Piezoresistive type 3-axis acceleration sensor HAAM-326B

Pedometer Feb, 2007 1st edition

Introduction

This application note aims for users to understand the method of counting number of walking step using piezoresistive type 3-axis acceleration sensor (HAAM-326B). This application note explains using digital value which is converted from analog value of acceleration that piezoresistive type 3-axis acceleration sensor (HAAM-326B) outputs.

Reference: HAAM-326B catalog http://www.hdk.co.jp/pdf/eng/e137507.pdf
3-axis acceleration sensor application note (Calibration of sensors' individual difference)

By building-in 3-axis acceleration sensor, pedometer counts number of steps walked.
By using 3-axis acceleration sensor, user can place pedometer in any angle, anywhere with the user.

1 Composite

This application note explains using 78K0/KB2 (uPD78F0500) as an example CPU which connects to HAAM-326B.
Please refer to HAAM-326B catalog for electrical characteristics.

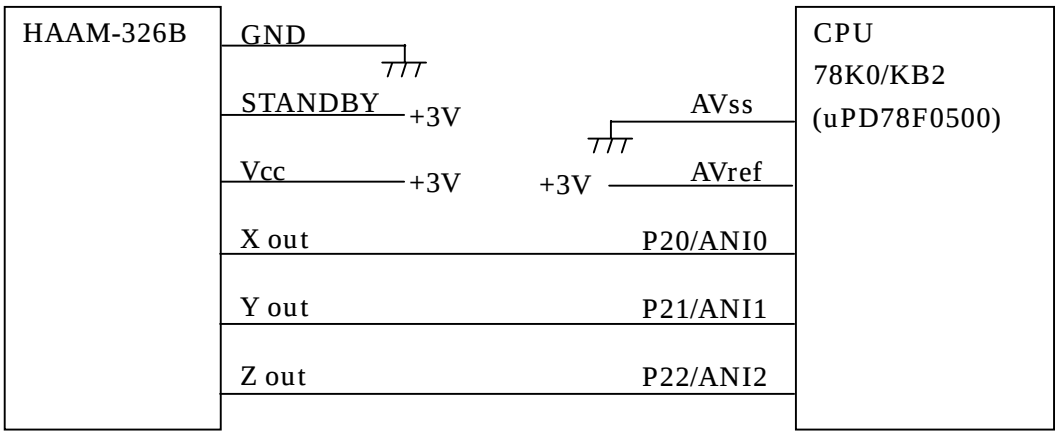

Figure 1 Connection of HAAM-326B and CPU

■ Input voltage and conversion result

There is a relation between analog input voltage that put into the analog input terminal (ANI0-ANI2) and logical A/D conversion result (10-bit A/D conversion result register) as the figure below.

The 78K0/KB2 used in this application note shows the figure below.

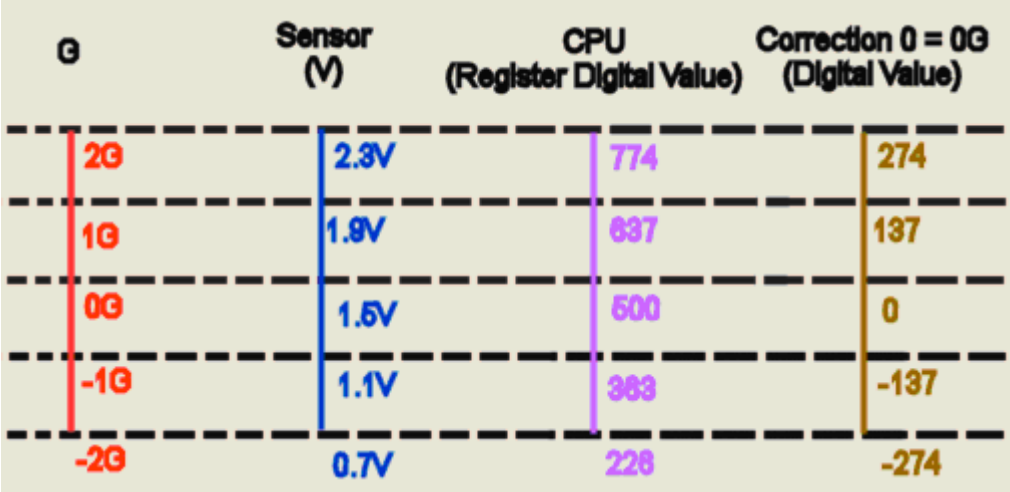

Figure 2 Input voltage and conversion result

■ Value to use on conversion result

In this application note, the digital value at 0G is considered as 0.

