LXSMWD12 Developer Manual

LXSMWD12 : ubpulse HRV API for Windows. USB HID communication.

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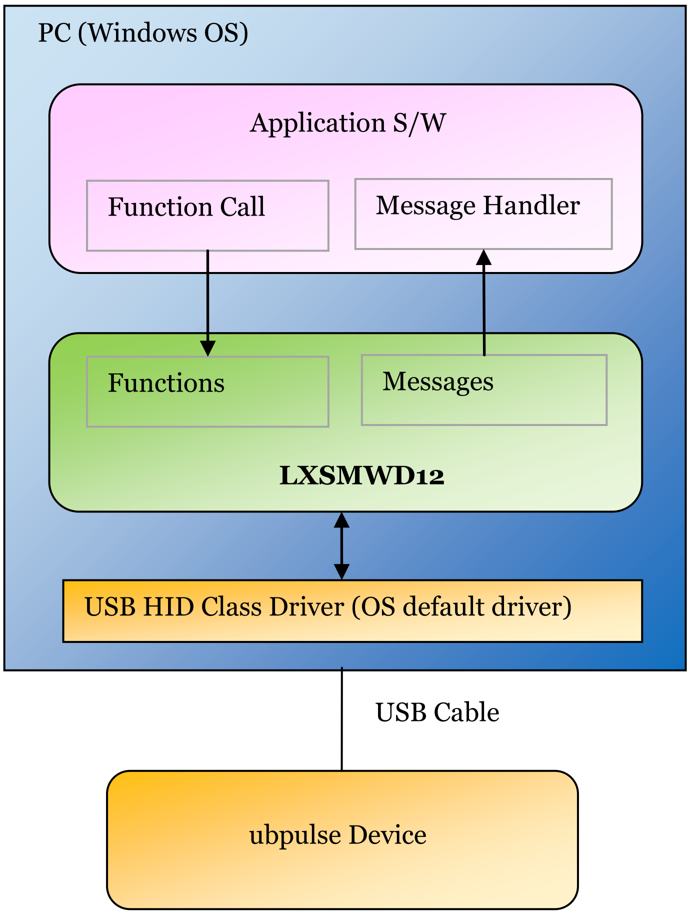
Abstract – LXSMWD12 is a win32 API DLL(Dynamic Link Library) for communicating with ubpulse device. Using LXSMWD12, the host software capable of communicating with the device. Host software can take real time measuring data(PPG wavwform, bpm, perfusion index, etc.) and HRV(Heart Rate Variabilty) inspection data.



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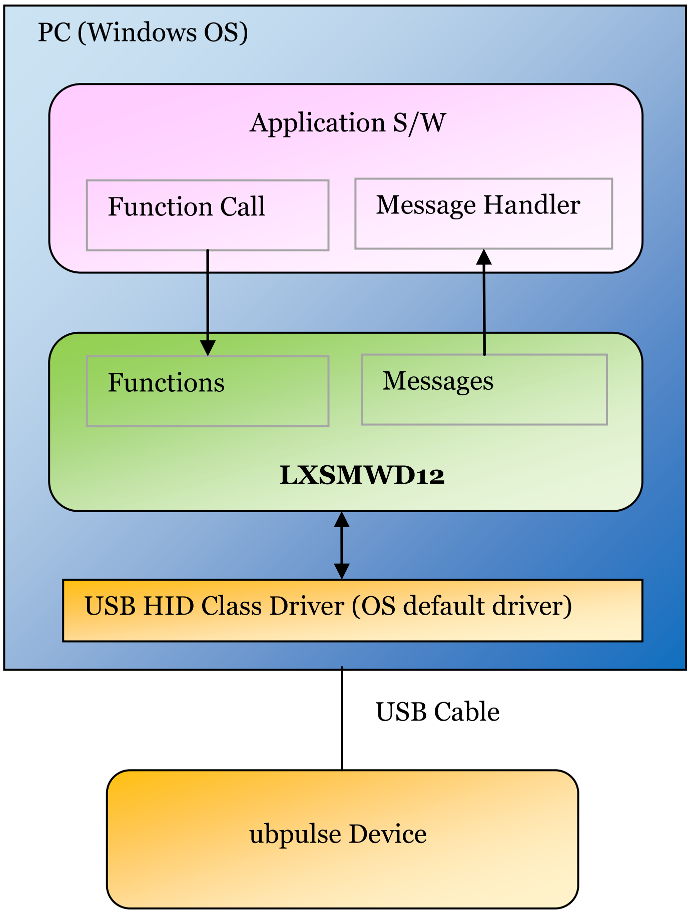
LXSMWD12 Overview

