condition with a fixed time interval or randomly, if there is an information forecasting a bad weather, remind the user with this.

4) A software used to capture the information of a vehicle. Maybe it can take pictures automatically and capture the vehicle information from the license plate and send it to the Cloud or the emergency contact person.

5) Wearable devices with the locating function. Add GPS module to the APP and send the location information can achieve this goal.

6) Verify a vehicle. Realize this function through using the information in the vehicle (perhaps the information of taxi drivers in the taxi) and the information of other devices in the vehicle.

7) Verify whether the driver is the owner of this vehicle or not. Use the comparison of the photo of the real driver and the driver's information shown in the vehicle.

8) Detect whether there is a car following the vehicle the user takes.

9) Intention prediction. Use the facial expressions, real-time images, speeches to classify whether the driver has a bad intention. Technically, this can be done by pattern classification techniques and wearable devices such as smart glasses. One problem is that there is not an effective way to deal with the unacceptable classification error in practical uses.

10) Mental detector. One possible obstacle is that there might be other mental devices in vehicle other than tools used for criminal purposes.

11) Do not allow girls to take vehicles at night. It is too mandatory.

12) A walking stick used to travel.

13) Build up a credit level system for passengers. Do not accept passenger with a low credit level (a high criminal level) to take free rides or get in the car in the middle of the trip.

14) A recording and communicating system placed in the car. One problem is that not all cars are willing to setup this system.

◆ **Discussion in the group**

Based on the results of the brainstorming step in the whole class, our group discussed the functions we think both feasible and able to meet the needs of users.

1) A small device, which could capture photos, pinned on bags of the user Equip this device with a button that can be used to make a fake call to the phone of the user him/herself or send messages to the emergency contact.

Figure I: Smart Cameras

2) While passing a cross, send the corresponding time and location to the Cloud so that if an emergency circumstance happens, this information can be searched and we can extract the information of the vehicle from the video captured from the monitor of that cross.

Figure II: Monitors at a Cross

3) Grant a higher privilege to the parents of users (mostly young female students) and let them to monitor the condition of the device.

4) Pin a camera on belts of backpacks. Maybe there can be a smart wristband

to control the actions of capturing and calling the police.

5) When step into somewhere unsafe, vibrate the wristband to remind the user.

Figure III: Wristbands

6) Provide different working modes. Decide automatically whether to activate the in-danger-mode according to the time, location, weather and other parameters got in this certain scenario.

7) Provide the function of establishing groups. This can be done by imitating WeChat, such as establish a group face to face (perhaps by touching two wearable devices) or via APPs in smart phones.

8) Perhaps use forms such as smart backpacks (with cameras on belts) or smart shoe-pads (compatible with functions such as calling the police by stamping using a certain frequency or reminding the user by vibration of shoe-pads).

9) One of the other forms include ornaments such as hairpins (hair clips) or breastpins.

10) One form is a smart respirator.

11) Another form is a ring. Put the button on the ring to make it easy to be pressed.

Figure IV: Rings

12) Use existing wearable devices such as iWatch to develop an application. We did a lot surveys on this, but found that there is no camera on iWatches. In addition to that, there has to be iPhones to cooperate with them. Thus we decided to design a wearable device by ourselves.

Figure V: iWatches

■ **CFP**

◆ **The most urgent needs**

In the Needfinding step, we propose the following needs.

1) The monitoring and sending of the location information.

a) One sub-function is a ranking and predicting of the safety score based on the location information.

2) Tackling emergency circumstances.

   a) Call the police.

   b) Inform relatives.

   c) Generate sound or light.

   d) Allow a revoking action if a wrong action occurs.

   e) Emit physical matters such as peppers.

3) The information of the vehicle.

   a) License recognition.

   b) The verification of the information of the vehicle.

   c) Inform relatives and friends promptly after entering the vehicle.

   d) The classification of the route of the vehicle. Remind if the vehicle goes beyond reasonable routes.

   e) Use infrared camera at night.

4) Send the information recorded to the Cloud.

5) Social functions.

6) Highly disguised appearance and beauty.

   Among all these needs, we figure out that the most urgent needs are as follows.

1) Monitoring and sending the location information.

2) Tackling with urgent circumstances.

3) The capturing and sending of the information of the vehicle.

◆ **An elaborate explanation of the functions of the APP**

Based on the most urgent needs above, and considering if there is a companion, the probability of facing an urgent circumstance will decrease dramatically. We proposed an application with an innovative function called *go together with your schoolmates*. Our concern is that if we limit the users to schoolmates in a certain university and verify the identifications of users, the safety rate will certainly increase. Our application is a combination of three

functions, namely *go together with your schoolmates, capturing and sending photos with one touch* and *call the police with one touch*. The *call the police with one touch* function may be combined with an external wearable device with a button.

An elaborate explanation of the functions of the APP is as follows.

Figure VI: Sketch Map of the Login Interface

➢ **Go Together With Your Schoolmates**
1) On registration, users should type in his/her school email address. He/she will receive a verification code in his/her email. Simply typing in this verification code and the registration step is finished.

Figure VII: Sketch Map of the Registration Interface

2) After a successful registration, the interface will turn to the traveling information interface. Users can type in his/her traveling information and choose to search for existing posters or to post his/her own. They can also enter the personal information interface by clicking the button on this interface.

Figure VIII: Sketch Map of the Traveling Information Interface

3) By clicking the button on the top left corner of the traveling information interface, users can enter the personal information interface. This interface shows the information of users such as name, gender, year of registration to the university, department and e-mail. The only thing changeable is the telephone number.

Figure IX: Sketch Map of the Personal Information Interface

Figure X: Sketch Map of the Phone Number Changing Interface

4) As for the search result, rank it according to the extent to which it corresponds with the traveling information of the user. The search result contains information such as the real name, the gender, the year of registration to the university and the department of the person posted this information. If the user want to contact the person posted the information, he/she should click the buttons named *call* or *send a message*. After clicking the button, our system will contact the person posted the traveling information using phone numbers provided by him/her. While contacting, both the user and the person posted the poster will use a fake number to protect privacy.