Figure 2 input voltage which adds offset to A/D conversion result and value of Correction0=0G (digital value) that is the conversion result will be used on later explanation.

■ Sampling rate

In this application note, XYZ is sampled every 4ms.

2 Algorithm of recognizing walk movement

■ Method being independent of sensor mounting angle

If X, Y, and Z-axis are referred to, respectively, detection will be dependent on sensor tilt angle. Therefore, this step-counting only refers to 3-axis composite value.

■ 3-axis composite value and XYZ axis value at walking

When sensor is moved to front, rear, right, left or aslant, 3-axis composite value will be deviated from 1G at the time of initial move.

During this deviated period, discernment process of step count is performed.

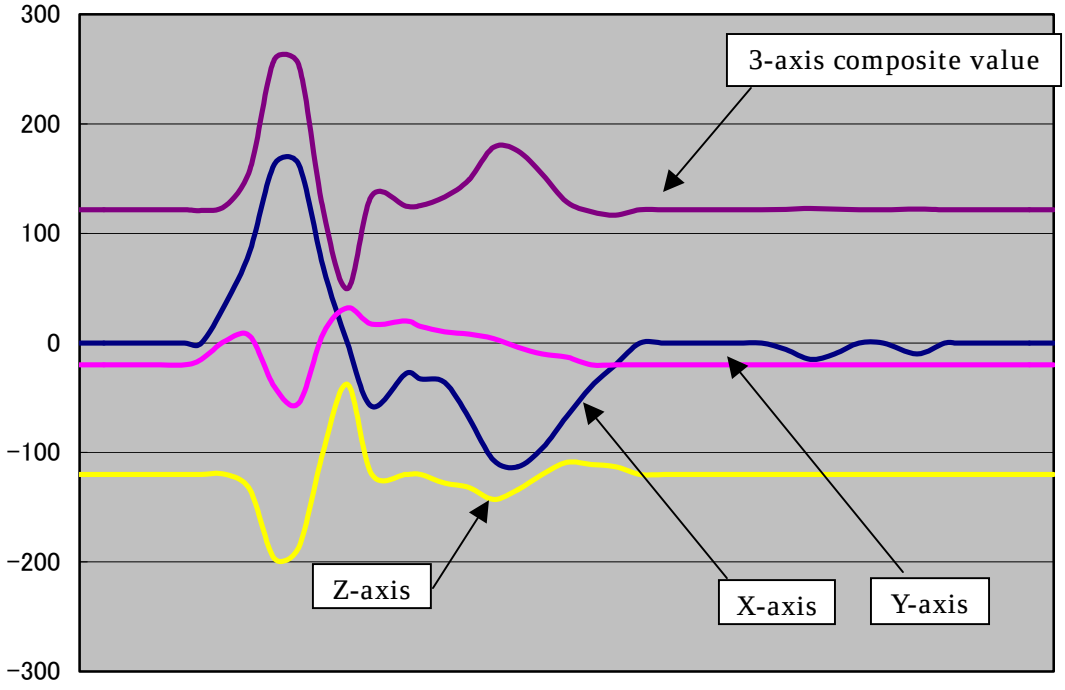

Figure 3 Data graph when moving a sensor

■ 3-axis composite values and XYZ axis other than walk

Since 3-axis composite value does not deviate from 1G when rotating a sensor and such, the period that 3-axis composite value is stable does not recognize as step-count.

