THE ANALYSIS OF UNCERTAINTIES IN THE MAN-MACHINE COMMUNICATION

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Abstract:In the last years the scientific community has become increasingly Interested in rehabilitation robotics. Starting from this premise in the paper we present uncertainty analysis in man-machine communication. As the human body needs certain organs to interact with the environment, and to support the body in life, so any robot model should contain several mechanical and electrical elements that perform various functions for it to operate. Classic mode of interaction of a robot consists of three steps. The robot can "feel" the environment, environmental information that is received by the sensors. The robot planning what to do next, building a model of the world around, of course taking into account both short-term goals (an example would be an obstacle detection) and long-term goals (eg. to reach the a certain puncture in a different set of environmental point). The robot implements its plan through effectors. The interaction will be achieved between the hands of a patient who suffered a stroke and a robotic glove that will help him in a faster recovery.

Key-words:*Machin, robot, uncertainty, analyze, human.*

1. THE IMPORTANCE OF UNCERTAINTY ANALYSIS BETWEEN HUMAN-MACHINE INTERACTION

When referring, to human-machine interaction, we understand human communication between a human user and a system.

"The qualitative analysis of the level of uncertainty provides an optimal insight into the best management techniques and methods that may contribute to achieving development objectives under crisis conditions." [1]

We propose that peoples who have suffered a stroke and have outstanding potential in terms of hand movements. So we will analyze the interaction of these people and robotic system for recovery. The novelty of this system is the balance of electrical stimulation and exoskeleton. Exoskeleton is getting used to the movement finesse. We propose that this prototype to accomplish two types of exercise: the first being an exercise predefined, the system detecting hand motion intent patient using a bending sensor mounted on one of his fingers, performing flexion and extension movements, and the second exercise is required by right limb movements, the healthy one. To achieve the second type of exercise is mounted on the right hand glove with sensors that will help copying healthy fingers movements, movements transposed to the injured hand (Figure 2).

Fig. 1 Glove type structure

Fig. 2 Glove with sensors for copying healthy hand movement

Uncertainty in the man-machine communication has evolved pretty much. A while ago, when we do not have a technology so advanced, not helped so much to avoid the state of uncertainty caused by natural events and processes. With the possibility of people controlling natural phenomena and reduce dependence on them, through technical and increasingly sophisticated technologies, the uncertainty has come to be managed more and more using specific methods and techniques.

Faster development of the production opportunities than science, international economic exchanges, the processes of collecting and processing information necessary to the economic agents who acting on growing markets, emphasized the insecurity and vulnerability. In the situation which essentially uncertainty is reduced to a feeling [2] acquired after a personal experience or the group to which it belongs, its size influences the performance of the economy directly and indirectly. So we cannot know exactly what will be possibilities of obtaining patient's recovery factors.

Uncertainty has become a norm for the processes involved in the development and functioning systems for recovery because the information traders need to get the best results in given conditions are not available, and when they get are partially affected by error or is incomplete [3].

Uncertainty in decisional phase refers to the preference for choosing a best solution.

Establishing decisions in conditions of uncertainty is performed using several methods known in the literature as optimization criteria - rules or techniques. The techniques most commonly used are: pessimistic or cautious (Abraham Wald), optimistic, optimality (Leonid Hurwicz), balance or equality of probability (Bayes-Laplace) and minimize regrets (Leonard I. Savage).

2. TYPES OF UNCERTAINTIES MNIFESTED IN THE COMMUNICATION BETWEEN MAN-MCHINE

In our case uncertainty may occur in communication between patient (man) - machine, patient- team, patient-sensors and the evaluation team - patient. Further, we analyze the type of uncertainty which we have to take the best decision using one of the techniques mentioned above.

a) In case of patient-machine

There's no way to know the type of patient who can come to recovery, therefore appears the patient's type of uncertainty. They can be patients who had suffered a stroke seriously, without an outstanding recovery potential. For this type of subjects the results will always be reserved and uncertain, meaning to recover again movements, dexterity, therefore for this category is not useful recovery system. This device addresses only for patients who have outstanding potential, meaning they can move even a finger how little. There are people who during exercise recovery have some involuntary movements due to desire a more rapid recovery or habit. Those who have had a stroke worse when attempting to move a finger moves his upper limb directly from shoulder . In these cases it should be immobilized the whole arm and left free only the hand to execute the exercises properly. We can also meet people who have spasticity of the hands remained stuck with his fingers in flexion position. In this condition we cannot perform flexion and full extension, requiring a large number of exercises for the release of spasticity. The exercises are performed gradually increasing the power of the electric stimulus. Because the probability of occurrence types of patients mentioned above is equal, the best technique is the technique of proportionality in making decisions developed by Bayes-Laplace.

Proportionality's technique developed by Bayes-Laplace requires that each status of the objective conditions has the same probability of occurrence and the optimal version it is the one for which the arithmetic mean of the results for the corresponding states considered is the most favourable. And to determine the optimum solution we use the formula:

$$V_{optim} = \max_{j} \frac{1}{n} \sum_{j=1}^{n} \left(R_{ij}\right) \quad \text{where:}$$

n - the number of states objective conditions. [4]

b) In case of evaluation team-patient

Another problem is the uncertainty assessment of the type of patient by the medical team. The assessment team must determine the type of patient, meaning the severity stroke . Usually these assessments are based on medical expertise of each team. A wrong assessment of the type of patient may have serious consequences, for example, to a person who shows spasticity of the hands, we cannot apply the maximum stimulus because we will cause burns to the fingers and muscle tears. Therefore we propose that the most appropriate technique in this respect - Minimum and Savage regrets technique or technique Anbraham Wald.