Figure XI: Sketch Map of the Search Result Interface (Folded)

Figure XII: Sketch Map of the Search Result Interface (Unfolded)

5) If there is no satisfying option, the user can choose to post a traveling information. In addition to the information provided before, he/she can also add remarks (for example the train number, the flight number, a more flexible time period) to provide more information about his/her traveling plan.

Figure XIII: Sketch Map of the Traveling Information Post Interface (Unfolded)

6) If someone contacted the poster provider, the person posted this poster can choose to delete this poster immediately or to wait for more companies. If the traveling time posted has already passed, our system will delete this poster automatically.

➢ **Capturing & Sending Photos with One Touch**
1) If there is a license number in the photo, the app can recognize it and attach this information to information sent to the Cloud.
2) Send the photos and the location information to the Cloud and send a message containing a URL to the appointed person. The person receiving this message can check the photos and location information

by clicking the URL.

Figure XIV: Sketch Map of the Photo Capturing Interface

3) Users can change or add receivers of this information, set whether to upload the photo, whether to upload the location information, whether to inform the receiver automatically and whether to recognize license numbers automatically.

Figure XV: Sketch Map of the Photo Capturing Settings Interface

➢ **Call the Police with One Touch**

1) Use an external wearable device to call the police. Press the button once can make a fake call to the telephone of the user him/herself. Press the button continuously can send an SOS message to the relatives or call the police directly.

2) Users can set the working mode of this wearable device on the APP. They can set the information of the receivers and choose whether to send the SOS message directly to the police.

Figure XVI: Sketch Map of the SOS Message Sending Settings Interface

■ **CEP**

1) Feedback one:

   a) The *go together with your schoolmates* section is a very common function. You should use the license number recognition function and the *call the police with one touch* as your main features.

   b) In the registration section, type in the password of the user's e-mail to complete the verification step.

   c) Give out discount coupons when users finish the verification step. Find companies to cooperate.

   Comments: It is beneficial to cooperate with universities, so we will accept it.

Typing in the password of user's e-mail may cause dissatisfactory.

2) Feedback two:

a) It is good to add the *go together with your schoolmates* section.

b) Maybe recommend posters according to the destination city because it is ok to go together if users' destinations are the same and they want to go in a few days.

c) It is not good to show the real name, gender and other information because they are just going a short distance together.

d) Maybe recommend posters according to the department or the registration year to the university. As it is for practical uses, the simpler the better.

Comments: The safety rate may decrease if we do not provide information like the real name and gender, and it may be acceptable to know each other's name since they will go together. So that we preserve our own idea of this feedback. As for the feedback about recommending according to the department, it will make our application more user-friendly. So that we accept this feedback.

3) Feedback three:

a) In the *go together with your schoolmates* section, it may be hard to find proper posters if it is not a common period of time to travel.

b) Users may be lazy and wait for others to post the traveling information if they can find other's traveling information freely. Maybe it is better to force the user to type in his/her own traveling information before he/she can search or see other's information. Or to enable the contact function only if the user has already typed in his/her own information.

c) It is proper to use APP as a platform. But make sure to attract enough users.

d) It may be troublesome to call the police directly.

e) The *call the police with one touch* function should be easy to find, and should be able to avoid misoperation at the same time.

f) It may be better to recommend users to use the *capturing and sending photos with one touch* function and the *call the police with one touch* function if they cannot find proper companies.

Comments: We accept the feedback that results and the contact information

are only visible after typing in the user's own information. We also accept the feedback that the *call the police with one touch* function should be easy to find and should be able to avoid misoperation. In addition to these two feedbacks, we also accept the feedback that the application should be able to avoid causing trouble to the police. Users may have the option to send the emergency information to the emergency contact person, to the Cloud and be able to inactivate the function of calling the police automatically.

4) Feedback four:

    a) I can accept to go with him or her as long as he or she is a student at USTC.

    b) You are able to put the function of *going together* under Educational administration system of USTC.

    c) You are able to combine the function of *going together* with taxi-hailing apps.

Comments: The school may not agree with that putting the function of *going together* under Educational administration system, and it is very inconvenient to log in if it is like that, so it is not viable. And the suggestion to combine the function of *going together* with taxi-hailing apps is not good enough because we are not sure that it is possible to protect users' privacy.

5) Feedback five:

    a) People prefer to find someone who is able to go home with them together instead of only going to railway station or airport together.

    b) It seems pretty inconvenient to make an APP to find a person to go with you together because the distance between school and airport or railway station is not very long.

    c) We have to find each other to go together in the APP, and we don't know each other, perhaps people will not like to use this APP.

Comments: We should not deny the existence of potential users because we can often see someone looking for people to go with him or her to airport or railway station on social network sites, there are indeed some people needing this function.

6) Feedback six:

a) You can achieve the function of *going together* on Wechat by a public account instead of an APP.

Comments: We can't deny that an APP is faster, has more functions and better user experience or interaction experience while indeed the public account has some advantages at the same time. We will consider how to make a balance in these two ways.

- **First Design**
  - **Features of Software Part**
    - ◆ Students in the same school can go out together
    - ◆ Protect the user's privacy
    - ◆ Reduce the risk when the user goes out

    We don't change our design that in the CFP part, so we do not need to introduce more about the software here.

  - **Features of the Watch**
    - ◆ Sending alert automatically

      a) When users are in some dangerous conditions such as under observation or threat, and they can not call the police by themselves

      b) When the operations are complicated for users to send alert

      c) Users become unconscious before they want to send alert

      d) When other devices such as mobile phone that used for sending alert have been graded by the criminal
    - ◆ Sending alert by users

      When users aware of dangers they can send alert by pressing on the button
    - ◆ Security model

      Under this model the watch just work as a common watch and do not test ambient environment of users
    - ◆ High risk model

      Under this model, the watch can test ambient environment of users and judge risk by analyzing information like location, time, users' heartbeat, etc.

