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優勝作品專輯

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作品名稱	**AUTONOMIC HEATING GLOVES**
得獎獎項	**大會獎 四等獎**

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INTRODUCTION

In today's world, medicine is very advanced, thanks to which many diseases that were previously considered incurable, are now treated almost all over the world. But, unfortunately, some diseases are still incurable and can only facilitate their course. One such disease is Raynaud's disease or Raynaud's syndrome. Statistics show that worldwide the percentage of patients with this disease is 3-4%. Raynaud's disease is a paroxysmal spasm of the arteries of the fingers of the hand, rarely the feet when cooling the extremities. As mentioned earlier, this disease is incurable. That is why the creation of a device that can help people overcome many inconveniences due to the inability to stay in the cold without gloves or the problem of discomfort in heated gloves is relevant. And one of the solutions to this problem is to create special heated gloves.

This work is also relevant, because even existing treatments, such as medication and conservative, do not completely solve the problem of reducing the sensitivity of the hands when cooled or even the slightest moisture on the palms. Also, these methods are very expensive, so our device will be cheaper and more affordable than existing ones. When using our gloves together with the two already mentioned methods, the treatment will be more effective. Unfortunately, medical and conservative treatments will lead to complications over time, so we not only maintain sensitivity in the hands, but also prevent further amputation of the upper extremities and the emergence of human health problems associated with the effects of drugs on the whole body.

Nowadays, people work hard to be able to live well, but it is difficult for people with Raynaud's phenomenon to do so, as the sensitivity of the upper extremities decreases during the exacerbation of the disease. It is important for us to

maintain the sensitivity of the hands by normalizing the thermal balance of the hands, which leads to the elimination of spasms of the atria of the hand.

The aim of the work is to create a simple and effective means to normalize and maintain the thermal balance of the upper extremities, in order to reduce the loss of sensitivity of the hands in patients, as well as reduce the likelihood of spasms of the arteries of the fingers.

The subject of the study is the course of Raynaud's disease and the current treatments for it.

The aim of the study is the creation of special gloves that can stop spasms of arteries and maintain blood flow in them by balancing the heat balance in the hand, and depriving patients of the disease during their wearing

During the work the following tasks were set:

- to theoretically investigate the peculiarities of Raynaud's disease;
- to analyze the existing clothes on the market with heating;
- to develop and improve its own design of heated gloves, which will be affordable and easy to use.
- calculate the cost of gloves taking into account all factors

SECTION 1

FEATURES OF RAYNAUD'S DISEASE AND RELIEF OF ITS SYMPTOMS

1.1. Features of Raynaud’s disease

Raynaud's disease - a disease characterized by symmetrical bilateral paroxysmal spasms of the arteries of the fingers, rarely the feet and manifested by paleness, pain and paresthesias. It is also often called the Raynaud's phenomenon, distinguishing between the primary form and the secondary (or Raynaud's syndrome) - a condition that resembles the symptoms of the primary form (Raynaud's disease), but occurs not primarily but secondary to some diseases. Thus, these two concepts are separated, although the clinical manifestations are the same. (Wikipedia)

The normal response of the vessels of the fingers to cold is the narrowing of blood vessels, which reduces heat loss. In the case of Raynaud's phenomenon, an overreaction occurs in which the effects of cold or emotion cause vasoconstriction in the fingers, expressed so as to give a change in color and / or discomfort. The Raynaud's phenomenon can be primary when it occurs in a practically healthy person, or secondary when it is one of the manifestations of another disease. [1]

In Raynaud's disease, a decrease in temperature leads to narrowing of blood vessels, resulting in necrosis without proper treatment, followed by amputation of the affected limb

1.1.1.Symptoms

Characteristically, the color of the fingers changes in three phases: first white, and then through blue to red. Vasoconstriction of finger arteries, arterioles and arteriovenous shunts causes initial pallor. During this time, blood accumulates, which gave oxygen, causing cyanosis. Subsequently, reactive vasodilation of skin

vessels occurs. This, in turn, causes redness due to the rapid resaturation of the blood. (world medicine)

Occasionally there are changes in color and / or discomfort in the fingers and toes, which appear in the cold or emotional stress, paresthesia (spontaneous numbness) of the fingers, tingling in the tips, cyanosis (cyanosis), low temperature of the soft tissues of the fingers . Most often the symptoms appear on 2-5 fingers and toes, less often on other protruding parts of the body (nose, ears, chin). (wikipedia + world medicine)

