TRENDS OF REHABILITATIVE ENGINEERING IN THE LAST 10 YEARS IN JAPAN.

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1. Introduction

The first approach to artificial hand was tried by I.Kato in 1965. It was a dawn of rehabilitative engineering (RE) in Japan.

The Waseda hand, The Tokyo hand, The Tokushima hand and etc., were borne in sequence. Representative works will be presented by next speakers after this lecture, so I will represent general trends of RE in the last 10 years in our country.

2. Establishment of P & O Institutes

The sun-rise of RE had occurred at 1969. In this year, The Labor Accidents P & O Center was initiated by The Labor Welfare Projects Corporation in Nagoya. It was the first institute of P & O organized with engineers and medical stuffs in Japan.

The Tokyo Metropolitan P & O Research Institute was borne in 1970 (Director; Dr. Shuichi Kakurai M.D.).

The National Rehabilitation Center for Physically Impaired had settled The P & O Research Institute (Director; Mr. Unokichi Iida) in 1971.

The Hyogo Rehabilitation Center had P & O Research and Development Project (Director; Dr. Seishi Sawamura M.D.) in 1972 and The Rehabilitation Engineering Department (Director; Prof. Kokichi Tsuchiya M.D.) was established in The Kanagawa Rehabilitation Center.

3. National Committees on RE

A) The Survey Committee of Research and Development on Rehabilitative Technology.

This committee was initiated in 1972 as a national demand of

Science & Technology Agency. The demand was borne as a result of technological prediction report by above Agency.

The committee had discussed on the settling of target and systematization of technological seeds which will be effective to the progress of rehabilitation medicine.

B) The Welfare Committee for Physically Impaired.

This committee was settled by Ministry of National Health and Welfare in 1970. The committee has discussed on next problems as follows; 1) The price of P & O or other aids which should be compensated by government for the impaired, 2) deliberation of new products to be used by the handicapped, 3) discussion on educational program or curriculum for the post-graduate medical doctors or therapists, etc..

C) The P & O Committee of Labor Administration

This committee was initiated in 1973. In this committee, problems which are important to the compensation for labor accidents are discussed mainly. Another problems which are seemed important to the general handicapped, i.e., education of medical team, improvement of P & O, elevation of technical level on P & O are discussed on as similar as The Welfare Committee.

4. National Projects on RE

We have several national projects on RE. They are classified into two categories; 1) Research project and 2) Development project. The before is mainly controlled by The Scientific Agency and the after is controlled by The Agency of Industrial Science and Technology.

A) Projects entrusted by The Agency of Industrial Science and Technology.

The Technology Research Association of Medical and Welfare Apparatus is entrusted from The Agency of Industrial Science. The items to be entrusted were deliberated by The Committee of Research and Developement on Medical and Welfare Apparatus. The aim of these projects is to make practically effective in clinical application.

The main projects are as follows;

a) Developement of Gait Analyzing System (from 1977 to 1979).

This system is composed of infrared LED (target), position sensitive detector(camera), mini-computer and interfaces. The accuracy of camera is equal to that of SELSPOT CAMERA. It is now settled in Tokyo Metroporitan P. & O Research Institute.

b) Developement of Electrical Powered Bed with Multiple Functions (from 1977 to 1979).

c) Developement of Modular Electric Powered Wheel-chair (from 1977 to 1979).

The above 3 projects has almost finished and soon after we may find them in market.

d) Developement of Safety Stick with guide sensor for the blinds (from 1979 to 1982). The sensor is constructed with super-sonic semiconductor and infrared light-beam LED.

e) Developement of Implanted Artificial Inner Ear for the who has difficulty in hearing (from 1979 to 1984). It is constructed by microphone, LSI, battery and connecting rod.

f) Developement of Trainning System of speaking for the deafs and dumbs (from 1979 to 1983). This system will be effectively for speech-therapist.

g) Developement of Powered Lower Prosthetics and Orthotics (from 1980 to 1983). This is the newest project of this year. The rotary servo actuator will be used as joint which has 4 motions of

flexion, extension, lock and free situation. This project is under concept-design.

B) Projects By The Fund of The Agency of Scientific and Technology.

These projects are belongs to the cathegory of research problem on RE.

a) Electric Powered Artificial Hand Controlled By Micro-computor (from 1975 to 1977). This hand has 7 degrees of freedom and it is controlled by micro-computor built in the arm. It has several modes of co-operating motion. Some combinations of pitch in user's voice decides the mode of co-operating motion.

b) Daily Living Aid System for the Heavily Impared With Electric Manipulators Which is controlled by Micro-computor (from 1978 to 1980).

These projects are directed by Prof. T.Funakubo (Tokyo Univ.).

They are in the last stage of research, so they will be tested in clinical field in the end of this year.

C) Another Projects on RE.

a) Developement of Modular System Legs by LAPOC.

b) Developement of Waseda-Imasen Myo-electric Hand (WIME HAND).

c) Developement of Environmental Control System by Micro-computor.

