Researches and Progresses of Modern Technology on Silk, Textile and Mechanicals

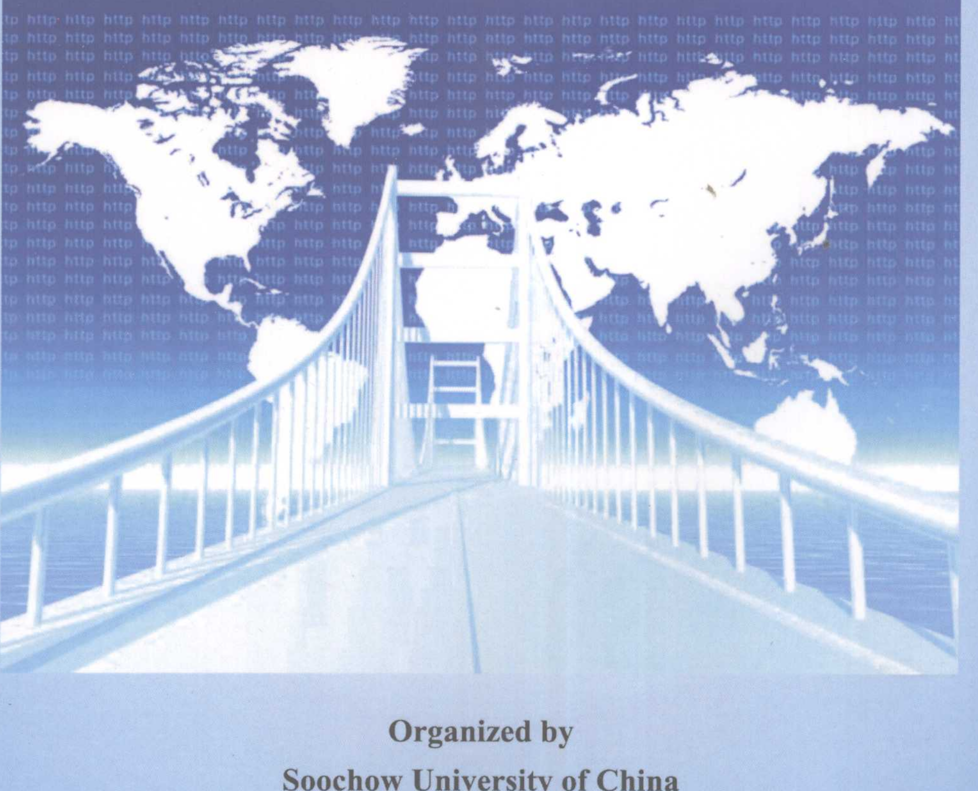
(Ⅱ)

The 4th China -Japan Conference on Mechatronics

(CJCM 2007 Suzhou, China)

Sep.13, 2007

Yannian Rui



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图书在版编目（CIP）数据

现代丝绸、纺织、机电技术研究与进展=Researches and Progresses of Modern Technology on silk,Textile and Mechanicals：英文/芮延年，白伦主编. —北京：化学工业出版社，2007.8
ISBN 978-7-122-01157-2

Ⅰ. 现… Ⅱ. ①芮…②白… Ⅲ. ①丝绸工业-国际学术会议-文集-英文②纺织工业-国际学术会议-文集-英文③机电工程-国际学术会议-文集-英文 Ⅳ. TS1-53; TH-53

中国版本图书馆 CIP 数据核字（2007）第 137165 号

责任编辑：程树珍　金玉连

出版发行：化学工业出版社（北京市东城区青年湖南街 13 号　邮政编码 100011）
印　　装：化学工业出版社印刷厂
880mm×1230mm　1/16　印张 47　字数 1000 千字　2007 年 9 月北京第 1 版第 1 次印刷

购书咨询：010-64518888（传真：010-64519686）　售后服务：010-64518899
网　　址：http://www.cip.com.cn
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定　　价：280.00 元（上、下册）

Preface

21st Century is a century with the characteristics of incessant knowledge innovation, rapid science and technology development and dynamic world change as well. Scientific and technological innovation has claimed a major role in social and economic development. The competitions between countries mainly focus on knowledge innovation, technological innovation and novel high technology industrialization. Therefore, innovation is the foundation stone of the sustainable development of national economy.

Competition and breakthrough of high technology play an increasing important role in creating new production mode and economic order. High technology reform leads to global economic integration characterize modern economy.

With development of science and technology, a large quantity of novel high technologies, such as advanced manufacture technology, micro-electronics technology, information technology, automation technology, biology technology, new material technology, new energy technology, space technology, ocean technology, laser and NIR technology and fibre-optic communication technology, have transformed into production with high speed and on an unprecedented scale.