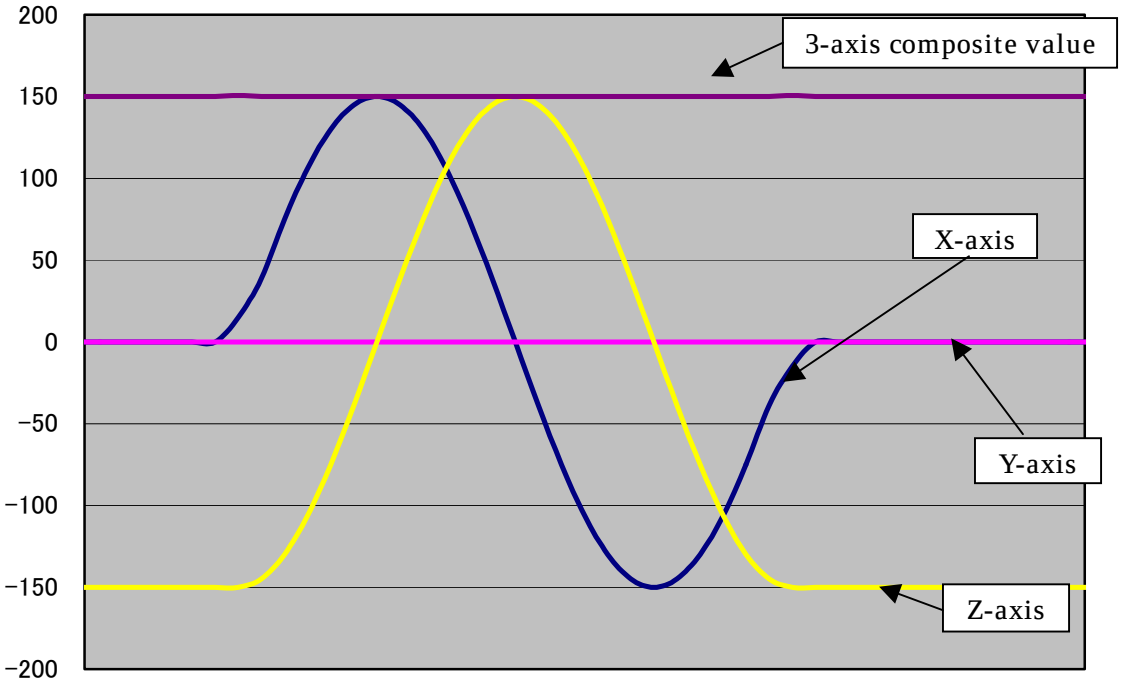

Figure 4 Data graph when rotating sensor single turn in X-axis direction

■ Algorithm of recognizing various walking style

Although there are various walking styles as shown in the following figure, basically 3-axis composite value becomes lower than 1G, then higher than 1G afterward.

By counting this cycle, walking steps can be counted whether slow walk or run.

■ Method of counting number of steps

1. detect lower than 1G
2. detect higher than 1G. Difference with last time detection has to be more than certain number.
3. If above 2 becomes true within fixed time, count as step.
4. If above 3 is done or it passed fixed time, return to 1 and repeat.

Threshold of gravity which recognizes having become lower than 1G	0.9G
Threshold of gravity which recognizes having become higher than 1G	1.1G
Threshold of gravity difference with last time detected	0.2G
Fixed time	1 second

Table 1 Table of various threshold value

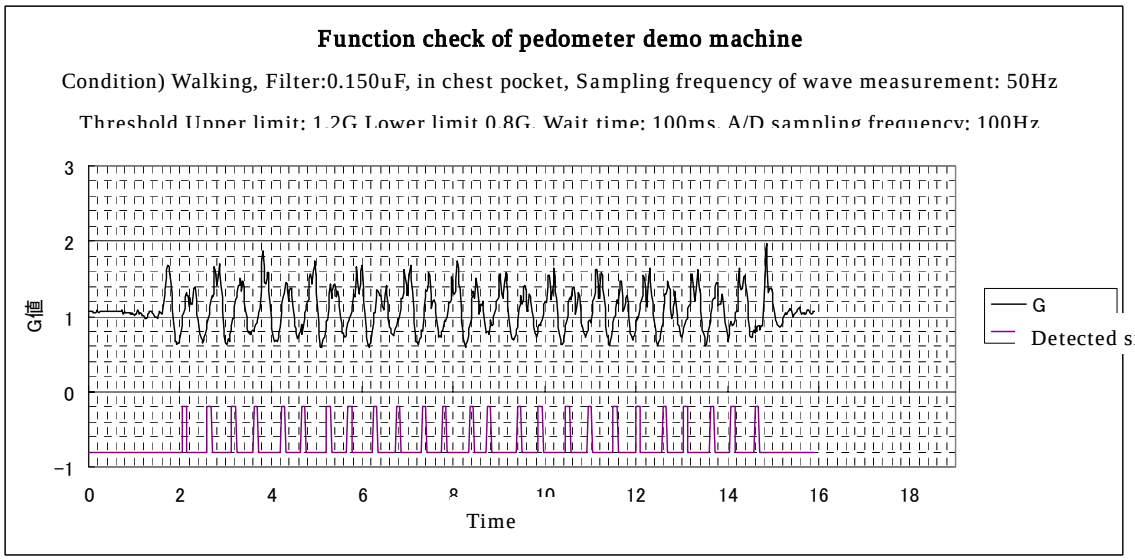

Figure 5 Walking (sensor in chest pocket)