These projects will be represented by next speakers.

5. Standardization of Parts on RE.

A) Japanese Industrial Standard (JIS) of Wheel-chair.

This is the 1st JIS in RE. It was registered in 1975. It was reexamined under consideration of safety standerd in 1978.

B) JIS of Electric Powered Wheel-chair.

This was registrated in 1978. Soon after this registration, The National Health and Welfare Administration had supplied the electric wheel-chair to the heavily impaired as a parts of P & O cathego-

ry. The Labor Administration also had supplied it to the same impaired by The Insurance of Labor Accidents.

C) JIS of P & O Parts.

This project was initiated at 1977 by the fund of The Agency of Industrial Science and Technology, Standards Division. Already, the proposal of the technical terms has done and now under deliberation.

Now, the original bill on the standards of foot is discussed. In sequence, the examination of artificial knee joints is in work.

This project will be finished in 1985.

6. Some Topics on RE.

Now, I will report some topics of gait analysis and application of micro-computors in rehabilitation training, because no speakers will be presented in this seminar.

A) The Flow of Gait Analysis.

The initiation of the P & O research institute had triggered the interests of bioengineers. The Society of Biomechanism (SOBIM), The Society of Instrumentation and Control Engineering (SICE), The Ergonomics Society of Japan, The Japanese Society of Medical Rehabilitation and etc., had shown interest on gait analysis. Several symposiums or seminars were opened between 1971 and 1977. It was the golden age of development on gait analyzing system. The more precisely, the more complex systems were designed in sequence. It seems to be synchronized with the economical growth of Japan. The interests and expectations of medical rehabilitation stuffs were concentrated to gait analysis. But the situation apparently was going to change drastically after 1977. When the economical growth of Japan gained the summit, 1st oil shock attacked the world. At the same time, disappointment and irritation to methodology of engineering because it was too high expensive and too complicated

to apply directly into clinical rehabilitation field. Reconsideration of engineers gradually changed the flow of methodology on gait analysis. After 1977, engineers has tried to simplify the system and tried to get gait evaluation function which is effective in clinical usage. On the contrally, the medical stuffs has grown familiar with computer and tried to analyze the data numerically by the aid of computers. To put it shortly, a standpoint between engineers and medical stuffs was slightly replaced.

Difference between normal and abnormal gait is very delicate, so we can not distinguish from the data of force-platform, because the probability to get the same data is very small. Statistical data processing is also considered in the treatment of reaction-force or kinesiological data. But, it is not enough to get understanding the difference between normal and abnormal.

Some researchers tried to built-in the force-platform under the plantar of the shoes. By telemeter, they can get the continuous and sequential data of floor-reaction. This system is very simplified and easy applicable into clinical field. This system will be play the leading part in gait analysis with the diffusion of micro-computer.

B) A Trial of Gait Description by micro-computer.

Two years ago, I had a proposal to describe the gait by finite states. Here, I will introduce it briefly. The plantar is divided into 4 divisions. If the force on one division overs a threshold value, then we describe as "1", otherwise, describe as "0". Thus, we can describe the all situation of plantar by 8-bits signal. Fig. 1 shows the 4 division of each plantar, and each situation is ordered by hexadecimal count as shown in Fig.2.

Then we can record all phase of plantar force just as like to record the process of chess on the chessboard. It is shown in Fig.3.

We named it "GAIT PATTERN MAP". From this map, we can find the rule of normal gait. If the gait is normal, the record should be sym-

Fig.1 4 division of plantar.

metry with a diagonal of this map. There are no combinations of all even except (0,0) in normal gait, and the combinations of both over 8 or 1 and 7 are also abnormal. Electro-conductive rubber was used as a foot phase sensor. 8bits signal was recorded to the cassette-tape recorder as series signal with

10ms sampling frequency. We can get

100 sampled signal/s

as the input of mic-

rocomputer, and this

signal speed is sui-

table and enough to

data processing.

This system is easy available in the clinical application. The statistical analysis in long walking is also possible. This system will bring us different quality of information of gait analysis.

C) A Trial on Game Program for Rehabilitation Training.

For the impaired, it is very difficult but necessary to bear the rehabilitation training. In many cases, they are obliged to overcome the pain of training. The training should be not heteronom-

ous but autonomous, then it is important to make motivate to the impaired. We had a trial to introduce the game program for motivate them. It is easy to make a game program by a micro-computer. For example, Block Breake Game or Space Invader Game will be applicable for the training. The racket of block break game is controlled by the difference of weight bearing between right foot and left foot. Speed of ball

Fig.3 Gate pattern map.

should be selected for the residual function of the impaired. It will be a new trend in rehabilitation training in the future. The details of this game will be show by slide in this seminar.

7. Conclusion.

The process of rehabilitation will be more electronic by the diffuse of micro-computer, but the skinship between rehabilitative team and the impaired will be more important to motivate them. The computer is a only tool. I have many thanks to president who gave me such chance.