WaistonBelt: A Belt for Monitoring Your Real Abdominal Circumference Forever

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Abstract
Metabolic syndrome becomes a serious problem in our life, because it is one of the reasons of arteriosclerosis, heart disease or stroke. In order to prevent a person from becoming a metabolic syndrome, it is important to know own current actual abdominal circumference, and care by yourself. However, any wearable devices cannot measure abdominal circumference.

In this paper, we propose and implement a belt-type wearable device, called "WaistonBelt", and a smartphone application that can keep monitoring an abdominal circumference forever. "WaistonBelt" can measure an abdominal circumference with ordinary action, and can visualize a transition of it. Through an experimental evaluation, we confirm that our system can measure an abdominal circumference with 0.66% error.

Author Keywords
Wearable Computing, Healthcare, Abdominal Circumference Measurement.

ACM Classification Keywords
C.5.3 [Microcomputers]: Portable devices.

General Terms
Theory, Experimentation.

Background & Concept

Recently, the increase of metabolic syndrome patient is serious problem in our life. According to the report by "Ministry of Health, Labour and Welfare", about half of adult men are patients or reserves of the metabolic syndrome[2](Figure 1).

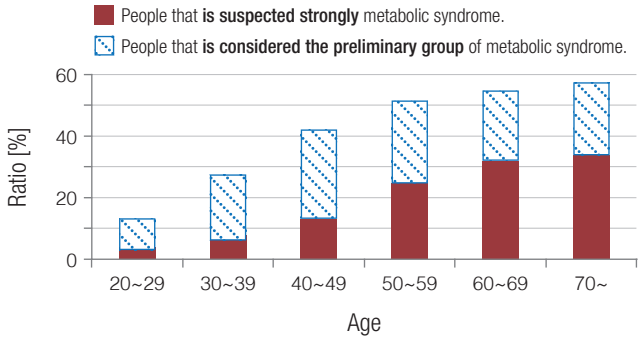

Figure 1: The ratio of patients or reserves of the metabolic syndrome in adult men.

The metabolic syndrome is a clustering of symptoms such as hyperglycemia, dyslipidemia and hypertension. This syndrome increases the risk of atherosclerosis, which is a factor for stroke and heart disease. Therefore, it is important to measure and record a daily abdominal circumference in addition to periodic health check[1]. However, day-to-day abdominal circumference measurement and recording by a tape measure is a heavy burden for the user.

In order to solve this problem, we propose "WaistonBelt" for measuring automatic abdominal circumference just by wearing a belt(Figure 2). By recognizing motions of wearing pants as trigger, a user can measure and record a daily abdominal circumference without labor cost.

Related work

We can collect biological data and momentum data easily by using a wearable device on a daily basis, because a wearable device is becoming popular in the world.

As the related work, Withings S.A.S. provides "Withings Active" and "Withing Pulse O_x" which are wrist-watch-type wearable devices[1]. These devices measure biological data and momentum data such as walking distances and steps, heartbeats, burned calories, status of sleep. Measured data are uploaded to the cloud server. Furthermore, this system realized management of measured data, and analysis of these data and data measured by other healthcare devices.

As other works, "Belty" based on similar concept[2] has been announced in CES2015. "Belty" has some function; dynamic adjustment of a belt's length and measurement of waistline trend and so on. But, details of measurement function (e.g. mechanical design, accuracy, measurement interval) have not been published yet.

Design & Implementation of "WaistonBelt"

"WaistonBelt" consists of a belt-type wearable device and a smartphone application. We adopted the "belt" as fashion item that we wear daily. The overview of "WaistonBelt" system is shown in Figure 2.

"WaistonBelt", which is belt-type wearable device, is implemented on the buckle of a belt. Figure 3 shows detailed structure of "WaistonBelt".

[1]Withings, "Withings", http://www.withings.com/
[2]emiota, "Belty", http://www.emiota.com/

Figure 2: A belt-type device and smartphone application.

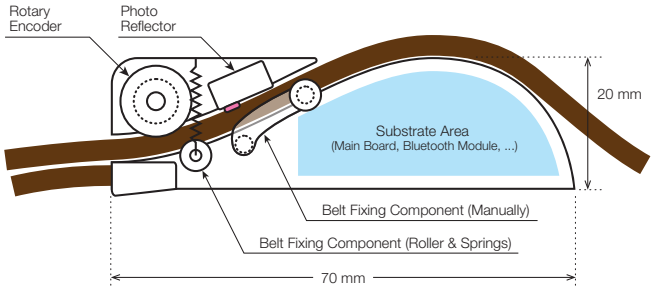

Figure 3: The device structure of "WaistonBelt."

It detects an insertion of a belt using a photo reflector, and automatically measures an insertion distance of the belt using a rotary encoder. To infer the insertion distance, it counts the number of pulses obtained from the rotary encoder when inserting the belt into the buckle.

Then, The insertion distance L can be calculated by using counted pulses with Equation 1.

$$L = \frac{\pi \cdot d}{12} \cdot P_c \quad [\mathrm{mm}] \tag{1}$$

P_c means a number of pulse of a rotary encoder. Also, d is a constant number which means the diameter of the rotary encoder. In this paper, we decided $d = 13.3$ mm. Therefore, a resolution of "WaistonBelt" is 3.48 mm. Then, by calculating difference between the initial length of the belt and the measured length, it can calculate the abdominal circumference.

The inferred data is transmitted to our smartphone app via Bluetooth. Figure 4 shows the communication procedure.

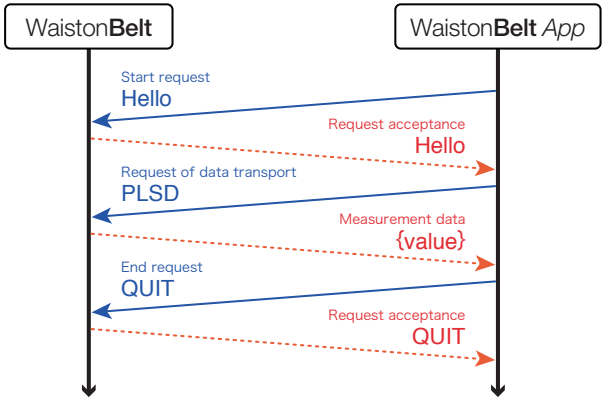

Figure 4: The communication procedure via Bluetooth.

"WaistonBelt App", which is smartphone application, manages and visualizes the inferred data. The screenshots of application are shown in Figure 5. The application stores an abdominal circumference inferred data in once of day or in short interval. A user can decide the interval of storing on the smartphone application.

In addition, the application can show several graphs: day-by-day data, trendline and user's objective (Figure 5-(a)). It can show some statistics information: the trend analysis by day of the week, the degree of progression of the metabolic syndrome (Figure 5-(b)).

Discussion

To evaluate our proposed system, we conducted 100 times measurements of abdominal circumference measurement. As a result of the evaluation, the mean relative error of abdominal circumference measurement was 0.66 %. Finally, we confirm that our proposed belt can measure an abdominal circumference with ordinary action, but high accuracy.

(a) Startup screen (b) Statistics screen

Figure 5: Interface of smartphone application.

Conclusion

In this paper, we have proposed a belt-type wearable device "WaistonBelt" and a smartphone application "WaistonBelt App" for keep monitoring a user's abdominal circumference automatically, continuously and unconsciously. In future, we will ameliorate "WaistonBelt App" for giving information of abdominal circumference efficiently.

References

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