1.1.2. Treating

Although the disease is incurable, there are few ways to alleviate the disease. Such methods are medical and conservative treatment. Both methods are quite effective, but they will not be able to help completely. Examples of both treatments are given below:

-- soothing;

Due to the fact that the symptoms of the disease appear not only when the hands are cold, but also with some manifestation of emotions, such as excitement, the person being under a sedative will not be able to be nervous

--spasmolytics (vasodilators);

When chilled or emotional, blood vessels constrict, which causes symptoms such as discoloration of the hands, spasms, etc., ie if you dilate blood vessels, blood circulation will not be disrupted, but vasodilators bring both benefits and harms: drugs that dilate blood vessels do so all over the body, not just the damaged parts of the body, which is not good.

-- physiotherapy in the early stages is recommended;

Physiotherapeutic treatment is aimed at improving microcirculation and metabolism, reducing blood clotting, normalizing the nervous system. [2]

-- long-term use of vasodilatory herbs;

Herbs, like regular vasodilators, dilate blood vessels when the disease manifests itself, but herbs can be taken more often because they are less effective than they are less harmful to the human body.

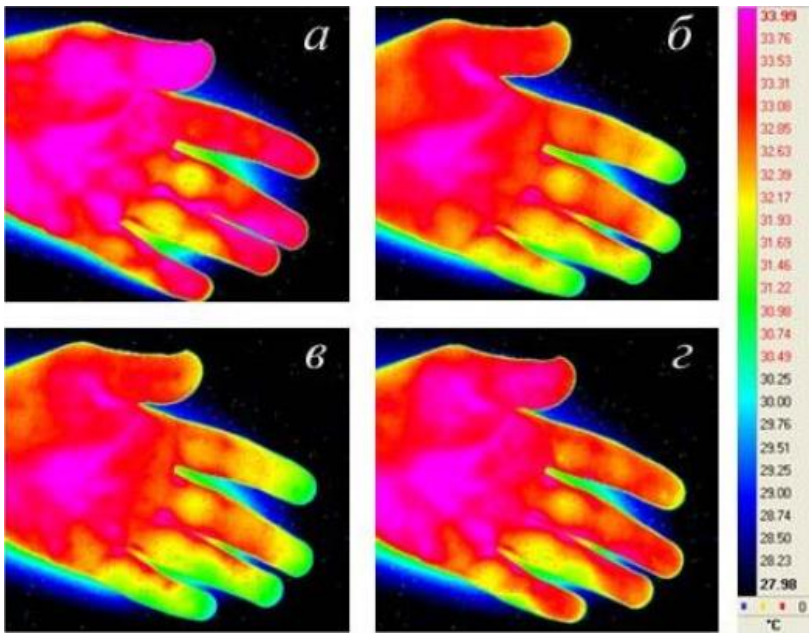
-- any exercise can be useful because it improves blood circulation, tones blood vessels and the nervous system;

-- sanatorium treatment: radon and hydrogen sulfide baths are recommended;

-- treat the disease with conservative methods, surgery is used only in case of necrosis. The acute attack is relieved by the use of warm baths for hands or feet, antispasmodics and analgesics. Mild forms of the disease often disappear after the patient quits smoking and avoids cooling;

-- The main means of conservative treatment is the use of so-called calcium channel blockers. It is especially effective in the spastic stage of the disease. [3]

As you can see, there are many treatments, but unfortunately any of the above treatments will lead to complications. First, if you do not provide good treatment, the disease progresses, and secondly, if you take for example vasodilators, they dilate blood vessels not in a specific place, but throughout the body. Also, if we talk about the disadvantages of conservative drug treatment, in addition to harm to the body, they are also too expensive, so because of the inability to pay for treatment, people bring their disease to severe stages, the only way out of which is amputation of affected limbs due to necrosis. That is why it is necessary to have a device that without harm to the body will cope with exacerbations of the disease and just its course, while maintaining the sensitivity of the hands.