LXSMWD12 is a win32 API DLL(Dynamic Link Library) for communicating with ubpulse device. Using LXSMWD12, the host software capable of communicating with the device. Host software can take real time measuring data(PPG wavwform, bpm, perfusion index, etc.) and HRV(Heart Rate Variabilty) inspection data.



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Features.

- API type : DLL (Dynamic Link Libtary)
- DLL name : LXSMWD12
- API making tool : Visual C++ 6.0. MFC regular dll project.
- Supporting platform : 32bit application.
- Supporting OS : Windows 10, 8.1, 8, 7
- Recommended IDE for developing the application program : Visual C++ 6.0, 2015, 2017.

Getting started with LXSMWD12

LXSMWD12 download

LXSMWD12.zip download URL : https://github.com/ubpulse/ubpulse-H3/raw/master/LXSMWD12.zip

Notice : You should unblock the LXSMWD12.zip and then unzip the file.

LXSMWD12 copy files.

files	Copy to
LXSMWD12.DLL	Copy to the same folder which contains application exe file.
LXSMWD12.LIB	Copy to application project's source folder.
LXSMWD12.h	Copy to application project's source folder.

LXSMWD12 Importing DLL

In your Visual C++ source file, add the codes for implicit linking library and include the LXSMWD12.h. It's ready to use all functions and messages from LXSMWD12.

```
#pragma comment(lib,"LXSMWD12.lib") // DLL implicit linking

#inlcude "LXSMWD12.h"
```


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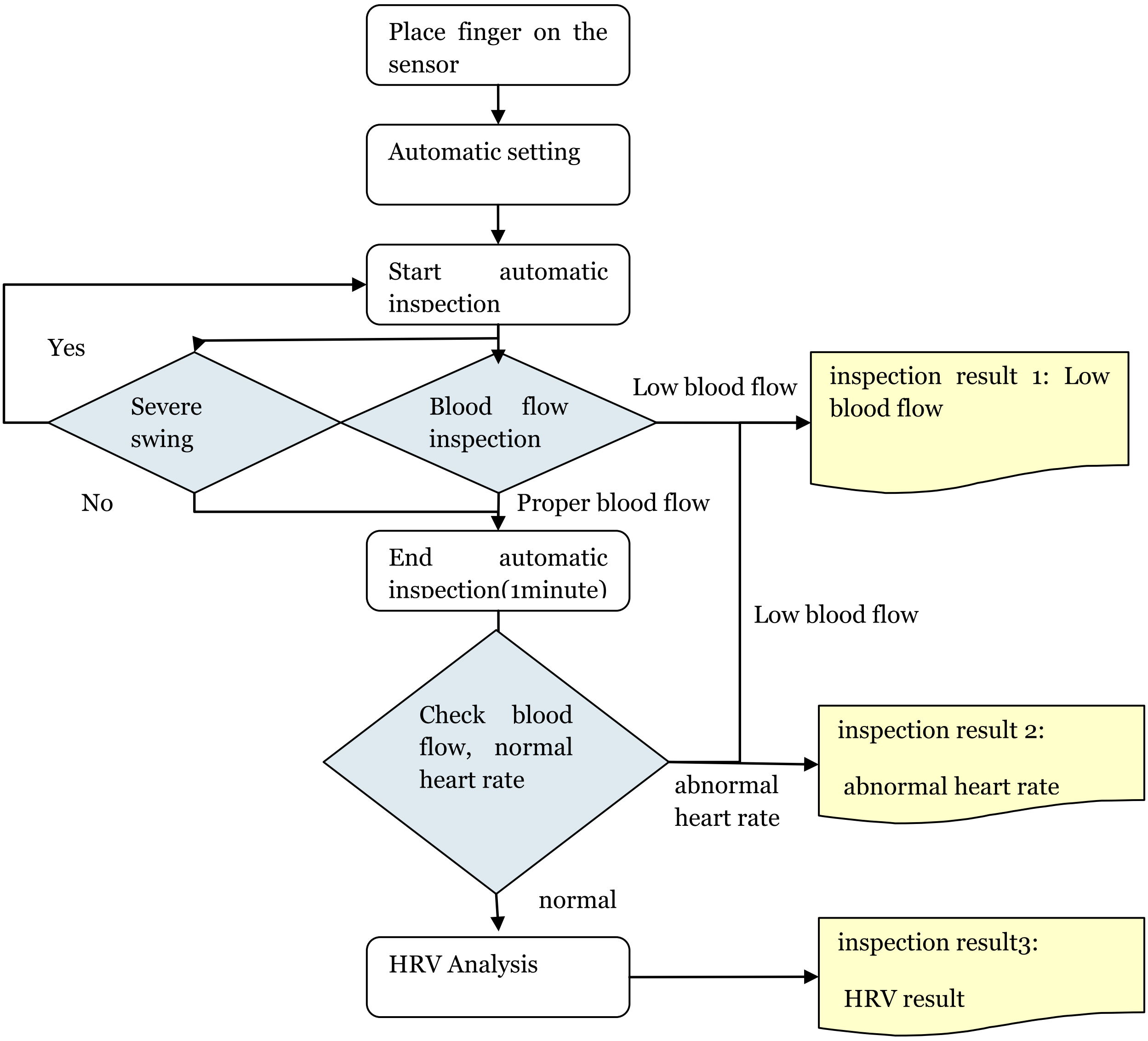
Operation flow.