With new and high technology infiltrating through traditional industry, traditional industry has profound reconstructed. For instance, Integration of micro-electronics technology, micro computer technology, automation technology and machinery technology brought about a qualitative leap of product structure and production system. For general case of typical mechatronic products, numerical control machine tool, manufacturing centre, Robot, air condition, digital camera and etc. are all the innovation achievements of integration of modern mechanical and electronic technology.

For the purpose of better development of modern mechatronics technology, Soochow University together with Shinshu University sponsored and successfully organized the China-Japan Conference on Mechatronics. The conference will be held in China, Japan, Germany and Australia by turns.

The 1st China-Japan Conference on Mechatronics was held successfully on September 2004 at Soochow University, China. Attendees from 7 universities and institutes located in 3 countries presented more than 20 papers.

The 2nd China-Japan Conference on Mechatronics was held successfully on August 2005 at Shinshu University, Japan. Attendees from 12 universities and institutes located in 4 countries presented more than 30 papers.

The 3rd China-Japan Conference on Mechatronics was held successfully on September 2006 at Fuzhou University, China. Attendees from 20 universities and institutes located in 5 countries presented more than 70 papers.

The 4th China-Japan Conference on Mechatronics togheter with 6th China International Silk Conference will be held on 13th September 2007 at Soochow University, China. Scholars, researchers, engineers from Japan, Korea, Germany, Australia, Canada and etc. are cordially invited to participate in the conference. More than 80 papers will be presented during the conference.

Technical topics of the conference include but are not limited to:

- Mechatronics technology and applications;
- Modern control theories, methodologies and applications;
- Robots and intelligent control technology;
- Intelligent materials, structure, instruments and sensors;
- Computer control technology and applications;
- Bionic technology and biological machinery;
- New theory and technology for design and manufacture;
- Advanced silk, spin and dyeing technology and equipments;
- Advanced medical and healthy instruments and equipments;
- Advanced electronic manufacture technology and equipments;
- Machinery dynamics and Micro- Nano- mechatronics technology;
- Simulation technology and Signal processing technology.

Suzhou is not only a famous cultural city with a history more than 2500 years but also a city with advanced high technologies and developed industries. We express our warm congratulations on the forthcoming 4th China-Japan Conference on Mechatronics. It can be firmly convinced that 4th China-Japan Conference on Mechatronics will be a successful and fruitful one in mutually efforts from all attendees and you. You will be the most honorable guests of Suzhou's people and Soochow University, and are warmly welcome during the conference.

Yannian RUI
Limin BAO

Sep. 13, 2007

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Communication, Modeling and Simulation Techniques and Methodologies

Intelligent Mechatronics Techniques

Mechanical Structures, Advanced Manufacturing, Special Manufacturing and Advanced Material

Automation Techniques and Control System

Research on The Fabrication Process and Failure Model of Bulk Micromechanical Velcro

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ABSTRACT

In the isotropic and anisotropic etching bulk micromechanical fabrication process, the micromechanical velcro is a microstructure used to surface mechanical attaching with high-density array rule. However the failure of occlusion is always a problem. From the bulk micromechanical velcro's structure and its fabrication process, a mechanical model is built for analysing the occlusion failure problem. Experiments have been done based on the theoretical Study.

1. INTRODUCTION OF MICROMECHANICAL VELCRO

Micromechanical Velcro is a surface mechanical attaching method, which is based on the occlusion between the bulk bottom surface. It is a two-dimension linear structure. The occlusion process is shown as Fig.1.

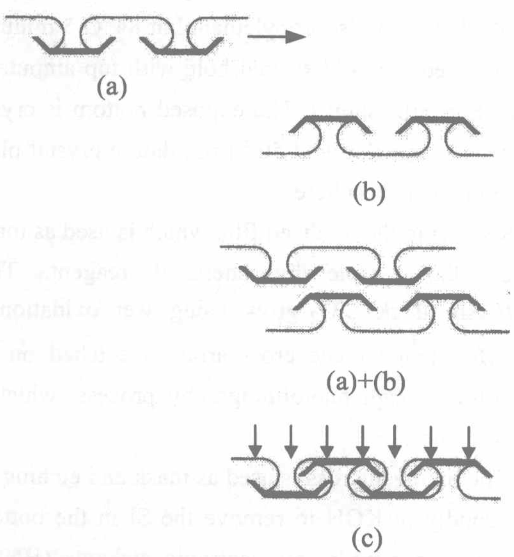

Fig.1 The occlusion process of micromechanical velcro.

When the two surfaces (a) and (b) with showed microstructure are moved to the position as (a)+(b), under the appropriate external pressure, the structure surfaces deform first and then rebound. As a result the occlusion occurs between two surfaces with automatic calibration and matching.

2. THE OCCLUSION FAILURE MODEL OF MICROSTRUCTURE

The analysis of occlusion failure problem of micromechanical velcro can be simplified as a cantilever model as shown in Fig.2.