[4]

Fig.1 - Thermograms of a healthy hand

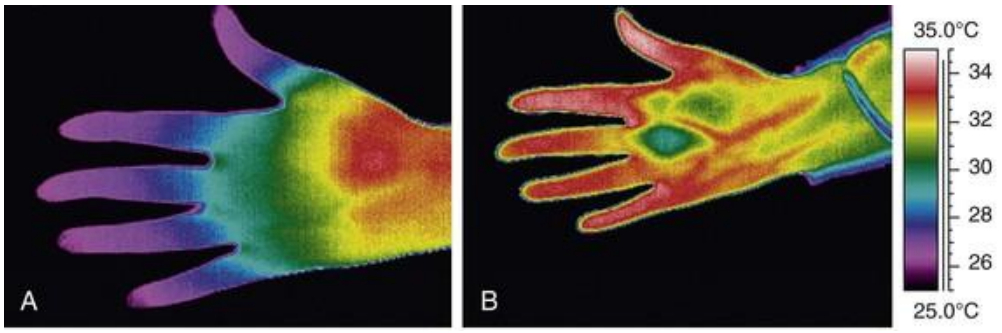
(a) hand before cooling

(b) thermogram of the brush after minutes of cooling

(c) an image of the palm after three minutes of cooling

(d) hand thermogram 3 minutes after the end of cooling.

This is what a palm that does not have Raynaud's disease should look like.



[5]

Fig.2 - Thermogram of the patient's hand

This thermogram shows the palms of a person with Raynaud's disease while cooling. As we can see, the hand cools much more than a healthy one, this is due to vasoconstriction. After a while we see that the palm has returned to normal, but this required the use of a vasodilator or artificially warm hands, because the heat balance is not restored.

1.2. Modern methods of heating parts of a body

In order to analyze modern means of alleviating the course of Raynaud's disease, we compared the existing gloves on the market for warming the body, resulting in a table 1.

Table 1

Comparison of gloves with heating

Name and picture	**Materials**	**Features**	**Cost**	**Weight**
Outdoor Research Capstone Heated  [6]	Top layer: 100% leather, Within: 90% nylon, 10% spandex Insulation: 100% polyester	Moisture resistant, breathable, windproof, waterproof, soft.	**13850 UAH**	677 gr
Ixs X 7 Goretex Gloves  [7]	Top layer: 55% polyamide 40% leather 5% neoprene Within: 100% polyurethane Insulation: 100% polyester	Works from the 7-volt block with batteries, warms fingers and a back side of a palm, moisture resistant, do not pass air.	**5425 UAH**	686 gr
Macna Atom Heated RTX  [8]	Top layer: Sheep skin, SoftFlex Insulation: 100% insulating fiber	Moisture resistant, the sensor responds to gloves, to the right of electricity.	**5915 UAH**	534 gr

Gloves with heating of each finger Heatact  [9]	Top layer: 100% nylon Insulation: 100% insulation	Uses long-wave heat, which helps with various diseases, the unit with batteries is removed, you can use gloves without the unit, the heating element is held for each finger separately.	**1900 UAH**	200 gr

Thus, all existing heated gloves are similar, but they all have one problem in common - their size, and some even weight. Unfortunately, it is very inconvenient to walk all the time in massive gloves, because the main purpose of our work is to preserve the sensitivity of the upper extremities so that you can work. Also a very important problem is that 3 of the 4 presented options are not sold on the Ukrainian market, so you need to order and deliver gloves from other countries, and this is, firstly, quite expensive, and secondly delivery is not fast, you will have to be without gloves, at best, for about 2 weeks. So the above models are not suitable and that is why we decided to make our own model of heated gloves so that they are smaller in size and weight so that people do not feel discomfort.

SECTION 2

CREATION OF HEATED GLOVES

2.1. Features of a product design

2.1.1. Materials

We analyzed possible materials for gloves, especially their upper insulating layer. The main search criterion was that the fabric should be breathable but retain heat in the middle. Unlike that year, we improved the design by changing our views on the design itself. We chose to make the top layer of the glove from perforated eco-leather. Eco-leather in this case will help us to make the glove as thin and comfortable as possible, as it can bend as well as a human hand without a glove. It is also known that the skin is able to retain heat well in the middle, and this is the effect and property of the fabric we need. And due to the perforation in the glove will be ventilation, which will avoid the appearance of moisture, which will bring the symptoms of the disease into action.

The advantages of eco-leather can be that the material is made artificially and does not harm nature, which is very important in the 21st century. The material retains heat well inside the glove, and due to the fact that the wine is air permeable, the hand does not sweat. These characteristics of the fabric make it a very good and profitable material for the top layer of our product. Also, among the advantages of the material is that it is a fairly cheap alternative to leather, but has the same properties and in some cases is even a more profitable material than ordinary leather. Thus, eco-leather will help us a lot to make the product as cheap as possible and so that it is competitive. [10]

An important fabric for the glove is its inner layer. This layer must be elastic so that the fabric is tight on the human hand. This factor will help reduce the volume of the glove, which will make it easier to find in them. Also, the fabric should be

breathable, so that there is ventilation so that the palms do not sweat. According to these criteria, a fabric called cotton knitwear was chosen.