After open device, DLL acquire the real time measuring data and HRV analysed data from the device. At the same time, DLL send messages to application program.



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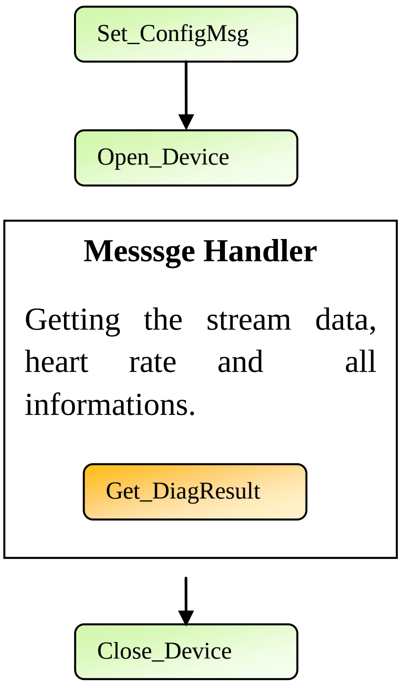
When the user places a finger on the ubpulse H3, the device detects it and achieves the optimum signal measurement condition in the automatic setting process which takes about 3 seconds. After 3 seconds, the device will automatically enter the inspection mode by itself. If the blood flow of the user is abnormally small in the inspection mode, the inspection is automatically stopped before one minute is completed, and the result of the "low blood flow determination" is displayed.

If the user moves his or her fingers heavily during the measurement, the inspection will start again from the beginning.

If there is no serious "abnormal low blood flow", the inspection is stopped at 1 minute after the normal time, and then the "low blood flow" is judged again. In the case of low blood flow, the result of "low blood flow judgment" is presented. If the blood flow is not low, the "abnormal heart rate" is determining. If the "abnormal heart rate" is abnormal, the "abnormal heart rate" is expressed. And arrhythmia are the most common causes of abnormal heart rate, and HRV analysis can not be applied when there is such an abnormal heart rate.

HRV analysis is performed when there is neither low blood flow nor abnormal heart rate, and the final analysis results are summarized and expressed.

Application program coding flow.



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API Functions.

Mandatory Functions.