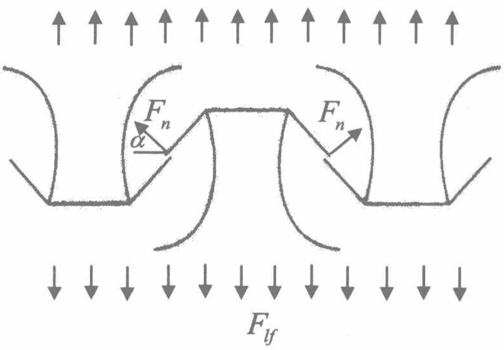

Fig.2 The simplified mechanical model of micromechanical velcro.

In Fig.2:

F_n — the interaction force between occlusion surfaces of micromechanical velcros;

l — the occlusion surface length of micromechanical velcro

Its combined stress σ_j can be calculated by equation (1),

$$\sigma(x) = \frac{M(x)y}{I_z} \tag{1}$$

Where,

x — is the distance from the occlusion surface edge to the force acted point;

$M(x) = F_n(l - x)$ — the combined moment;

$I_z = (bh^3.12)$ — the inertial moment of square's cross area to the gravity centre axis z ;

b— the cross width of substrate's occlusion surface ;

h— the thickness of substrate's occlusion surface ;

y— the distance from middle surface to occlusion surface.

When $x=0$, $y=\pm h/2$, the maximum adhesion stress is:

$$\sigma_{\max}=\frac{6F_n l}{bh^2} \quad (2)$$

From the similar deduce as above, it can be known the maximum shear stress $\tau_{\max}$ occurs on the middle surface where $y=0$.

$$\tau_{\max}=\frac{3F_n}{2bh} \quad (3)$$

Because $\tau_{\max}/\sigma_{\max}=h/4l$, $\sigma_{\max}$ is larger than $\tau_{\max}$ as design in general.

The mass experiments show the damage of occlusion surface's edge causes the occlusion failure of Velcro. It is consistent with the conclusion that the occlusion failure occurs when $\sigma_{\max}$ is over σ_{yp}, the stress of bending point. From Fig.2, it can be drawn that,

$$F_n=\frac{F_l d^2}{4\sin\alpha} \quad (4)$$

Where,

F_l— the tensile load (the force acted to unit area);

From equation (4) and equation (5), we can get F_l as equation (6)

$$\sigma_{\max}=\frac{3F_l d^2 l}{2bh^2\sin\alpha} \quad (5)$$

$$F_l=\frac{2\sigma_{\max}bh^2\sin\alpha}{3d^2 l} \quad (6)$$

If friction is calculated with its static coefficient μ, then

$$F_l=\frac{2\sigma_{\max}bh^2\sin\alpha}{3d^2 l(1+\mu\cos\alpha)} \quad (7)$$

The structure tensile strength (destructive load) can be calculated based on the designed parameters b、h、l、α、μ(=0. 5) and $\sigma_{\max}$ from equation (7) (as for silicon dioxide, $\sigma_{yp}=6\times10^5$ kPa; as for silicon nitride, $\sigma_{yp}=6.5\times10^5$; as for aluminium, $\sigma_{yp}=6\times10^6$). The calculated value of F_l is about 1.1MPa。

3. EXPERIMENTS

3.1 FABRICATION PROCESS

The fabrication process of micromechanical Velcro in the experiments is shown as below:

(1) Put silicon wafers in dry oxygen at 960℃, the SiO_2 film grows to 150nm thick on the crystal plane (150). Then a 10 μ m^2 square "island" array is made by photolithography process, and one of its side should be at 45° from the flat as showed by Fig. 3(a).

(2) After removing the photoresist, put the wafers into anisotropic etchants with main components of aqueous KOH(33%~45%) and isopropylethanol at 84°C 5 minutes. Then an inverted pyramid-shaped hole with top amputated appears as Fig. 3(b) shows. The exposed bottom is crystal plane since the etch flat is at 50° from datum crystal plane so the etch rate is fastest here.

(3) Removing the oxidized film which is used as mask, and clean the sample by chemical reagent. Then 1.0~1.5 μ txm thick SiO_2 grow using wet oxidation at 1000°C. After that Greece cross array is ectched on the oxidized film through photolithography process, which is shown in Fig. 3(c).

(4) The oxidized cross is used as mask and etching the sample secondly in KOH to remove the Si in the bottom. Then putting the sample into isotropic etchants (HNO_3 : CH_3CO_2H : HF, 15: 5: 1) 2.5 minutes to complete the microstructure. In this step, the necessary matching space for occlusion in vertical direction is got. And in the horizontal direction four cantilever used for occlusion are produced as Fig. 3(d) shows.

