# Measurement and Analysis of Body Pressure Distribution on a Bed

Se Jin Park*, Min Cheol Whang*, Chang Bum Kim**

* Ergonomics Lab.; Korea Research Institute of Standards and Science
** Computer Science Department, Korea Advanced Institute of Science and Technology

## ABSTRACT

We spend about 40% of lifte time on a bed and seek how such amount of time is spent comfort. Bed comfort has been pursuited. The pressure distributions on a bed by body pressure has been considered as one of the most important factors of bed comfort. This study is to quantify the subjective assessment by the body pressure distribution and develop the objective evaluation method of bed comfort.

A new measurement system for body pressure on a bed was developed in this study. The thin film pressure sensor (FSR: Force Sensing Resistor) of an elastomer-type was used to prevent the distortion of contact pressure. The pressure distribution is measured by FSR and displayed on the monitor by color-coded contour patterns.

Some of the bed test results were described. And the relations between body pressure distribution and bed comfort were evaluated.

# I. INTRODUCTION

We spend more time than any other room of the house, close to 40% of our lives [4]. A bed has intensively considered but little experimented. Design characteristics of beds should be well defined by enough experimental data for specifying such important parameters as size, firmness, height, and etc. The lack of this data can not progress the human factor research of a bed.

The human factors of bed components are considered as the mattress and bedstead (bedspring). The mattress and bedstead are joined to produce relative firmness. The question of the relative firmness appears to be what primarily determines how much the supporting surface conforms to the body. Different extents of conformity both between and within types are vertical open-coil-spring, pocketed-coil-spring, foamy, air-filled, and water-filled(waterbed) mattress.

A number of researches have looked at the factors in mattress design. Laird and Miller started some experimental work [2]. Berglund, et al.[1] gave some attention to the firmness factor in bed design. One conclusion was that conformity is the most important aspect. It should be better defined but better definition calls for new, improved methods of measurement. As a limited and brief effort in this direction, the investigators developed a pressure-measuring apparatus.

Orthopedists emphasized firmness and horizontality. On the other hand, B. Akerblom found that too hard bed is unhealthy because it fails to distribute pressure enough. E. Hohwü-Christensen also observed that softness is necessary to distribute pressures, although it is not easy to specify the distribution.

The body pressure distribution on a bed may play an important role in evaluating human factors in bed comfort. Therefore, the purposes of this study are to develop a new measurement system for body pressure on a bed and to quantify the subjective assessment by the body pressure distribution.

## II. BODY PRESSURE MEASUREMENT SYSTEM

In order to measure, display, and analyze the body pressure distribution on a bed, a new body pressure measurement system has been developed in this study. This system enables to display the real-time pressure distribution and process the 2-D and 3-D data.

Fig.1 shows the body pressure measurement system. This system is composed of FSR(Force Sensing Resistor) array on the cloth mat, controller, monitor, 486 PC and the software. The software was coded and its function is real-time displaying and analyzing of pressure distribution. A elastomer-type thin film pressure sensor(FSR) has been used in order to prevent the distortion of contact pressure.

Fig.2 shows the array of FSRs on the cloth mat. FSRs are arranged in the form of a matrix on the cloth mat and sandwiched in rubber molds. The number of FSRs are 32 x 80 with a total of 2560 FSRs. The size of FSR is so small that an occupant on the bed feels almost nothing.

In recent years, several types of pressure sensors have been developed. A new and promising sensor is the conductive elastomer sensor such as the Force Sensing Resistor. Figure 3 shows the force/resistance characteristic of the FSR [3]. It consists of a force-sensitive organic film screen printed on a Mylar sheet. When a force increases on the top, the contact area increases. Increasing contact area reduces the resistance of the force-sensitive film. The pressure-resistance relationship is not linear but log-linear. It has full-scale repeatability of ±1%. It is thin and small enough not to effect the bed characteristics.