Function.	개요
Open_Device(int pid)	Open device to communicate. pid : device ID. ● ubpulse H3 : 33 ● ubpulse G3 : 58 ● ubpulse OEM1 : 56
Close_Device()	Should be called before your application closed.
Get_DiagResult(st_DiagResult *diagresult)	Get the HRV results. You can find structure type definition of st_DiagResult in the file LXSMWD.h
Set_ConfigMsg(int msgtype_idx, HWND hwnd_msgtarget,int msgid, unsigned char on_off)	Set Message You should specify the your application's windows handle(hwnd_msgtarget) which receive the DLL's message (msgtype_idx) . on_off ● 1 : receiving the message ● 0 : not receiving the message

Optional functions.

Function	Description
Diag_ManualStart();	HRV inspection manual start at any time.
Get_QBufferSize();	DLL internal que buffer size.

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API Messages

DLL send messages by function sendmessage(WParam, LParam). Application program should implement the message handler..

msgtype_idx	Cause	WParam	LParam
0	DLL acquired 4 sampling PPG waveform from the device. .	type : unsigned int Current number of data in Que buffer.	type : (float *) Starting address of float type 1 dimensional array which contains the stream data.
1	Heart beat occurred.	0	type :unsigned char bpm(beat per minute). ex : 78
	Perfusion Index changed.	1	type : unsigned int perfusion index : % value x 100. ex. 556 means 5.56%

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msgtype_idx	Cause	WParam	LParam
2	Finger in out changed.	0	type : unsigned char 0: finger out. 1: finger in.
	stability changed.	1	type : unsigned char 0: unstable, 1:stable
	Auto setting status	2	type : unsigned char 0: Auto setting not going. 1: Auto setting on going.
	HRV inspection status	3	type : unsigned char 0: inspection not going. 1: inspection on going. 2: inspection stopped. - finger out during inspection. 3:inspection stopped. Low blood flow.
	HRV results data.	4	0: No HRV result data. 1: There is HRV results.
	HRV inspection remaing time.	5	type : unsigned char down counting from 60 sec to 0 sec.
	Acquired number of heart beat during HRV inspection.	6	type : unsigned char

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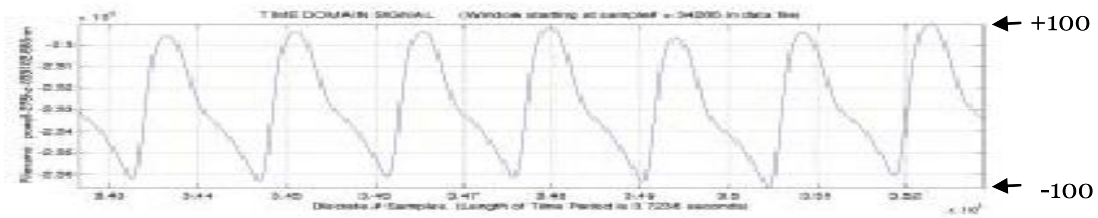
Stream Data for PPG wave form

The “stream data” means DLL internally defined float type 1 dimensional array. DLL acquires the PPG wave form data from the ubpulse device and save into the float array sequentially. When 4 sampling are saved into array DLL send message (msgtype_idx = 0) to application program. Application program’s message handler should get the 4 sampling data immediately.

PPG sample 1	PPG sample 2	PPG sample 3	PPG sample 4	…	…	

Application should get the 4 sampling data which means PPG waveform.

The range of PPG waveform value is between -100 and +100.



code example : Getting the 4 sampling PPG waveform

```
float save_data[4]; /


void CChildView::OnStreamData(WPARAm wParam, LPARAM lParam ) // Message Handler function
{
      Get_Data((float *)(lParam)); // lParam type casting to (float *)
}

void Get_Data(float * my_data)
{
      for(int i = 0 ; i< 4 ;i++)
      {
            save_data[i] = *(my_data+i); // get 4 ssmpling PPG waveform data
      }
}
```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struct St_DiagResult. HRV inspection results.