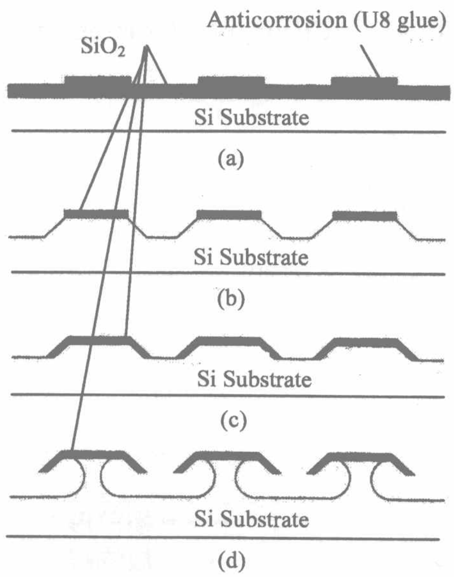

Fig. 3 Fabrication process of micromechanical Velcro.

3.2 MECHANICS TESTS

The sample dimension is 10mm × 10mm. The mechanics tests have been done using TS7140 tension testing machine manufactured by SANS Group Company (China). Through the loading to the sample two microstructures occlude. A micro pressure meter YTS-2000W is fixed under the clamp for pressure measurement. The combined strength of occluded structure is measured directly by the method of adding tension load till it is demaged. The tests result is showed by Fig. 4 and Fig. 5.

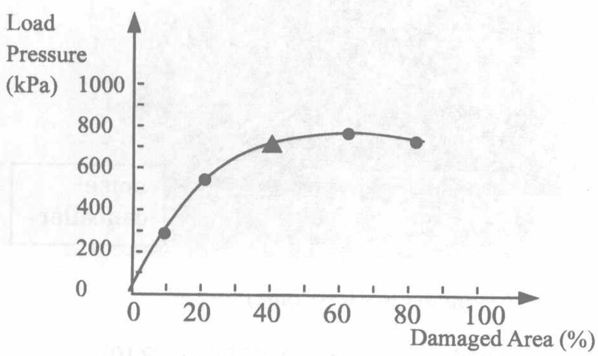

Fig. 4 The relation between damaged area of micromechanical velcro and the load pressure

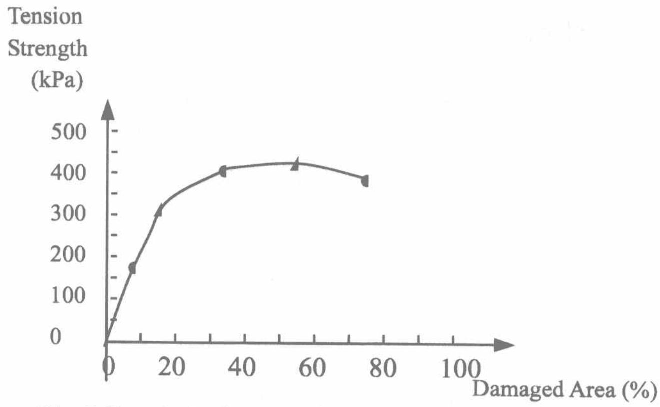

Fig. 5 The relation between damaged area of micromechanical velcro and the tension strength

3.3 Result Analysis

It can be seen from the experiments that:

(1) The damaged area is positive ratio to the load pressure. When the load pressure is larger than 650kPa, it speed the damage. When the load pressure is approaching 800kPa, the mass of the velcro is damaged. Even the load pressure is down after that the damage still goes on as shown in Fig. 4.

(2) The damaged area is positive ratio to the tension strength. The damage is limited when the tension strength is less than 300KPa. When the tension strength is around 350kPa, it speed the damage. When the tension strength is approaching 400kPa, the mass of the velcro is damaged. Even the load tension is down after that the damage still goes on as shown in Fig. 5.

(3) In the experiment it is noted that there is damage in the occlusion area when the velcro is in the damaged process, which possibly means the actual occlusion only exists in those damaged area.

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Effect of Sound Gathering Hoods on Voice Recognition with a Remote Microphone

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1. INTRODUCTION

At the present voice recognition, the recognition engine has taken the learning methods by setting a narrow-direction microphone close to the mouth and by pronouncing words clearly. Therefore the engine cannot recognize words at the different conditions such the case as apart from and/or lateral direction from mouth to microphone (call mic).

In the past years authors took experiments on recognizing 5 words adopting ViaVoice(IBM soft), pronouncing over 100 times in the morning to the evening through the week, making a funnel like hood of diameter 30cm, locating a mic at the bottom of the hood, then pronouncing words apart from 1 to 1.2m distance, and amplifying a preamplifier.That recognition resulted in quite good at recognition ratio(RR) around 95 to 100% for easy words even when the lateral direction, and 90% for a difficult word of migi(right) although depended on amplification of the amplifier.