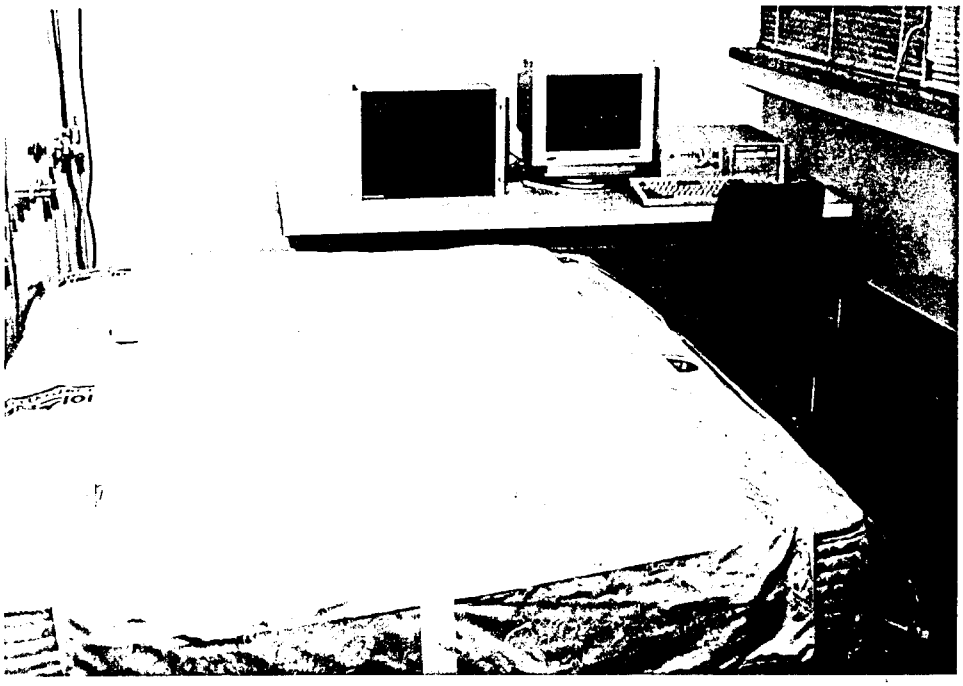

Figure 1. The body pressure measurement system

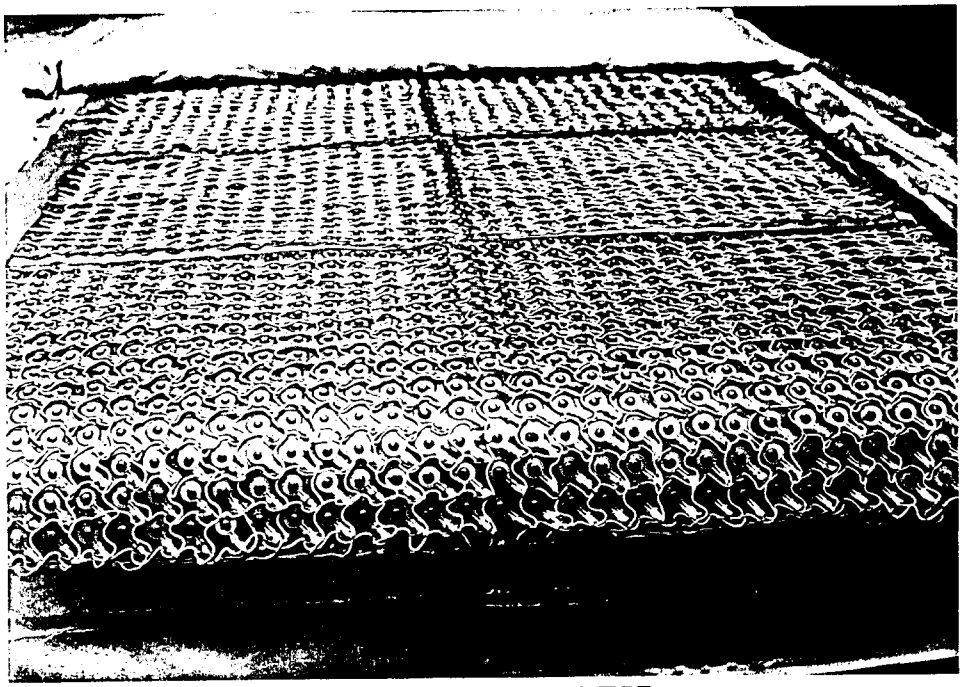

Figure 2. Array of FSRs

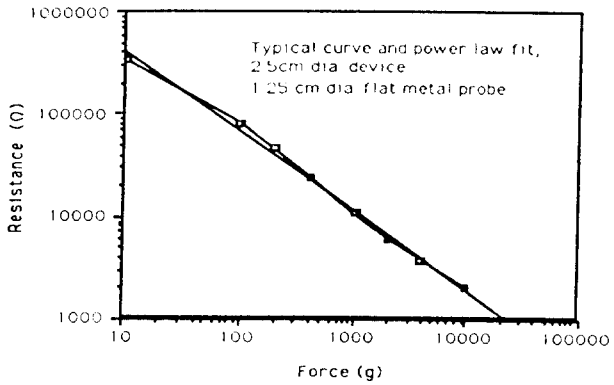


Figure 3. Force/resistance characteristic of the FSR

## III. Testing Results

In order to measure and display the body pressure distribution on a bed, a new measurement system has been developed. This system enables the display of the real-time pressure distribution and enables the processing of the scanned data to a computer. The real-time display of the dynamic change in the pressure distribution makes it possible to understand its correspondence with human feeling visually. The data processing makes the statistical and quantitative treatment of the data possible.