This fabric is very elastic, which makes the glove easy to put on and take off. The fabric is quite easy to care for, and due to the fact that the fabric is made of natural materials and is hypoallergenic, it thus meets our requirements for the inner layer, and is suitable for many people because it does not cause allergies. Also in our design this fabric can be removed and washed if necessary. It is important to note that the fabric is thin, and this will have a good effect on the overall thickness of the glove, as our main goal is to maintain the flexibility of the hand so that a person can function well with it. [11]

The last element of the fabric in the creation of a quality glove that will work well - is a conductive fabric. We have chosen a fabric that has the following characteristics: the base of the fabric is nylon, and the coating due to which this fabric is electrically conductive is silver added to the nylon threads. The fabric is safe for humans, it is also elastic and stretches in all directions. Also, the resistance of this fabric is about 1 Ohm per square inch. [12]

2.1.2. Power

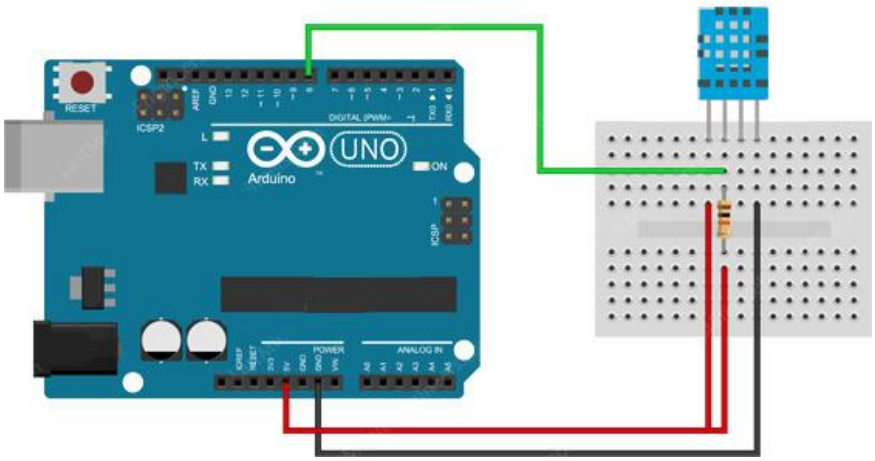
One of the most important parts in the design of our stand-alone hand heaters is the power supply. We have chosen a method of providing electricity to the gloves due to galvanic cells (6LR61 "Crown") or batteries. They will be attached separately to the cuffs of the gloves for added convenience.

In order for the hands of the person wearing the gloves to receive the right amount of heat and not overheat, as well as to control the humidity of the hands, we decided to use temperature and humidity sensors. It will make sure that the temperature does not rise above 36.6 degrees Celsius, which is a normal temperature for a healthy person, and the humidity sensor will make sure that there is no excess

moisture on the palms. Both sensors will be connected to the Arduino-nano board, which will be connected to our wires, which in turn will be connected to the heated fabric.

The choice of Arduino Nano board is due to its compactness, sufficient functionality for our project and ease of use.

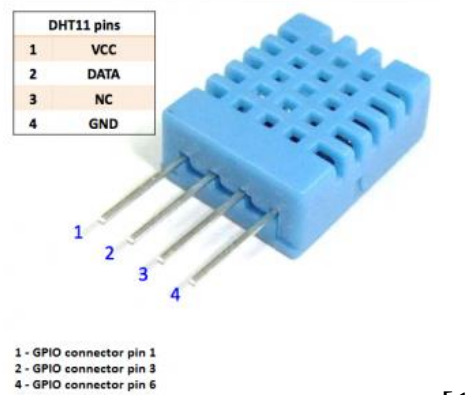
Below (see Fig. 2.1) is a schematic diagram of a device for controlling the temperature of the fingers



[13]