We are anxious for recognizing voice even when apart from the sound source. This paper is a first step to recognize voice apart from the sound source by using hoods to gather sounds, designing size and curve of the hoods and selecting omni-directional mic(ODM) or narrow-directional mic (NDM).

Purposing this system setting up to our electric wheelchair, we raise up the recognition ratio(RR) above 75% when speaking words at the distance of 10 to 50cm apart from the mic. The method of categorizing resembling words is employed here, where the method includes resembling but unmeaning words to the proper word, for example: "mi" and "mii" are categorized into "migi(right)".

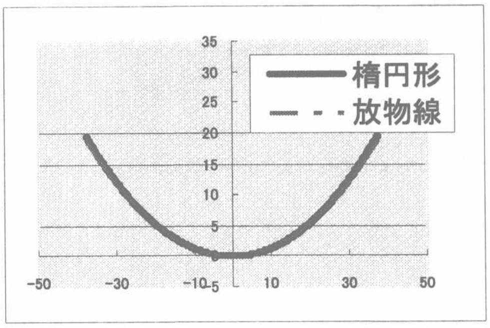

Fig.1 Ellipse and parabora(dia:7.5cm)

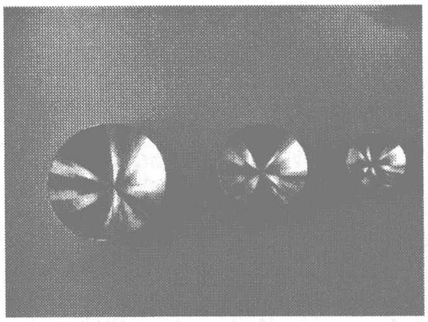

Fig.2 Parabolic hood10, 7.5 and 5

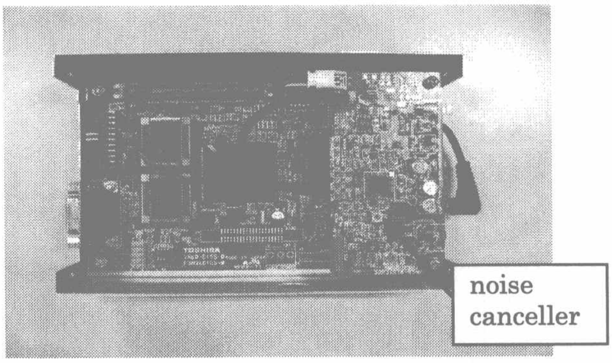

Fig.3 VRSB(Toshiba)

2. EXPERIMENTAL TOOLS

2.1 Configuration of hoods

The hood has factors of shape, size and material. Firstly using aluminum blocks, cutting two shapes of ellipse and parabola we chose diameters of aperture as 5,7.5 and 10cm, which is called hood5, hood7.5 and hood10. The ellipse gathers voice issued from one focus point to another focus point. The parabola gathers voice issued from far distance to its focus point. We will examine whether difference exists or not between the two shapes.

2.2 Other Apparatus

(1) Microphones (mic) are all electret-condenser type; omni-directional mic (ODM: SONY: ECM-C115) and narrow-directional mic (NDM: SONY:ECM-CZ10).

(2) Voice recognition and synthesis unit with noise filter board (VRSB: Toshiba, VRSB-0155U).

3. EXPERIMENTS

3.1 Checking VRSB without Hoods

We took experiments on the cases of mic at the mouth, and distance 5 and 10cm apart from the mouth. At the same time we examined the cases of voicing at the frontal side and the rear side of a mic to find the difference of mics (total 12 cases). Subjects were 4 (male 2, female 2, all 20 years). Voicing words were 5 as "stop(tomare), forward (mae), back(ushiro), right(migi) and left(hidari) and voicing 5 times for each person.

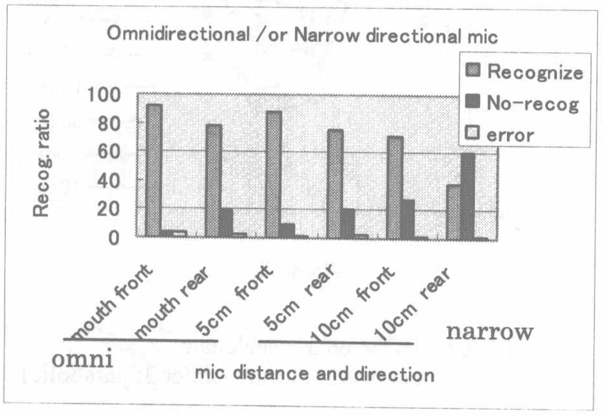

Fig.4 Recognition by ODM (almost the same for NDM)