The pressure distribution measured with the body pressure mat is displayed by color tone on a color monitor with a color indicator divided into 16 levels. This color monitor can shows a general tendency of the body pressure distribution at a given time. For a minute analysis, the distribution is converted into a uniform pressure chart, and other necessary processing is performed on a computer.

Figure 4, 5, and 6 show the examples of the body pressure distribution, and the analytic displays of a new body pressure distribution.

And now, subjective evaluation, the measurement of body pressure distribution and the measurement of the spinal column shape are carrying out in Ergonomics Laboratory of KRISS.

## ACKNOWLEDGEMENT

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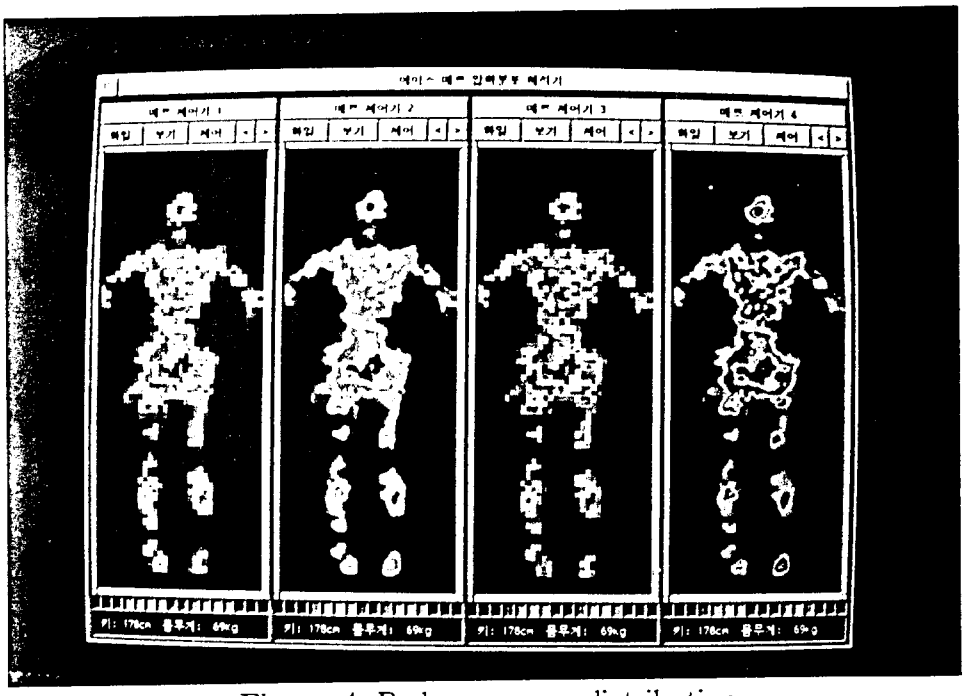

Figure 4. Body pressure distribution

(Possible to compare 4 different patterns)