Fig. 2.1

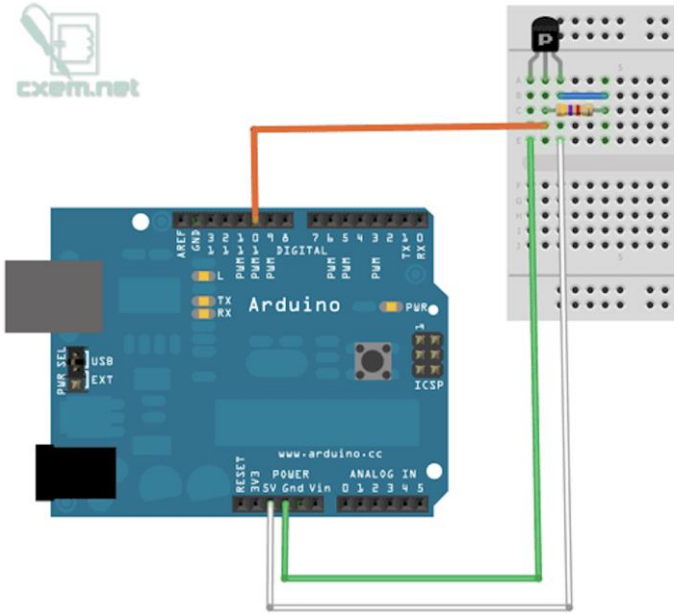
As a temperature sensor, we use DHT 11 (Fig.2.1.2), but without a housing in order to increase the measurement accuracy.



[14]

Fig. 2.1.2

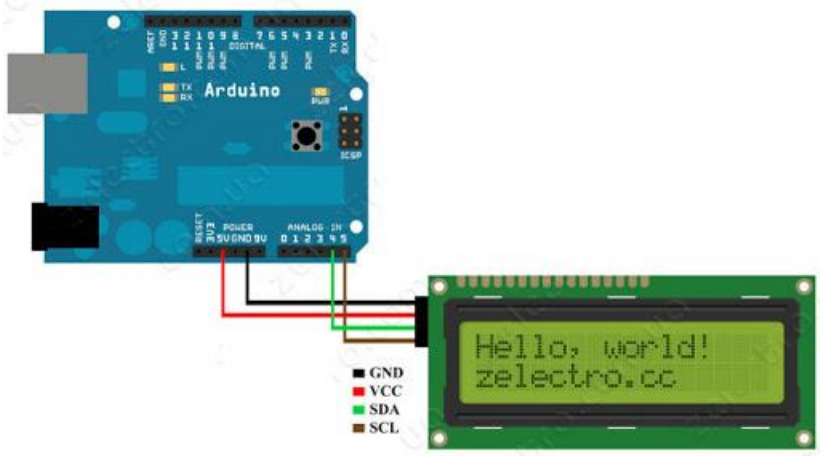
Also, we are going to use transistor because there should be some regulation in order for our scheme to work proper and not to break. (see Fig.2.1.3.)



[15]

Fig.2.1.3

In addition, in our cinstruction we are using screen. It is made so the person can see the temperature and analize at what temperature and humiduty they feel most comfortable. (see Fig. 2.1.4.)



[16]

Fig.2.1.4

Thanks to this design, the glove will ensure that the temperature and humidity are not above normal, it will regulate the operation of the heating parts in the glove.

It was also important to correctly calculate the current that will be applied to the glove, so we made the following calculations: from the system:

Q=I^2*R*T*0,7 - Joule-Lenz law,

(multiply by 0.7 because we believe that heat loss to the environment is 30%, and T is considered as a unit of time)

where R ≈ 2 Ohm (resistance of the conductive tissue on a piece for one phalanx)

Q=c*m*Δt (Δt=10 degrees assuming that the temperature varies from 26.6 degrees to 36.6)

We find that I=0,34 A.

It is also important that since the creation used 4.5 V batteries, then:

$$I = \frac{U}{R};$$

$$R = \frac{U}{I} = 11{,}2 \text{ Ohm}$$

Then the calculations show that we need an additional resistor with a resistance of 9.2 ohms so that the fabric does not burn.

2.1.3. Heating method

Since our device is made for people suffering from Raynaud's disease, it was important for us to position the conductive tissue correctly. Also, based on the fact that our goal is to balance the heat, and not the usual heating, we consulted a doctor. In a conversation with a doctor, we found that it is not necessary to heat the whole palm, but only each finger and the center of the palm. A temperature sensor will be installed at each place where the power will be supplied, which will ensure that the temperature at a specific place, such as the extreme phalanx of the finger, does not rise above 36.6 degrees Celsius. Once the temperature reaches its extreme value, the power will be stopped until the hand begins to cool again.