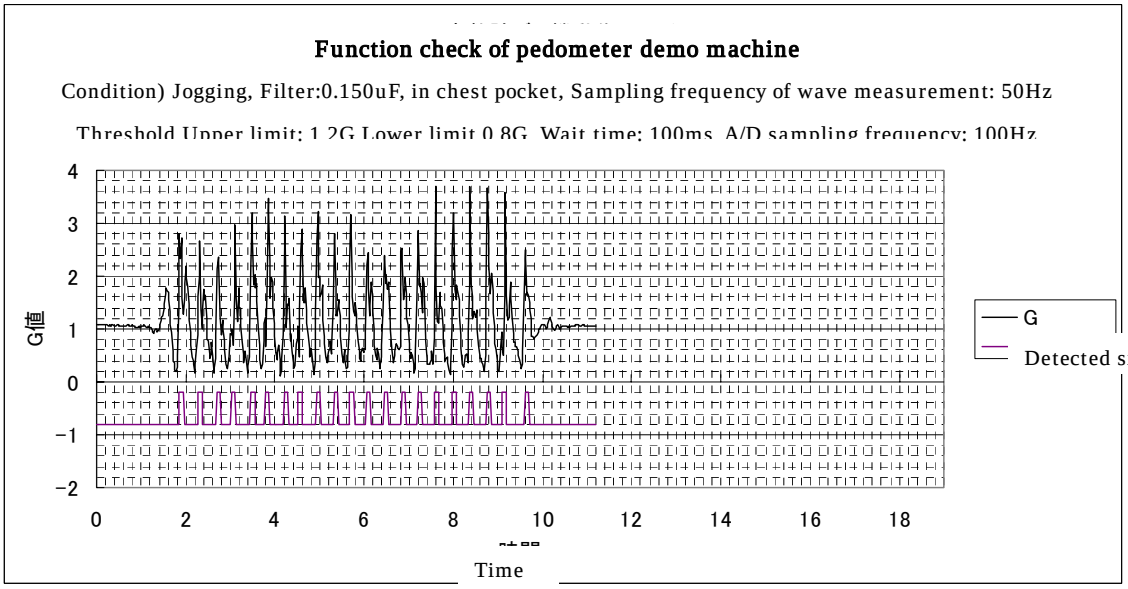

Figure 6 Jogging (sensor in chest pocket)

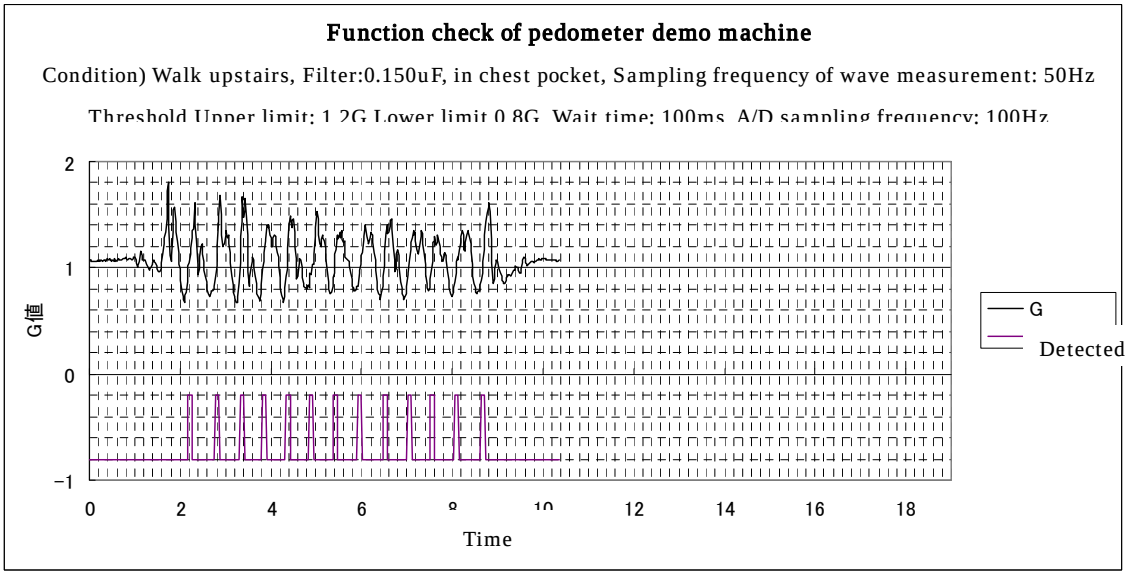

Figure 7 Walk upstairs（sensor in chest pocket）