The technique used in optimizing decisions in condition of uncertainty is to minimize regrets, established by L. Savage, according to which, the optimal diagnosis is for that, regret is minimal. In this phase we should we consider two stages:

➢ determination regrets matrix in which each element is obtained by subtracting from the value of its initial maximum element in column:

$$r_{ij} = R_{ij} - \max_{j} R_{ij}$$

➢ finding the maxim value obtained regrets, and of these the minimum amount on each line:

$$V_{optim} = \min_i \max_j (r_{ij})$$

Pessimistic technique developed by Abraham Wald, on the premise that optimal diagnosis is one that requires maximum benefit in situations where objective conditions are nefaorabile.

Optimizing decisions using this technique reach the following result:

$$V_{optim} = \max_i \min_j (R_{ij}) \quad [4]$$

c) In case of patient-evaluation team

Uncertainty patient's feedback provided on the electric stimulus.

The feedback provided by people coming on recovery can be verbal or nonverbal because people who are following a stroke cannot speak; the feedback from them is only through signs or physiognomy's reactions. For this case we need to establish a minimum and maximum level of the electrical stimuli without affecting the patient's skin or muscles. The exercises must be conducted in several sessions increasing stimulus value from a session to another.

Uncertainty patient recovery time depends heavily on the patient's active involvement in exercises, the number of sessions and severity of stroke. Recovery time can be estimated only after a considerable number of sessions. To predict the recovery time should be grip force measurements of each meeting and according to the grip force can to establish a recovery time. To measure grip force will be used GFTS device (GRIP FORCE TRACKING SYSTEM) developed as a tool to analyze the effects of physical therapy or to train the patient who has suffered a stroke. GFTS involve biofeedback training methods and consists of two force measuring devices having various shapes (one cylinder shaped and one flat) that connects to a personal computer through an interface. During the exercise the person applies gripping force as visual feedback on the target signal (Figure 3 and 4) minimizing the difference between target and actual response.

Fig. 3 The management of clamping force [5]

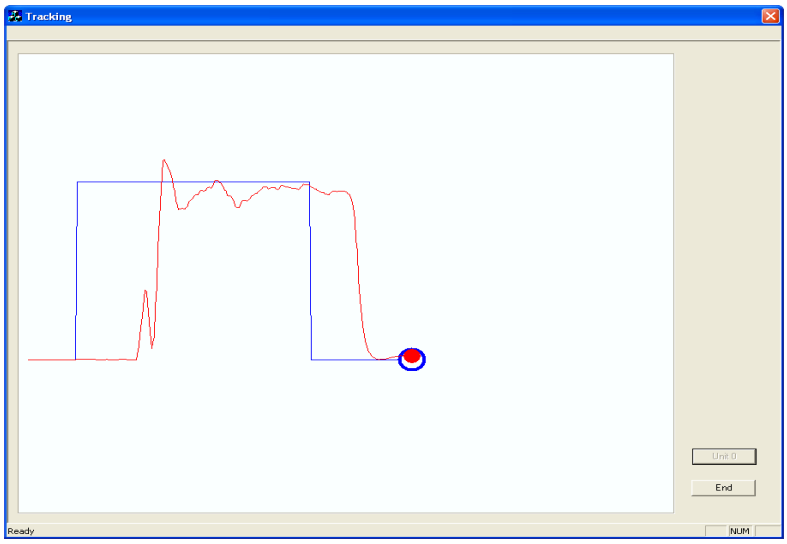

Fig. 4 Tracking error of the signal gave [5]

To estimate the recovery time of the patient should be used weighted optimism technique or technique of Hurwiz that balances the consequences optimistic and the pessimistic technique by introducing a coefficient of optimism - α technique described below.

Technical optimality (Hurwicz), focuses by introducing a coefficient of optimism, several steps are necessary to obtain optimal variant:

- Adoption of optimism coefficient (0 <α <1);

- Determine the elements Hi, using the formula:

$$H_i = \alpha A_i + (1-\alpha) a_i$$

where:

Ai - the most favourable element of the line i (max Rij);

ai - the unfavourable element of the line i (min Rij);

Optimal decision is given by the following formula:

$$V_{optim} = \max_i (H_i)$$ [4]

d) In the case of patient-sensors

Uncertainty in communication between patient and sensors can occur when the system is installed wrong, you do not make the necessary adjustments or the environment can affect sensors, such as temperature or humidity. We use optimistic technique to analyse the environment, in which we analyze three states of temperature and humidity: low, medium and high.

The optimistic technique involves the selection of optimal situation that is as objective conditions most favourable, resulting that this rule can be defined as the rule maxi max:

$$V_{optim} = \max_i \max_j (R_{ij})$$ [4]

Indifferent of the type of information that we want to get, it should cover the relationship between past and future is dominated by uncertainties inevitable.

Conclusion

The information needed to develop strategies and decisions concerning the distant past, near or on the right.

The conditions of uncertainty are when necessary information is not available to determine the probabilities of manifestation states the objective conditions and variables are partly uncontrollable.

For any product should carry out such an analysis to determine uncertainties. With the identification of uncertainties are reduced for any problem that may occur in system operation.

For each uncertainty, have been identified optimal techniques in order to take the optimal decision applied to each uncertainty.

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