Member variable	Descrioption
Type	HRV inspection result type. 1: low blood flow, 2: abnormal heat beat. 3 : HRVinspection result.
SNSBal	The ratio of sympathetic. 100 * sympathetic activity / (sympathetic activity + parasympathetic activity)% values are recorded. For example, if 48, the sympathetic activity was 48% and the parasympathetic activity rate was 52% (100 - 48). Sympathetic : Para Sympathetic = 48:52
SNSBal_Level	Decision value of SNSBal.
PSNSBal	The ratio of para sympathetic. 100 * parasympathetic activity / (sympathetic activity + parasympathetic activity)%
PSNSBal_Level	Decision value of PSNSBal.
SNSAct	Sympathetic Activity. Unit : msec^2
SNSAct_Level	Decision value of SNSAct.
PSNSAct	Parasympathetic Activity. Unit : msec^2
PSNSAct_Level	Decision value of PSNSAct.
ANSAct	Autonomic Activity. Unit : msec^2
ANSAct_Level	Decision value of ANSAct.
HRVIndex	HRV Index. Unit : none.
HRVIndex_Level	Decision value of HRVIndex.
HR	Average heart rate Unit : bpm
HR_Level	Decision value of HR.
PI	Average Perfusion Index. Unit : %
PI_Level	Decision value of PI.

Note1. The meaning of decision values.

Decision value	meaning
0	Very small
1	small
2	Standard
3	large
4	very large

Note2. The meaning of SNSBal_Level

SNSBal_Level	meaning	Description.
0	very small	Sympathetic << Para sympathetic
1	small	Sympathetic < Para sympathetic
2	standard	Sympathetic ~ Para sympathetic.
3	large	Sympathetic > Para sympathetic
4	very large	Sympathetic >> Para sympathetic

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Member variable	desctiption
HBI[255]	Heart beat time interval . Unit : mili sec (= 1/1000 sec).
NUM_HBI	The number of data above HBI[].
NUM_FaultHBI	The number of abnormal heart beat. In the case of inspection type is 2 abnormal heart beat.
Histogram[225]	Histogram The number of heart beat in each time interval from 0.2sec to 2 sec, divided step 0.008 sec. i.e. Histogram[0] : The number of heart beat interval time at 0.2 to 0.208 sec. Histogram[1] : The number of heart beat interval time at 0.208 to 0.216 sec. ... Histogram[224] : The number of heart beat interval time at 1.992 to 2 sec.

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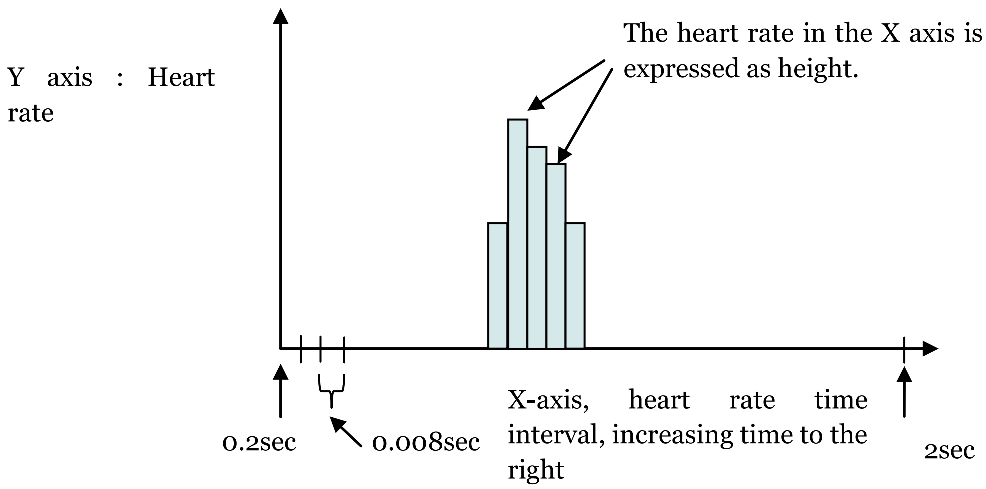
Histogram representation guide.

The histogram data provided by the device is the heart rate corresponding to the interval between heartbeats at intervals of 0.2 seconds to 2 seconds at the heartbeat interval of 0.008 seconds. As shown in the example of the figure below, the X axis is the time rate and the Y axis is the heart rate A histogram representation of the height corresponding to the quantity is appropriate..



Limitations on histogram representation should not only represent all of the measurements, but also the readability and comprehensibility of the information presented by the user. There is no compulsory regulation that must be followed in expression, and the key point is to achieve the following expression goals.

Histogram representation goal.