2.2. Cost calculation

Since one of the most important problems is the price of existing body heating products, the cost of our gloves should be lower.

We have developed two tables to calculate the cost of the glove (Fig. 2.2.) and the cost, taking into account such factors as depreciation of cars, rent, wages to employees, etc (Fig 2.2.1):

Size	Eco-leather	Conductive fabric	Arduino-nano	Power	Screen	Wires	Conectors
6	0.07 (11 UAH)	0,009 (10 UAH)	220 UAH	300 UAH	200 UAH	40 UAH	40.5 UAH
6.5	0.072 (11 UAH)	0,009 (10 UAH)	220 UAH	300 UAH	200 UAH	40 UAH	40.5 UAH
7	0.074 (11.5UAH)	0,009 (10 UAH)	220 UAH	300 UAH	200 UAH	40 UAH	40.5 UAH
7.5	0.076 (11.5 UAH)	0,009 (10 UAH)	220 UAH	300 UAH	200 UAH	40 UAH	40.5 UAH
8	0.078 (12 UAH)	0,009 (10 UAH)	220 UAH	300 UAH	200 UAH	40 UAH	40.5 UAH
8.5	0.08 (12 UAH)	0,009 (10 UAH)	220 UAH	300 UAH	200 UAH	40 UAH	40.5 UAH

Fig. 2.2.

Size	Materials	Sallary (5000 UAH + 40% taxes)	Rent	Utillities	Amortization of equipment	Overhaul	Prime cost
6	1132.5 UAH or 40$	87.5 UAH or 3$	7 UAH or 0.25$	7.31 UAH or 0.26$	4 UAH or 0.14$	0.25 UAH or 0.0089$	1238.56 UAH or 44$
6.5	1132.5 UAH or 40$	87.5 UAH	7 UAH	7.31 UAH	4 UAH	0.25 UAH	1238.56 UAH or 44$
7	1133 UAH or 40$	87.5 UAH	7 UAH	7.31 UAH	4 UAH	0.25 UAH	1239.06 UAH or 44$
7.5	1133 UAH or 40$	87.5 UAH	7 UAH	7.31 UAH	4 UAH	0.25 UAH	1239.06 UAH or 44$
8	1133.5 UAH or 40$	87.5 UAH	7 UAH	7.31 UAH	4 UAH	0.25 UAH	1239.56 UAH or 44$
8.5	1133.5 UAH or 40$	87.5 UAH	7 UAH	7.31 UAH	4 UAH	0.25 UAH	1239.56 UAH or 44$

Fig.2.2.1

CONCLUSIONS

With the help of information found in some medical collections about the disease, as well as information obtained after consulting a doctor, the course of Raynaud's disease, its features, as well as known methods of treatment were identified. An analysis of various treatments was performed, during which it was determined that any of the known methods of alleviating the course of this disease leads to complications.

The paper considers the existing autonomous hand warmers on the market, gives examples of them and a complete analysis of the main models. The analysis identified the most important issues, including price, weight and affordability.

As it was noted that most of the existing gloves on the market are unavailable due to the high price, materials were selected that are cheaper than those already used in the created gloves with heating. Also, the problem that was found in the presented models is their massiveness, which significantly restricts and in some way limits human movements. We have carried out the selection of thin materials that will not be very massive and will allow a person to fully function with his hands and work without feeling discomfort.

In the future, it is planned to create a mobile application that will allow a person to see the temperature and humidity level in their smartphone, as well as adjust them as needed. It is also planned to improve the operation of the chip by making the glove mode more comfortable for the user (improve the heating mode) by making it changeable so that a particular person can change the temperature to be set independently or in consultation with a doctor. That is, it is planned to make the product more regulating so that a particular person can adjust the glove to their own needs and feelings. Also, we plan to change the sensors to smaller ones to increase the ergonomics of our device.

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【評語】100042

This work is aiming to develop heated gloves to address Raynaud's Disease, along with related topic discussion, including (a) theoretical investigation of the peculiarities of Raynaud's disease (b) analyzing the existing heating clothes on the market (c) development and improvement of affordable heated gloves (d) cost consideration.

The idea is certainly encouraging. A working design completed with humidity and temperature sensing was implemented. A thermo-graph of the gloves under operation should also be presented in the report, for its efficacy. Additionally, the finger parts may need more heating, which would require adequate distribution of heating wire or good fiber thermo-conductivity. The author may want to reveal how the heating wire is woven into the gloves. Fail-safe design can also be considered.