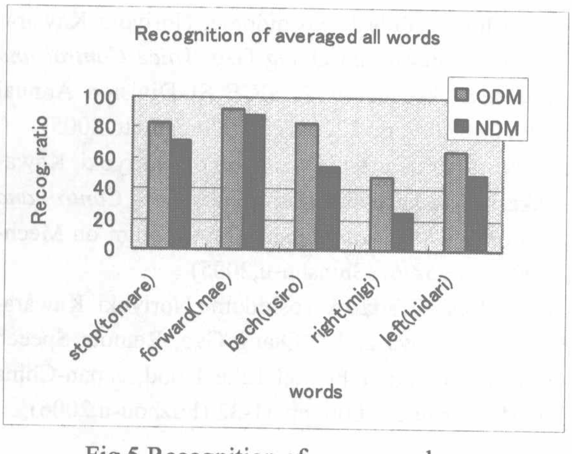

Fig.5 Recognition of every words

We can find from Fig.4 and 5 that recognition without hoods degrades RR when the mic apart 5cm or more from the mouth, and that generally speaking recognition of ODM, including rear side voicing, is better than NDM. VRSB as well as ViaVoice can hardly recognize "right(migi)".

3.2 Voice Gathering Hoods

Experimental conditions were the same as section 3.1 adding voice gathering hoods. The distance between mouth and mic were 0(at mouth), 10, 30 and 50cm.

3.3 Discussion of the hood experiment

There were almost no differences between elliptic and parabolic hood, and also between ODM and NDM, but ODM is a little better. From Fig.7, we got recognition ratio (RR) 90 to 96% for all hoods for a mic apart 10cm from the mouth, getting RR 80 to 90% for hood5 and hood7.5 apart 30cm, and also getting RR 60 to 74% for hood7.5 (this is the most stable) apart 50cm distance. Hood5 is not so bad comparing with others.

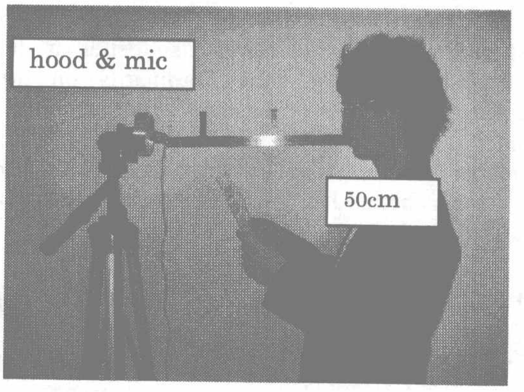

Fig.6 Photograph of a experiment

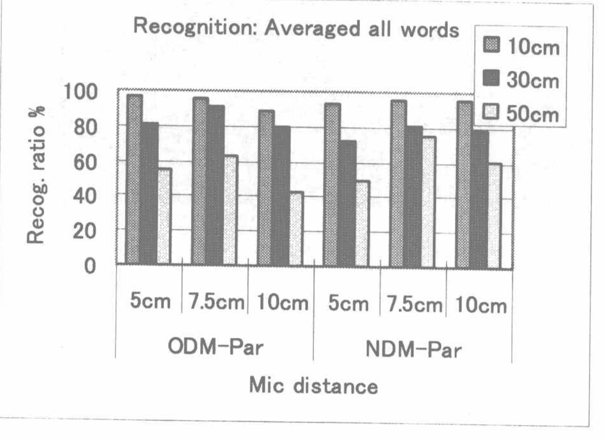

Fig.7 Recognition of words (all averaged) for the parabolic hoods

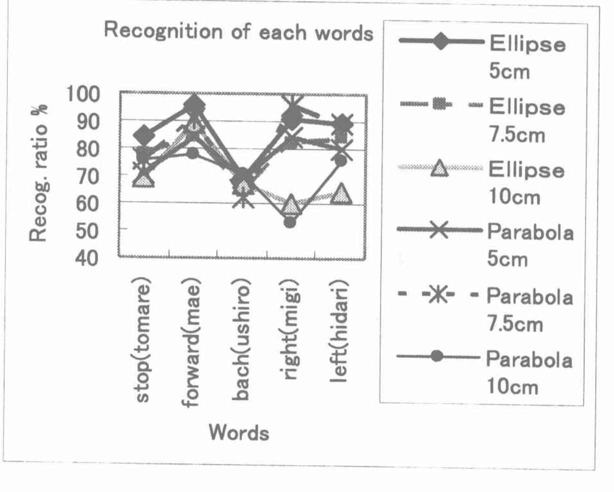

Fig.8 Recognition of each word

3.4 Mounting hoods on a wheelchair

To find the actual size of a hood and an effective mic type we took experiments on recognition mounting hoods on an actual wheelchair whether it can be controlled by voices. A hood was attached to a rod from the footrest of the chair, then the distance between mouth and mic was 30 to 35cm. Subjects were 3 (20 years). Command words were the above 5 words, voicing 5 times for each subject.