Also it can remind users of danger and require users give confirm whether they are safe or not.
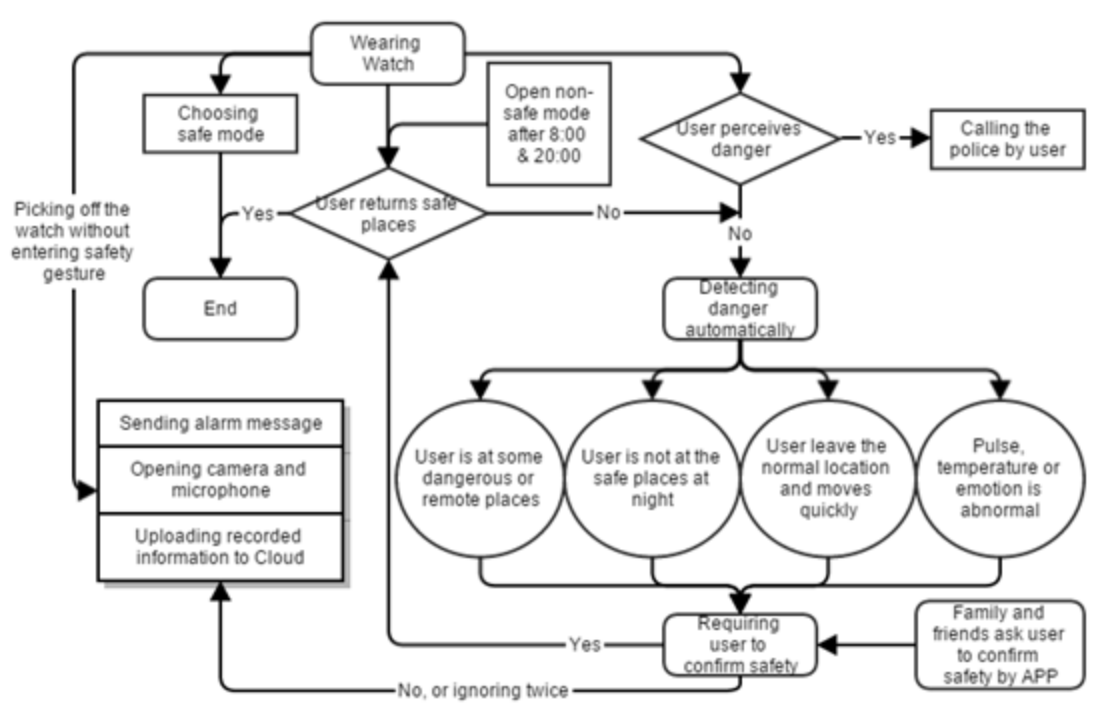
Figure XVII : Flow Chart

● **Prototype**

■ **Dark Horse**

We decide to give up some functions of the previous design of our project for some reasons as follows:

a) The design of *go together with your schoolmates (GTWYS)* does not fit the project's topic very much. Instead of eliminating the possibility of people going out alone, the need of predicting danger and calling for police in time is much more serious.

b) The function of One-Click Camera is kind of inconvenient, because this function requires users to take out the cellphone and aim at the part of plate number, which is a relatively complex process and easily to be interrupted by bad guys.

c) The wristband will not vibrate and have no touch screen to unlock the high-

risk mode any more, these functions are too difficult for us to realize and will magnify a lot the size of wristband.

We improve the design of our project into the final edition:

a) The wristband has only two functions: 1. Detect the heart rate of users and send it to app; 2. There is a place easily to snap to send a signal to app asking for sending message to emergency contacts immediately;

b) The APP is able to show the heart rate sent by wristband on the welcome page and when the heart rate is not belong to one special section, the APP will ask users to confirm the safety situation.

c) The APP is able to detect whether the easily snapped part has already been snapped. Once the movement is done, the APP will send "call for help" message to emergency contacts at once.

d) There will be two working modes for APP, including SAFE MODE and UNSAFE MODE. When the app is working under SAFE MODE, it will only judge the situation of heart rate and easily snapped part; When the app is working under UNSAFE MODE, it will also calculate the Safety Score of the current position and time, if the current Safety Score is lower than one threshold, the user will be required to confirm the safety situation.

■ **Wristband**
  ◆ **PCB Design**
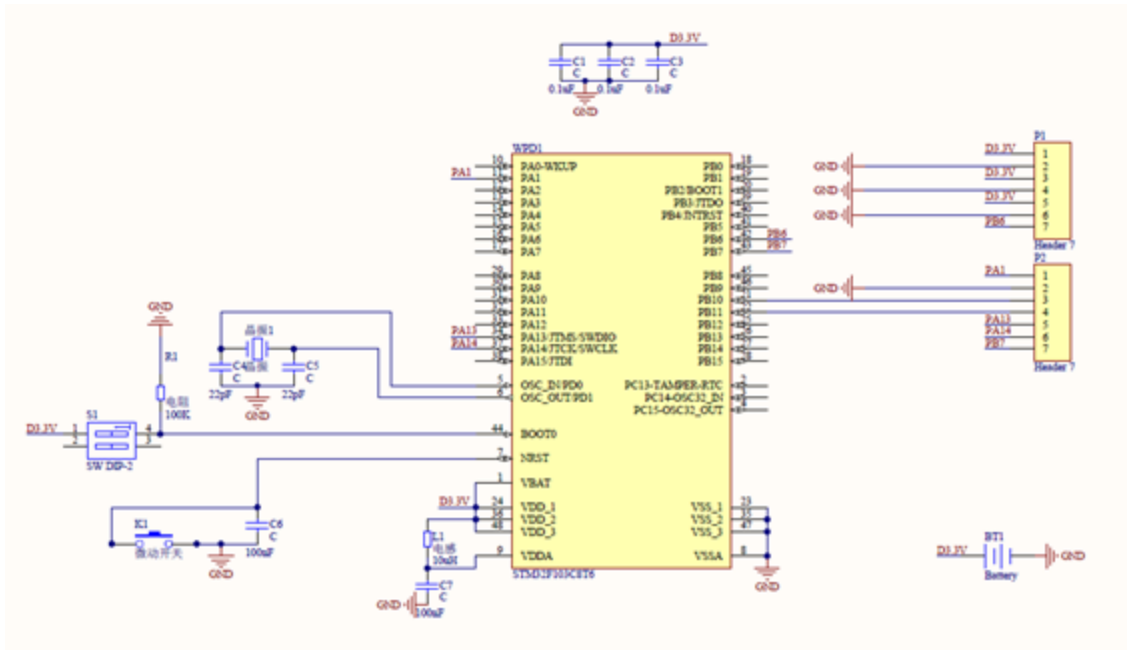
The main functions of the wristband are:

a) Detect the user's heart rate

b) Pull off alarm: send an alarm short message to emergency contacts when users pull off the wristband.