The core of the information to be grasped in the histogram is that it is used to judge the degree of sharpness or widespread distribution of the subject in the test, so it is important to visually grasp the data in the expression of the data.

Considerations for achieving a histogram representation goal.

1. The scale of the X-axis (= minimum representation unit), which can affect the geometry of the histogram distribution, is fixed. If the X-axis scale has a different scale for each measurement, it is difficult to make relative comparison with another person's test result.

2. The minimum and maximum values of the x-axis of the histogram do not have to be 0.2 or 2 seconds provided by the device. A heart rate interval of 0.2 seconds is a very high heart rate corresponding to a heart rate of 300 bpm, and a heart rate interval of 2 seconds is a very slow heart rate of 30 heart rate per minute. For the completeness of the measurement itself, the device calculates and provides all the measurements in the 0.2 second and 2 second intervals. However, in a practical product

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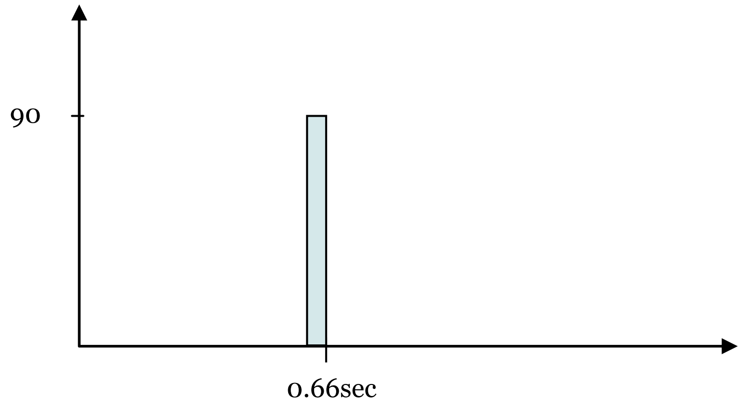
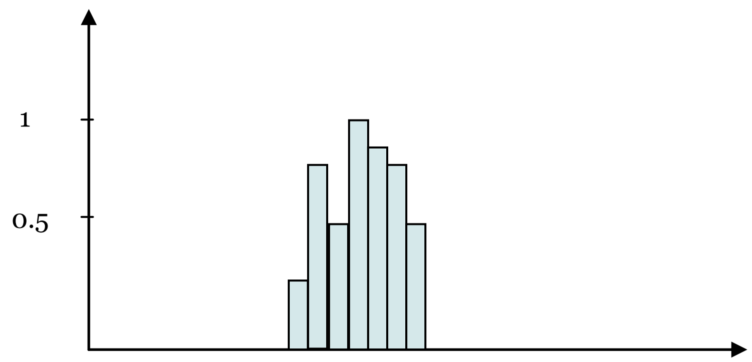
application, the heart rate is rarely more than 150, and rarely less than 50. Therefore, the maximum and minimum values of the X-axis of the histogram can be determined in consideration of a practical situation.

3. Range of Y-axis values - the maximum value you can have. If the test result of the subject ascends at a heart rate of 90 per minute (heart rate interval = 0.66 sec) without change of heart rate interval for 1 minute measurement time, the value of Y axis will be 90 as shown below.



However, in reality, the heart rate interval of a person changes from a small value to a large value for one minute, and since the distribution of the individual and the maximum value of the Y axis fluctuate greatly, the method of fixedly designating the maximum value of the Y axis is not suitable. The value of the Y-axis is preferably changed dynamically whenever the inspection result is expressed. Alternatively, the remaining values may be scaled and expressed by setting the mode to 1. As shown in the figure below, if the mode is 20, the mode is expressed such that the mode is expressed as 1 when expressed in the Y axis, and the height expression is expressed as a real number by dividing all the remaining values by 20. The advantage of this approach is that the charts that are represented always maintain a fixed setting so it is convenient for coding, but since the heart rate information is gone, the user has to say, "How many times did it jump?" It is a disadvantage in that it leaves a question



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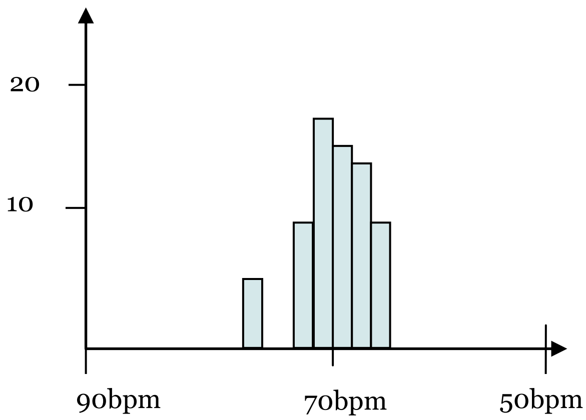
Expression example.

