

# VIRTUAL REALITY SYSTEM “ROBOT-SECRETARY”: METHODOLOGICAL PROBLEMS AND NEURO-FUZZY APPROACH

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## Summary

The methodological problems of the processing of imagery knowledge about the world on the brain-like specifics basis and corresponding formal presentations for the virtual reality system “Robot-Secretary” are presented.

**Keywords:** virtual reality, cerebral asymmetry, neuro-fuzzy algorithms, perception, understanding, formation of the result.

## 1 INTRODUCTION

The present time is characterized by the great achievements of the computer technologies (structures, memory, frequency and methods of the calculations) and wide differentiation of the neurochips. One priority of the future stage of the civilization will be “the Personal-orientness” for the different forms the User’s activity (business, culture, medicine etc). These possibilities allow to realize the important achievements of the neuropsycholinguistical investigations for the both approaches:

- the simulation of the neuropsycholinguistical processes of the processing of knowledge about the world (Perception [P]—Understanding [U]—Formation of the result [F]);

- the formation of the procedures of the (P-U-F) for the personal-oriented systems of the virtual reality (VRS).

The applied tasks are characterized by the following aspects:

- wide differentiation of the forms of the perception of knowledge about the world (sensorical channels, forms of the mematext, types of the bearers of the information),

- preferable forms of the presentation of imagery knowledge,

- important influence of the User’s specifics for each process,

- development of the User’s cognitive ability and creative activity.

These aspects are embraced by means of the technologies of the VRS.

## 2 METHODOLOGICAL PROBLEMS

### 2.1 MULTISIGNIFICANT IMAGES IN DESCRIPTION OF WORLD

The multisignificant images are characterized by the both:

- the complexity presentation of the Gestalt and un-synonymous expression;

- the multisensotical (multimodal) presentation (audio, visual, tactile, smell) by means of the different forms of the metatext.

The realization of the ( P-U-F ) stages is based on the three methodological conceptions: “Ego in the World”, “Meaning—Text—Meaning” and “Two Forms of Activity”.

The central problem of the U-stage is the discovery and interpretation of the Meaning (DIM) which is contained in the concrete form of the metatext [MET]. The [MET] is presented by the different sensorical channels (audio, video, tactile, smell) and different types of the bearers (printed text-order, poetic, art text, scientific text, notes, hieroglyphs; visual image-expression of the faces and poses, graphics, structures, picture on the screen, TV-presentations ; audio text- music play, intonational

characteristics of the speech, natural sounds, technical sounds; “smell accord”). The discrimination of this forms of the metatexts is characterized by the type of the channel and , influence of the art, science, life or nature, influence of the temporal factors (Past-Present-Future) and degree of the temporal presentations (at To or at the interval).

The meaning of the concrete realization of the metatext is Sc (which is the membership to the set of the meanings Sc E {S}).

The DIM-problems are characterized by the determination of the interconnections [MET]  $\iff$  Sc.

The types of the DIM -problems:

Type-I: determination of the degree of membership of the concrete meaning to the interval

$$[MET] \implies \{M(Sc) \longrightarrow [S1, \dots, Sn]vr\},$$

where: M is the membership function, Sc is the concrete sign of the meaning, v is the type of the sensotical channel, r is the concrete feature.

Type -II: determination of the degree of the membership of the multisignificant image to the certain meanings ( when the information is presented by the different sensorial channels, or characterizes the complex context)

$$[MET] \implies \left\{ \begin{array}{l} \{M'(Sc)for[, \dots, S, \dots]'\} \\ \{M''(Sc)for[, \dots, S, \dots]''\} \end{array} \right\}$$

Type -III: creating of the new image for the concrete sign of the meaning (membership function)

$$\{M(Sc)vr\} \implies [MET]vr$$

The examples of the realization for the Type-I DIM-problems are interpretation of the expressions of the concrete faces (more kind, then jolly) for the Type-II DIM-problems are interpretation of the situation “Distruccion of the Titanik”.

The formation of the new image on the procedure “the hysteresis of the perception” basis is the samples example of the Type-III DIM-problem. These are only the illustrative examples. The real tasks need the very complex Base of Knowledge and very labour intensive works for the exposure of imagery knowledge in the concrete classe

of the context and environment. The formal procedures are based on the dual and multiconnections neural models and neuro-fuzzy algorithms.

## 2.2 HUMAN’S SPECIFICS FOR PROCESSING OF IMAGERY KNOWLEDGE

Knowledge about the world are presented by means of the different forms of the [MET] and are processed on the Human’s specifics basis (discovery of the meaning and formation of the new metatext). Such procedures are based on the Human’s possibilities cognitive ability and creative activity which are determined by the highest brain’s functions and structural-functional specifics.

The highest brain’s functions include the following: attention, cerebral mechanisms of the processong of imagery knowledge, learning, imagery memory, assotiative-ness which are based on the interconnected structural-functional features: dualism, plasticity, adaptiveness, multilayerness, multiconnectionness, self-organization).

The brain’s Dualism is characterized by the specifics of the cerebral asymmetry mechnisms (parallele different -functional Left and Right hemispherical procedures). The brain’s Placticity is realized on the both (Churchland, 1989): neural layer (neural interconnections) and on the “learning-behavioral” layer which is characterized by the cognition and learning of the influence of the environment and personal sensation.