The components of wrist band are as follows:

a)Mainboard: It contains the circuits that designed by us and the chip microcomputer

b)Blue tooth: It can be used to transfer information between the wristband and APP

c)Heart rate senor: By contacting to the skin,it can detect the user's heart rate

d)Snap position: when the user in danger, she can snap this place so her emergency contact can know her situation

Component selection:

a) Chip Microcomputer: STM32F103C8T6

b) Blue Tooth: HC-05

c) heart rate senor：SON1205

Pins used in STM32:

a) Based on the functions we need, we choose to use STM32F103C8T6 as our main chip. STM32F103C8T6 has 48 pins. Some of them are specifically defined, while others can be defined freely by programmers.

b) As for the battery unit, there are three 0.1uF capacities between D3.3V and GND. We connect VBAT, VDD_1, VDD_2, VDD_3 and provide +3.3V voltage to them. Then we add a 10uH inductance between these pins and VDDA. All these pins are connected with GND through an electric capacity.

c) The oscillation part is consisted of two 22pF capacities and one 8MHz crystal oscillator. The capacities filter the oscillation signal and ensure the stability of the system.

d) The start mode selection unit is consisted of one resistance and one switch. As is shown in the figure, when the switch is on, the signal level at BOOT0 is 1 (high). This design can be improved by simply design two via holes to avoid space consuming.

e) The reset part needs a switch and a 100nF capacity. This part can also be simplified or removed.

f) Some pins are connected to pin holes and may be used to connect with other independent units. These include three D3.3V pins and three GND pins, which are main components of P1. Another pin hole in P1 is connected to PB6, one pin used in pull off alarm function. Correspondingly, PB7 in P2 is the other pin in pull off alarm function. Some other pin holes in P2 are as follows. First, PA1 and GND are used in the heart rate counting function. Second, PB10 and PB11 are USART pins used to communicate with the Bluetooth unit. Third, PA13 and PA14 are used to download program into STM32.

g) During the process of welding, we first add pins into the pin hole of PA13 and PA14 to enable download function. After the downloading process, we removed these pins to reduce space consuming.

h) The energy providing circuit we actually use is not as shown in the figure above. We use the voltage converting circuit in the Bluetooth unit to convert the voltage from 3.7V to 3.0V. And then we use the 3.0V output to provide energy to the main board and the heart rate sensing unit.

◆ Microcomputer Programming

Programming for the wristband：

Software：keil mdk 4.74

Reference document: mainly from our TA Yifei Zhang

1、电子系统设计概况及电子元器件.pdf	2015/3/29 9:04	Foxit Reader PD...	1,877 KB
2、STM32最小系统板.pdf	2015/3/29 9:04	Foxit Reader PD...	1,984 KB
3、STM32单片机基本功能.pdf	2015/4/28 20:18	Foxit Reader PD...	3,123 KB
4、STM32定时器及中断 (1).pdf	2015/4/28 20:18	Foxit Reader PD...	2,089 KB
4、STM32定时器及中断.pdf	2015/4/20 20:27	Foxit Reader PD...	2,089 KB
5、STM32外设通信.pdf	2015/4/28 20:19	Foxit Reader PD...	5,902 KB
6、模拟信号链和运算放大器 (1).pdf	2015/4/28 20:19	Foxit Reader PD...	229 KB
6、模拟信号链和运算放大器.pdf	2015/4/20 20:27	Foxit Reader PD...	229 KB
7、ADC采样及DMA传输 (1).pdf	2015/4/28 20:20	Foxit Reader PD...	4,869 KB
7、ADC采样及DMA传输.pdf	2015/4/20 20:44	Foxit Reader PD...	4,869 KB
8、电机与控制.pdf	2015/4/28 20:20	Foxit Reader PD...	1,880 KB
9、电源管理.pdf	2015/4/28 20:20	Foxit Reader PD...	171 KB
10、PCB的设计与制作.pdf	2015/3/29 9:04	Foxit Reader PD...	4,969 KB
STM8和STM32产品选型手册.pdf	2015/4/28 20:43	Foxit Reader PD...	2,547 KB
STM32F10xxx英文手册.pdf	2015/4/28 20:44	Foxit Reader PD...	12,712 KB
STM32F10xxx中文手册.pdf	2015/4/28 20:44	Foxit Reader PD...	13,970 KB
STM32F10xx英文硬件开发入门.pdf	2015/4/28 20:43	Foxit Reader PD...	417 KB
STM32F10xx中文硬件开发入门.pdf	2015/4/28 20:43	Foxit Reader PD...	682 KB
STM32F103R8T6电路图.PDF	2015/4/28 20:43	Foxit Reader PD...	533 KB
STM32F103x8英文说明文档.pdf	2015/4/28 20:43	Foxit Reader PD...	1,414 KB
STM32F103x8中文说明文档.pdf	2015/4/28 20:43	Foxit Reader PD...	1,865 KB
STM32F103引脚功能定义.pdf	2015/5/26 18:28	Foxit Reader PD...	476 KB
stm32v3.5固件库时钟系统配置流程.pdf	2015/4/28 20:43	Foxit Reader PD...	146 KB
STM32固件库V3.5.0建立工程模板（网...	2015/4/28 20:43	Foxit Reader PD...	203 KB
STM32固件库使用手册的中文翻译版.pdf	2015/4/28 20:43	Foxit Reader PD...	2,856 KB

Function implementation:

a)Timing: we use TIM3 as base timer to count 5s's time

b) Heart rate detection: detect the electrical level of pin PA1 and use two variables pre_val and val to mark the prior and current electrical level state of it; if these two variables are different, it means the electrical level has changed, so the variable used to express the heart rate will plus 1; every 5s the wristband will send the value of the variable pulse to the mobile phone.

c) Pull off alarm: Under normal situation, the electrical level of PB6 is high. When the wristband has been snapped, the electrical level of PB6 will become low. We detect the

electrical state of PB6. Once it becomes low, the wristband will send the special character 'A' to the mobile phone.