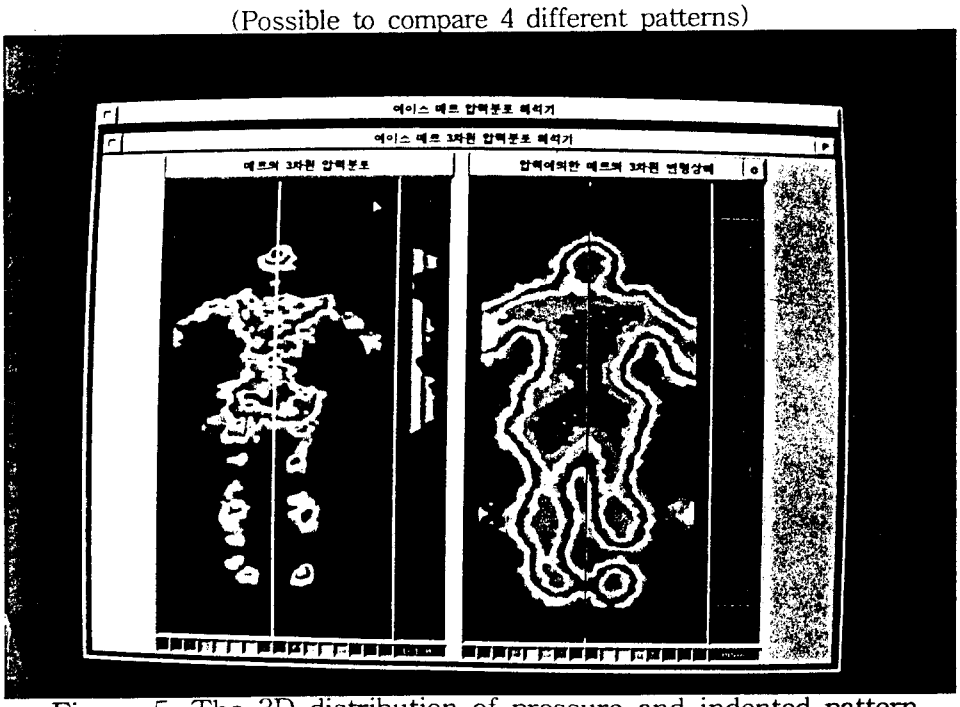

Figure 5. The 3D distribution of pressure and indented pattern

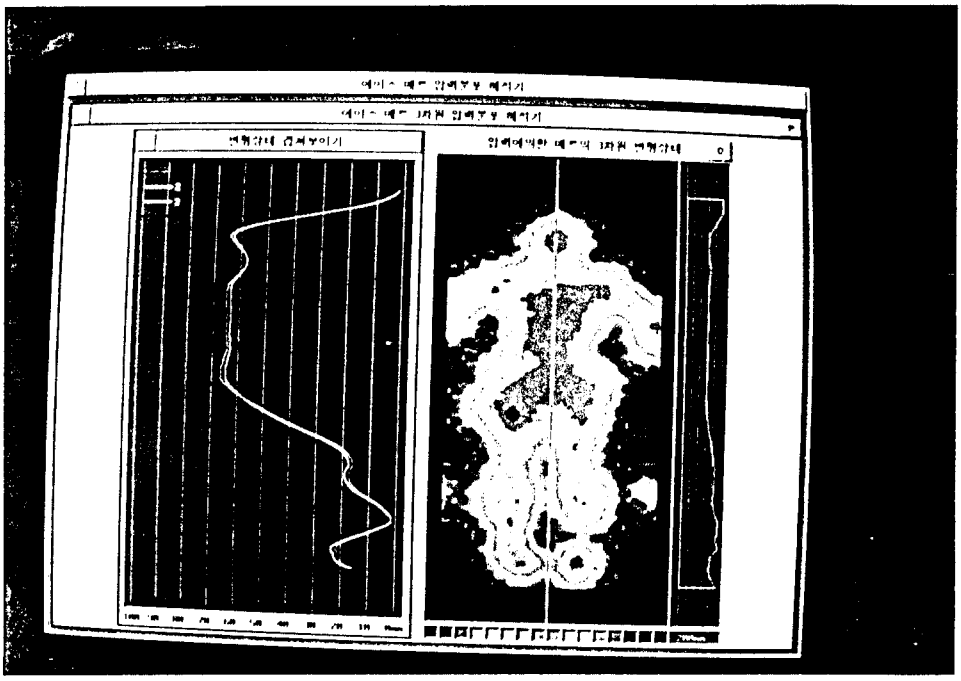

Figure 6. Comparison of beds with the different firmness

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