As an example of a method of achieving the above goals and improving readability and comprehension, the following method is also possible.

1. The values of the Y-axis are dynamically represented by referring to the histogram's mode at every measurement. In the figure below, 20 is expressed, but the reason for this expression is that the mode is expressed as 17 because the mode is 17. When examining another subject, the maximum value of the Y axis may be 10 or 40, so it must be dynamically configurable for each test result.
2. The information used for data representation on the X-axis is the heartbeat interval, but in terms of expression, it is expressed as the heart rate per minute. To better understand the heart rate per minute than the heart rate interval, users should be able to see the values presented on the X axis for intuitive understanding.
3. A histogram corresponding to the average heart rate of the heartbeat histogram is placed at the center of the X axis and a new value is calculated every time the histogram is expressed so that the minimum value and the maximum value of the X axis are the same interval from the average heart rate. Example of calculating the minimum and maximum values - If the result of 1 minute is 70 bpm (heart rate interval = 0.857 seconds) is the average heart rate, the center of the histogram X axis is set to 0.857 seconds. The maximum value on the X axis is 50 bpm (heart rate interval = 1.2 seconds) minus 20 bpm at 70 bpm. On the other hand, the minimum value of the X axis is from 70 bpm to 20 bpm plus 90 bpm (heart rate interval = 0.66 seconds).



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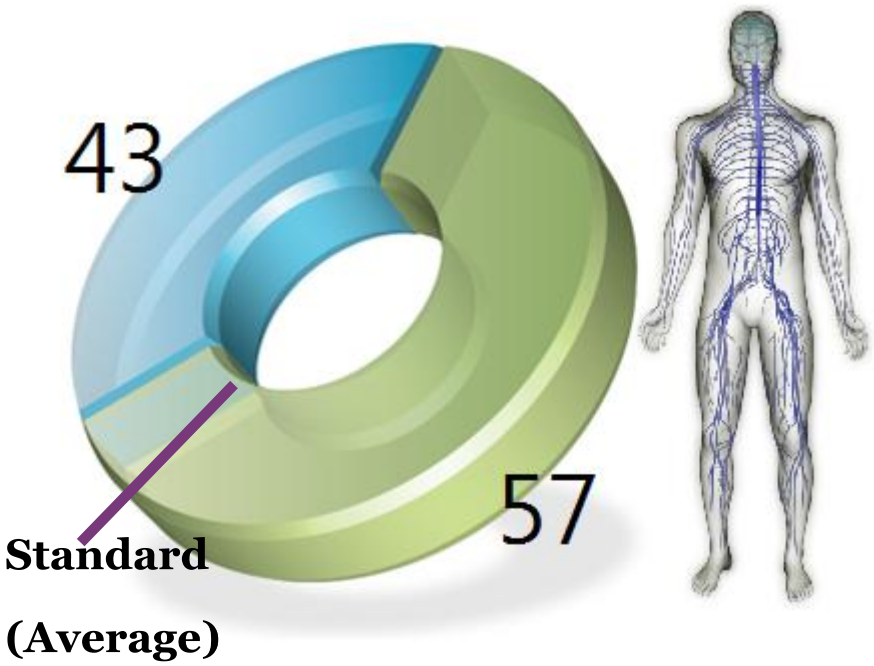
Expression example. - Autonomic, sympathectic, parastmapathetic activation.

Inspection items	Inspection results				
	Very low	Low	Standard	Large	Very large
Autonomic nerve activity				6.3	
Sympathetic activity			5.8		
Parasympathetic activity.					7.5

Expression example - Autonomic balance.



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Revision History

Release Date	Doc. ID	Description of Change
2018-04-27	LXE33 v1	First release

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