Code:

```
#include "stm32f10x.h"
#include "math.h"

u8    counter=0;
u8    pulse=0;
u8    alarm=0;
u8    pre_val=0;
u8 val=0;
void RCC_Configuration(void);
void GPIO_Configuration(void);
void tim4(void);
void nvic(void);
//void exti(void);
void USART_Configuration(void);
void delay_nus(u32  n)          {
   u8 i;
   while(n--)
   {
     i=7;
     while(i--);
   }
}


void delay_nms(u32  n)        {
    while(n--)
        delay_nus(1000);
}
```

```
void RCC_Configuration(void){
RCC_APB2PeriphClockCmd(RCC_APB2Periph_GPIOB|RCC_APB2Periph_GPIOA
|RCC_APB2Periph_AFIO, ENABLE);
RCC_APB1PeriphClockCmd(RCC_APB1Periph_TIM2|RCC_APB1Periph_TIM3,
ENABLE);
}


void GPIO_Configuration(void)              {
    GPIO_InitTypeDef GPIO_InitStructure;
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_IPD;
    GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
   GPIO_InitStructure.GPIO_Pin = GPIO_Pin_6;
    GPIO_Init(GPIOB, &GPIO_InitStructure);


    GPIO_InitStructure.GPIO_Pin = GPIO_Pin_10 ;
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AF_PP;
    GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
    GPIO_Init(GPIOB, &GPIO_InitStructure);


   GPIO_InitStructure.GPIO_Pin = GPIO_Pin_11;
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_IN_FLOATING;
    GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
    GPIO_Init(GPIOB, &GPIO_InitStructure);


   GPIO_InitStructure.GPIO_Mode = GPIO_Mode_IPD;
    GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
   GPIO_InitStructure.GPIO_Pin = GPIO_Pin_1|GPIO_Pin_11;
    GPIO_Init(GPIOA, &GPIO_InitStructure);


   GPIO_SetBits(GPIOB, GPIO_Pin_7);
```

```c
        GPIO_InitStructure.GPIO_Mode  = GPIO_Mode_Out_PP;

        GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;

      GPIO_InitStructure.GPIO_Pin  = GPIO_Pin_7;

      GPIO_Init(GPIOB,  &GPIO_InitStructure);


      GPIO_PinRemapConfig(GPIO_Remap_SWJ_JTAGDisable,ENABLE);
      }


void  USART_Configuration(void)
{
        USART_InitTypeDef  USART_InitStructure;


        RCC_APB1PeriphClockCmd(RCC_APB1Periph_USART3  , ENABLE);


        USART_InitStructure.USART_BaudRate  = 9600;

        USART_InitStructure.USART_WordLength  = USART_WordLength_8b;

        USART_InitStructure.USART_StopBits  = USART_StopBits_1;

        USART_InitStructure.USART_Parity  = USART_Parity_No;

   USART_InitStructure.USART_HardwareFlowControl=
USART_HardwareFlowControl_None;
        USART_InitStructure.USART_Mode        =       USART_Mode_Rx      |
USART_Mode_Tx;


        USART_Init(USART3,  &USART_InitStructure);


        USART_ITConfig(USART3,  USART_IT_RXNE,  ENABLE);


        USART_Cmd(USART3,  ENABLE);


        USART_ClearFlag(USART3,  USART_FLAG_TC);
}
```

```c
void tim3(){
    TIM_TimeBaseInitTypeDef    TIM_TimeBaseStructure;

    TIM_TimeBaseStructure. TIM_Period =6000-1;
    TIM_TimeBaseStructure.TIM_Prescaler =36000-1;
    TIM_TimeBaseStructure.TIM_ClockDivision = TIM_CKD_DIV1;
    TIM_TimeBaseStructure.TIM_CounterMode = TIM_CounterMode_Up;