The results obtained were that the combination of ODM and parabolic hood was also better at this time. Fig.10 shows RR for sitting ordinarily on the sheet (distance: 30cm) and for crouching a little toward the hood (distance: 15 to 20cm). The latter exhibits better RR. Hood5 can recognize the difficult word "right(migi)" , therefore hood 5 seems better than hood7.5, although the latter seems not so bad.

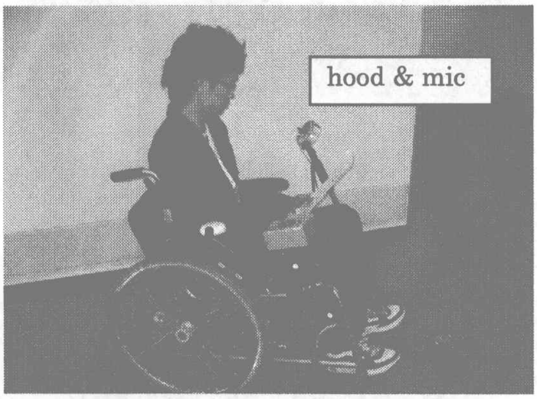

Fig.9 Hood on a wheelchair, distance 30cm

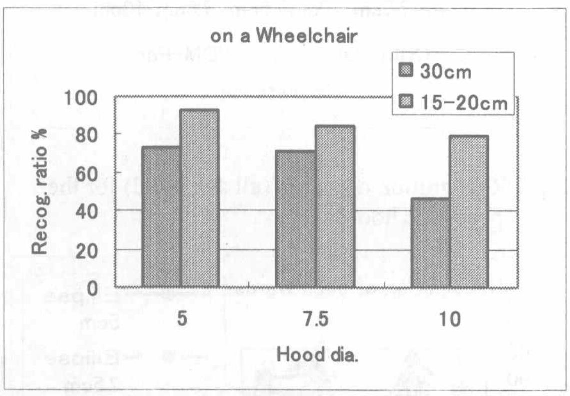

Fig.10 ODM, Parabolic hood on a wheelchair

4. CONCLUSION

(1) Omni-directional microphone is better for the remote voicing.

(2) Parabolic hood is better to gather voices and the size of hoods could be diameters: 5 or 7.5cm for the distance 15 to 30cm apart from the mouth. Other measures are necessary when apart 50cm or more.

(3) It is better to speak facing frontal side of a hood.

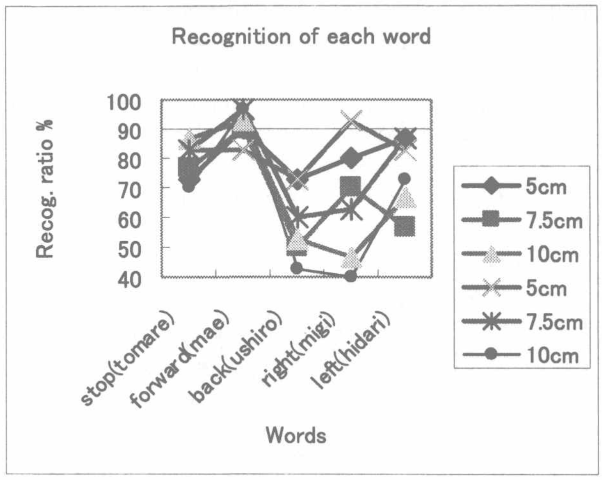

Fig.11 RR by ODM on a wheelchair
(Legend above 3: elliptic, under 3: parabolic)

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APPENDIX

This recognition experiments were based on a categorizing method of the resembling words, for example, "migi mini mii", "hidari hidai hirai dari idai", "tomare umare mare tamare", "mae mai", "ushiro shiro", and so on.

Reliability-Based Design and Sensitivity of Mechanical Components

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ABSTRACT

This paper presents mainly the reliability-based design and reliability-based sensitivity method of mechanical components. Techniques from the probabilistic perturbation method, reliability-based design theory and sensitivity analysis approach are employed to directly make the reliability-based design and reliability-based sensitivity of mechanical components on the condition of known probabilistic characteristics of basic random variables. The reliability-based design and reliability-based sensitivity information of the mechanical components may be accurately and quickly obtained by using the practical computer program. The effects of design parameters on reliability of the mechanical components are studied. The method presented in this paper provided the theoretic basis for the reliability-based design of the mechanical components.

1. INTRODUCTION

In the recent years much research has been done to quantify uncertainties in engineering systems and their combined effect on the reliability. Theoretically, these uncertainties are modeled as random variables governed by joint probability density or distribution functions. In practice, the exact joint probability density functions are often unavailable or difficult to obtain for reasons of insufficient data. Not infrequently, the available data may only be sufficient to evaluate the first few moments such as the mean, variance and correlations.