The brain’s adaptiveness is characterized by the ability of the dynamic change of the characteristics for the better processing of the input pattern. The adaptive procedures are used two types procedures: dynamic change of the structures and dynamic change of the axiomatic basis.

The concrete procedures of the dynamic change of the axiomatic basis are realized on the (P-U-F) stages. The realization of the P-stage is characterized by the choising of the suitable method (scanning on the screen, movement on thr contour, segmentation, whole embrace of the Gestalt) for the concrete input pattern, Human’s state and environment.

The realization of the U-stage is characterized by the estimatiion of the elements and interconnections, logical-

combinatory and analytical procedures; whole estimation of the Gestalt, interpretation of the meaning and associations. The realization of the F-stage is characterized by the choosing of the suitable form of the reaction (verbal, operational and extralinguistical).

### 3 FUZZY AND NEURO-FUZZY ALGORITHMICAL APPROACH

#### 3.1 FUZZY CATEGORIES AND MEANING

The types of the functional characteristics for the presentation of the changing of the meanings by four types are determined:

- Type-I: Monotonic changing;
- Type-II: Unmonotonic changing;
- Type-III: Central point of the several meanings;
- Type-IV: Double meaning.

The qualitative scales are characterized by the “supporting elements”(SE), (for example, Normal, High, Low - signs) and the formation of the another elements in the internal interval ( the interpolational procedure) and external interval (the extrapolational procedure).

The qualitative scales (“beauty”, “not beauty”, “not enough beauty”) and the SE are determined on the experience basis. This experience is formed on the genotype and phenotype layers (“mother’s voice”) and behavioral procedures basis.

#### 3.2 U-STAGE: SPECIFICS OF THE LHP AND RHP

The LH-procedures realize the following neuro-informational mechanisms: formation of the qualitative scales  $\{q\}$ , estimation of the features of the world, logical-combinatory, probability and analytical procedures, decision making, analysis of the grammatical constructions and interpretation of the strong associations (“vodka-butl”). The formal LHP procedures are based on the using of the fuzzy categories and estimations  $\{q\} : X \rightarrow Y$ , fuzzy algorithms and fuzzy production rules. The fuzzy categories are presented by means of the membership function M

(X) and fuzzy decision making by the membership surface  $Re, M(Re) = O(Y_1, \dots, Y_n)$ , ( where  $Re$  is the rational recommendation,  $Y_i$  is the estimated parameters) and the procedures “IF [ $\langle . \rangle, \dots, \langle . \rangle$ ] THEN  $\langle . \rangle$ ” and also by the fuzzy graphs for the estimation of the structures.

This procedures are formed on the human-like learnig basis. The formation of the qualitative multielement scales is realized on the human’s professional and personal experience basis.

The LH-procedures present the estimated characteristics of the world by  $Y = (Y_1, \dots, Y_n)$ .

The RH-procedures realize the the whole estimation of the Gestalt, interpretation of the images and wide associations, discovery of the meaning.

The RH procedures form the the personal oriented model of the world. These procedures realize the answers on the question 1.

The interior implicate model (IIM) forms the personal presentation about characteristics of the world, their estimated qualitative shades (“mother voice”, “beauty”, “very much” etc) and personal option (“common sense is own option”). The IIM is the specialized fragment of Base Knowledge. on the experience basis by means of the set  $\{Y_{1m}, \dots, Y_{nm} = Y_m\}$ .

The characteristics of the Gestalt are determined by the whole estimation on the qualitative scalel basis

$$G\{X, f(X)\} \implies \{\langle Yg \rangle\}$$

The problem of the global estimation of the characteristics of the world and exposure of the meaning is determined by the following interconnectons:  $\{\langle Yg \rangle, \langle Ym \rangle, \langle Y \rangle\}$ .

The formation of the result (F) is the LH procedure which is characterized by the following stages:

- determination of the specifics of the input signals,
- determination of the specifics of the interior presentations about the human’s state and environment,
- selection of the forms for the concrete behavioral realization (verbal, operational and extralinguistical).

#### 3.3 RHP (CHORUS)

The formation of the brain-like procedures of the understanding needs of the using of all power of the brain’s

structural-functional specifics and features of the high functions. This is a new methodology which is based on the ideas of M.L. Tsetlin (Tsetlin's Models, TM.; 1969). Three principles characterize of the TM: "Polyfunctionalism of the neural pools"; "Principle of the shortest interconnection"; "Games of the automats in the stochastic space". The TM allows to aggregate the different brain's features: the regions, structures of functioning and local behavioral procedures, influence of the input signals and subject's specifics, local games which are characterized by the "intensity" of the estimations and the local strategy.

## CONCLUSION

The applications contain the interpretation of the expressions of the faces, poses and intonational characteristics of the speech, articulations for the inner procedures (IP) of the system "Robot-Secretary" for the different concrete problems: "Multisensorical personal discourse", "Attendance of museums and libraries for human with sensorical and operational violations" (Shapiro, 1996), "Walks on Rinascimento Roma with Stendal" (Shapiro, 1998), simulation of the neuropsycholinguistical processes (interpretation of the metaphors, expression of the faces and poses, and intonational characteristics of the speech) for the formation of the discourse in the systems of countrylogy.

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