    TIM_TimeBaseInit(TIM3, &TIM_TimeBaseStructure);

    TIM_ClearITPendingBit(TIM3,TIM_IT_Update);
    TIM_ITConfig(TIM3,TIM_IT_Update|TIM_IT_Trigger,ENABLE);
    TIM_Cmd(TIM3,ENABLE);
}


void tim2(){
    TIM_TimeBaseInitTypeDef    TIM_TimeBaseStructure ;
    RCC_APB1PeriphClockCmd(RCC_APB1Periph_TIM2, ENABLE) ;

    TIM_DeInit(TIM2);

    TIM_TimeBaseStructure.TIM_Period = 0xFFFF ;
    TIM_TimeBaseStructure.TIM_Prescaler = 0x00 ;
    TIM_TimeBaseStructure.TIM_ClockDivision = 0x0 ;
    TIM_TimeBaseStructure.TIM_CounterMode = TIM_CounterMode_Up ;
    TIM_TimeBaseInit(TIM2, &TIM_TimeBaseStructure);
    TIM_ETRClockMode2Config(TIM2,TIM_ExtTRGPSC_OFF,
                            TIM_ExtTRGPolarity_NonInverted, 0);
    TIM_SetCounter(TIM2, 0);
    TIM_Cmd(TIM2, ENABLE);
}
```

```c
void nvic(){
    NVIC_InitTypeDef NVIC_InitStructure;

    NVIC_PriorityGroupConfig(NVIC_PriorityGroup_1);
    NVIC_InitStructure.NVIC_IRQChannel = TIM4_IRQn;
    NVIC_InitStructure.NVIC_IRQChannelPreemptionPriority = 1;
    NVIC_InitStructure.NVIC_IRQChannelSubPriority = 0;
    NVIC_InitStructure.NVIC_IRQChannelCmd = ENABLE;
    NVIC_Init(&NVIC_InitStructure);

    NVIC_PriorityGroupConfig(NVIC_PriorityGroup_1);
    NVIC_InitStructure.NVIC_IRQChannel = TIM3_IRQn;
    NVIC_InitStructure.NVIC_IRQChannelPreemptionPriority = 0;
    NVIC_InitStructure.NVIC_IRQChannelSubPriority = 3;
    NVIC_InitStructure.NVIC_IRQChannelCmd = ENABLE;
    NVIC_Init(&NVIC_InitStructure);
}

void TIM3_IRQHandler(void) {
    TIM_ClearITPendingBit(TIM3, TIM_IT_Update);
        //pulse=TIM_GetCounter(TIM2);
          //TIM_SetCounter(TIM2,0);
              USART_SendData(USART3,pulse);
              pulse=0;
//   USART_SendData(USART3,pulse);
//    pulse=0;


//   if(TIM_GetITStatus(TIM3,TIM_IT_Update)!=RESET)
//   {
```

```c
//        TIM_ClearITPendingBit(TIM3, TIM_IT_Update);

//      pulse=TIM_GetCounter(TIM2);

//      TIM_SetCounter(TIM2,0);

//    }

//    //TIM_Cmd(TIM2,ENABLE);

//    USART_SendData(USART3,pulse);


}


int main(void)
{
    RCC_Configuration();


    GPIO_Configuration();
    USART_Configuration();
    nvic();
    tim2();
    tim3();
    while(1){
        alarm=GPIO_ReadInputDataBit(GPIOB,GPIO_Pin_6);
            if(alarm==0){
             USART_SendData(USART3,'A');
             delay_nms(50);
           }
        val=GPIO_ReadInputDataBit(GPIOA,GPIO_Pin_1);


        if((pre_val)==0&&(val==1))
                    pulse=pulse+1;
        pre_val=val;


        delay_nms(40);
```
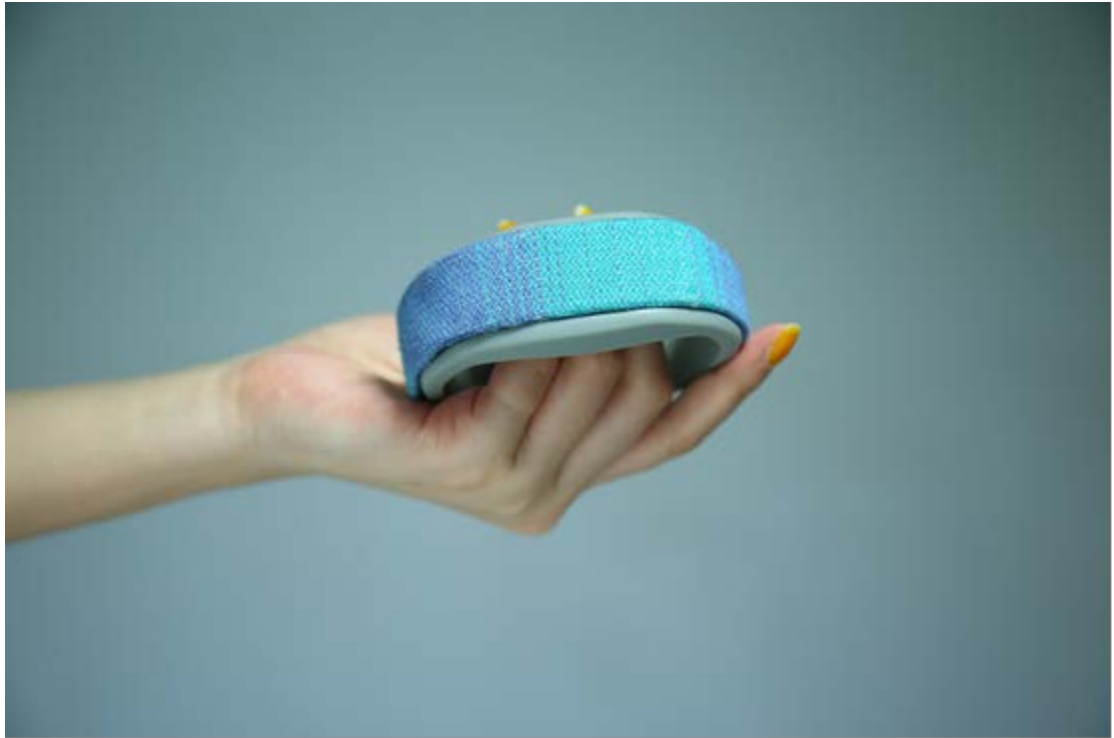
```
//              if(GPIO_ReadInputDataBit(GPIOA,GPIO_Pin_1)==1)
//              {
//                  pulse++;
//                  delay_nms(40);
//              }
//          else{delay_nms(40);
//
//                  if(GPIO_ReadInputDataBit(GPIOA,GPIO_Pin_1)==1)
//                  {
//                      pulse++;
//                  }
//              }
//          }
            }
        }
```