For satisfying production technologic and considering convenience of manufacture, transportation, installation, examine and repair, a great deal equipment sometimes makes knock-down structures. Flange connect is one of universal model in knock-down structures. In the process of flange design, there are many theoretical problems that have not solved. In this way the engineers design the flange connect under some theoretical assumption. It is undoubtedly that the design is conservative to be extravagant. Applying probability, statistics and second moment technique, a numerical method should be introduced for reliability analysis of mechanical components. During the last four decades, reliability-based design [1,2,3] and reliability-based sensitivity analysis technique [4] have been described.

This paper focuses on extension for reliability-based design and reliability-based sensitivity analysis of mechanical componentss. Using the perturbation method, the reliability theory and sensitivity analysis approach, this paper proposes a numerical method to calculate the mechanical components reliability-based design and reliability-based sensitivity. The useful program can be used to obtain the reliability-based design and reliability-based sensitivity information of mechanical components accurately and quickly.

2. THE PERTURBATION METHOD ON RELIABILITY

A fundamental problem in reliability analysis is the computation of the multi-fold integral of the reliability R

$$R = \int_{g(X)>0} f_X(X)\mathrm{d}X \tag{1}$$

in which $f_X(X)$ denotes the probability density function of random parameter vector $X=(X_1, X_2, \ldots, X_n)^{\mathrm{T}}$, and $g(X)$ defines the state function, representing the safe state and failure state

$$\left.\begin{array}{ll} g(X)\le 0 & \text{failure state} \\ g(X)>0 & \text{safe state}\end{array}\right\} \tag{2}$$

where $g(X)=0$ is the limit-state equation, representing n-dimensional surface, that may be called the "limit-state surface" or "failure surface".

The vector of random parameters X and the state function $g(X)$ are expanded as

$$X = X_{\mathrm{d}} + \varepsilon X_{\mathrm{p}} \tag{3}$$

$$g(X) = g_{\mathrm{d}}(X) + \varepsilon g_{\mathrm{p}}(X) \tag{4}$$

where ε is a small parameter. The part of Eq. 3 and Eq. 4 that expressed by subscript d is the certain part of the random parameters, and the part that expressed by subscript p is the random part, having a zero mean value in the random parameters. Obviously, it is necessary for the value of the random part to be smaller than the value of the certain part. Both sides of Eq. 3 and Eq. 4 are evaluated about the mean value of random variables as follows

$$\mathrm{E}(X) = \overline{X} = \mathrm{E}(X_{\mathrm{d}}) + \varepsilon\mathrm{E}(X_{\mathrm{p}}) = X_{\mathrm{d}} \tag{5}$$

$$\mu_{\mathrm{g}} = \mathrm{E}[g(X)] = \mathrm{E}[g_{\mathrm{d}}(X)] + \varepsilon\mathrm{E}[g_{\mathrm{p}}(X)] = g_{\mathrm{d}}(X) \tag{6}$$

Similarly, according to the Kronecker algebra [5], the both sides of Eq. 3 and Eq. 4 are evaluated about the variance of the random variables as follows

$$\mathrm{Var}(X) = \mathrm{E}\left\{[X-\mathrm{E}(X)]^{[2]}\right\} = \varepsilon^2\left[X_{\mathrm{p}}^{[2]}\right] \tag{7}$$

$$\mathrm{Var}[g(X)] = \mathrm{E}\left\{[g(X)-\mathrm{E}(g(X))]^{[2]}\right\} = \varepsilon^2\mathrm{E}\left\{[g_{\mathrm{p}}(X)]^{[2]}\right\} \tag{8}$$

By expanding the state function $g_{\mathrm{p}}(X)$ to a first-order approximation, in a Taylor series of vector-valued functions and matrix-valued functions at a point $\mathrm{E}(X)=X_{\mathrm{d}}$, which is on the failure surface $g_{\mathrm{p}}(X_{\mathrm{d}})=0$, this given the following

$$g_{\mathrm{p}}(X) = \frac{\partial g_{\mathrm{d}}(X)}{\partial X^{\mathrm{T}}} X_{\mathrm{p}} \tag{9}$$

Substituting Eq. 9 into Eq. 8, we obtain

$$\sigma_{\mathrm{g}}^2 = \mathrm{Var}[g(\mathbf{X})] = \varepsilon^2\mathrm{E}\left[\left(\frac{\partial g_{\mathrm{d}}(\mathbf{X})}{\partial \mathbf{X}^{\mathrm{T}}}\right)^{[2]} \mathbf{X}_{\mathrm{p}}^{[2]}\right]$$

$$= \left(\frac{\partial g_{\mathrm{d}}(\mathbf{X})}{\partial \mathbf{X}^{\mathrm{T}}}\right)^{[2]} \mathrm{Var}(\mathbf{X}) \tag{10}$$