Show of our wristband

■ APP

◆ Function Part

Based on the previous survey and analysis, we decide to design the functions of app as following:

1. One-Click SOS

Users could use a tap to send SOS message to emergency contacts. The SOS message is a simple SMS message, which includes an URL link with the longitude and latitude of the user's current position. When emergency contacts receive the message, they could open the URL link in the web browser and will see the precise position of users.

2. Display of Heart Rate

Smart phone could connect with wristband using Bluetooth. Once connected, the application could display the heart rate in real-time. In the meanwhile, when users snap the wristband, it will send a special signal to smart phone, then the app will call the function of One-Click SOS automatically.

3. Safety Score

We define the safety score of every position in a certain region using the situation of criminal cases in a certain period in that region. We use the information of position, time, and the severity of each case. The safety score of each point is determined based on following three points:

1) When current position is closer to the position with high criminal cases, current position is more dangerous.

2) When current time is closer to the time of criminal cases' occurrence, current time is more dangerous.

3) When the criminal cases are severer, the position that is closer to the position of these cases is more dangerous.
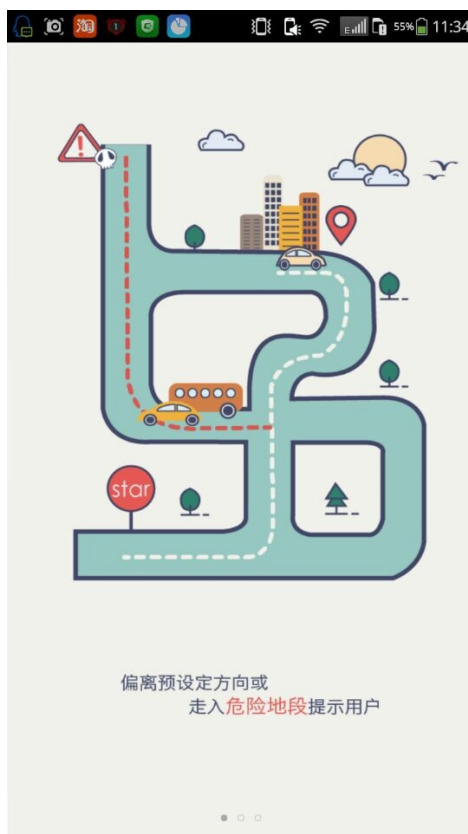
In general, when we input the situation of criminal cases in a certain period in a certain region, we will get the safety score of every position in that region. The sketch is as follows:
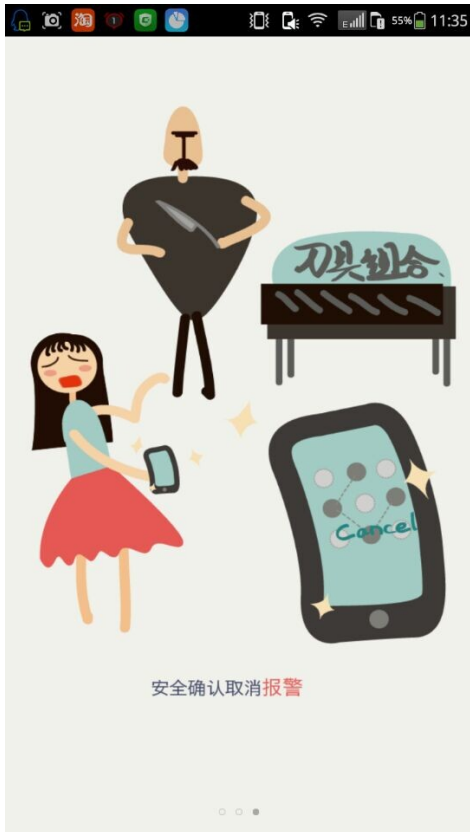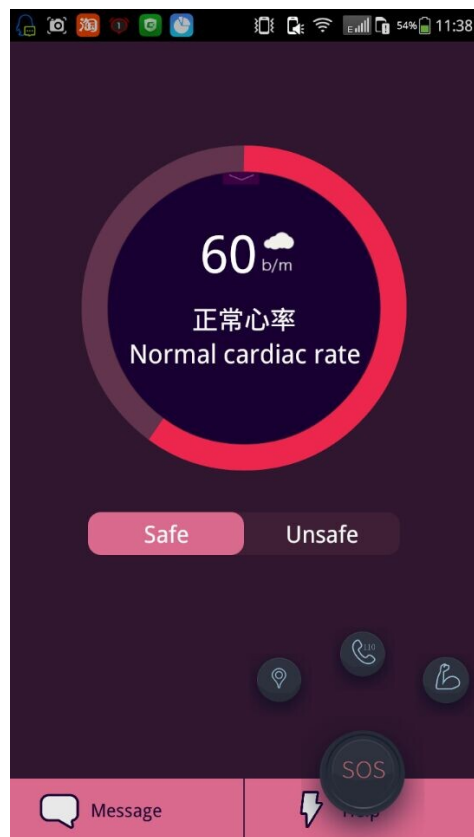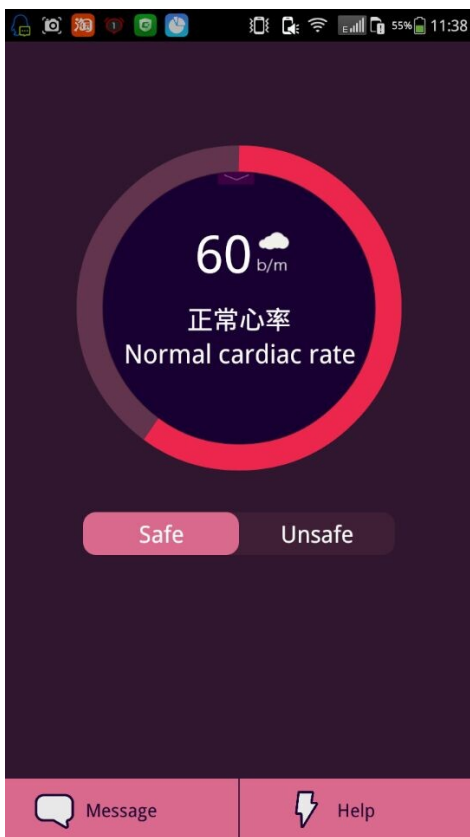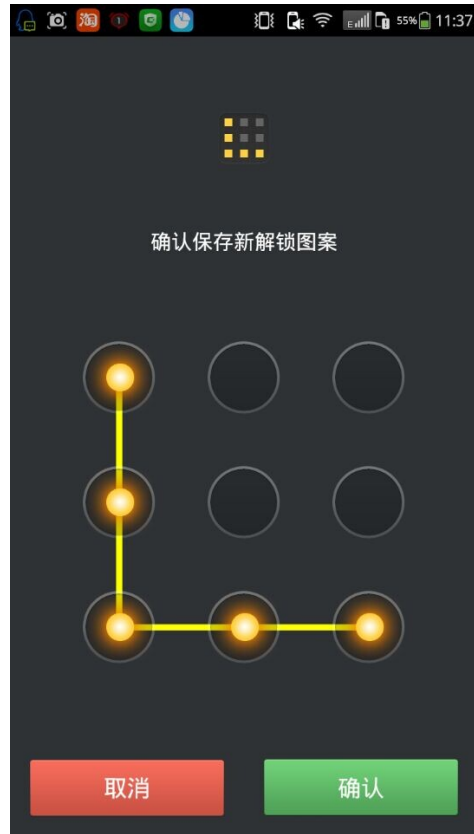

The red area indicates that safety score of that area is relatively low, which means that the area is more dangerous than others.
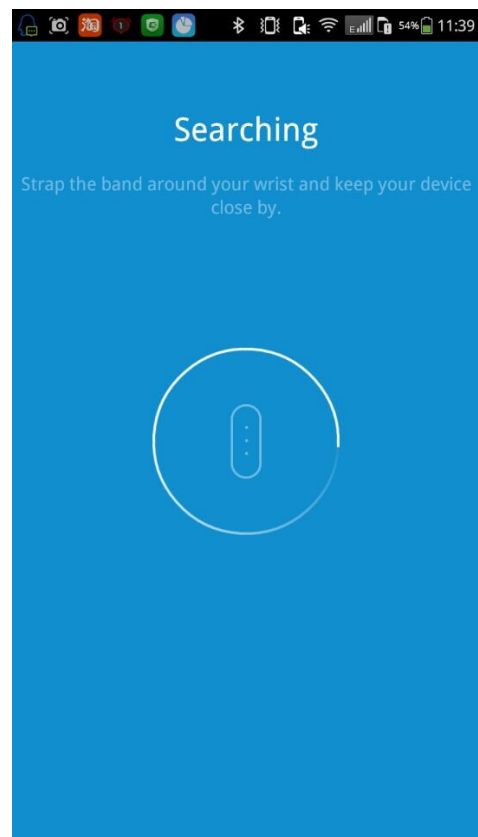
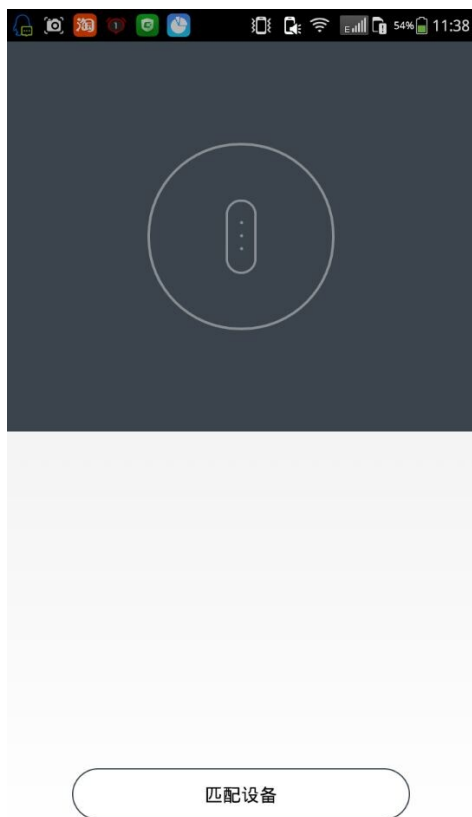When user switches to the Unsafe mode, the system will get the current location of the user and gives a safety score, thencomparethe safety score with a pre-defined threshold every 5 minutes. If the safety score is lower than the threshold, system will ask user to confirm his/her safety. If user does not draw the correct pattern in 60 seconds, system will call the function of One-Click SOS.

◆ **UI Part**

安全确认取消报警

添加紧急联系人

打开通讯录

你可以创建一个解锁图案，在非安全模式下当系统做出危险提醒时，你可以确认安全。

创建手势密码

穆晓倩 (15155933948)已添加

如何绘制解锁图案

确定

图案已记录

重试　　继续

确认保存新解锁图案

取消　　确认

60 b/m

正常心率
Normal cardiac rate

Safe　Unsafe

Message　Help

60 b/m

正常心率
Normal cardiac rate

Safe　Unsafe

SOS

Message　Help

ANGLE BABY

Contact	⊕
穆晓倩(15155933948)	⊖
Gesture	⟩
Bluetooth	⟩

BACK

ANGLE BABY

Contact	⊕
穆晓倩(15155933948)	⊖
余林峰(15855155452)	⊖
Gesture	⟩
Bluetooth	⟩

BACK

匹配设备

Searching

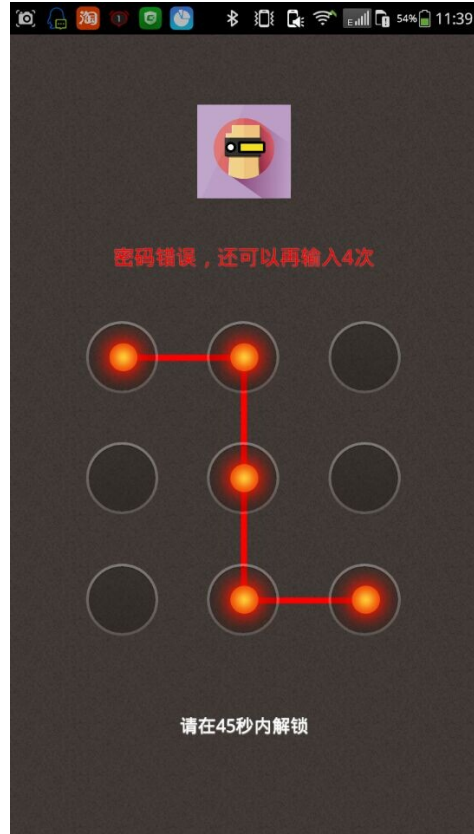Strap the band around your wrist and keep your device close by.

- **Summary**

    Design Innovation Course is a magical place. We all learned a lot of things in the process of taking Design Innovation Course. In one aspect, we have much more profound cognition of design and innovation. In the past nine months, we did a lot of surveys, and based on these survey results, we thought out many novel ideas to solve the problem of women's personal safety. We all agree that these nine months is an amazing period of time during which our thoughts lost constraints. In another aspect, working in a team improved our ability of making compromise between insisting on our own opinion and adopting our teammates' ideas. Moreover, we all took full of our own responsibility for the team as well as helped others and our abilities of presentation and communication also got improved.

    Thank all the people who helped us in this period and wish DIC better in the future.

    This word finally completes on 2015.8.15 4:48p.m.

    The other three partners have already arrived in America now, and I will leave soon as well. Time flies, wish all the following people attending this course are able to enjoy the pleasure of making something useful and original.