TWMS Jour. Pure Appl. Math., V.3, N.1, 2012, pp.92-102

MATHEMATICAL MODELS FOR INDEPENDENT COMPUTER PRESENTATION OF TURKIC LANGUAGES

PAVEL S. PANKOV[1], BATYIGUL J. BAYACHOROVA[2], MUKHTAR JURAEV[3]

Abstract. We give new definition of language as a concept and the definitions of mathematical and computer models of notions (words) of a natural language suitable for computer presentation with random choice of additional objects. We propose to create interactive presentations of foundations of Turkic languages with the following aims: to offer all computer users an acquaintance with Turkic languages without other languages as a media; to develop effective electronic text-books and complex examinations on Turkic languages; to fix their up-to-date state and to distinguish similar and same notions in them by comparing corresponding mathematical models.

Keywords: mathematical model, Turkic languages, concept, computer presentation, independent presentation, interactive presentation.

AMS Subject Classification: 91C99, 97R40, 97R60.

1. Introduction

One of main tasks in the current informatics is developing of interactive computer presentations of all familiar real and virtual objects to offer the user the opportunity to master the said objects safely and effectively before real treating. If such computer presentation does not depend directly on the user's knowledge and ability to perform in similar presentations then we will call it 'independent'. We believe that such presentations are more effective because the user becomes proficient in the object, immediately, without referring to other pre-conceived topics in mind.

Earlier, investigating and learning a living language was executed with the assistance of bilingual dictionaries and text-books as well as of those who who had a complete command of it; investigating of a dead language was done by means of studying remained bilingual texts and texts with additional implicit suggestions and conclusions. The invention of sound recording gave the possibility to create objective examples of oral communication. The invention of filming gave the opportunity to set examples of phrases that can be connected with certain situations and actions. Computer games gave the user the opportunity to choose actions in the response to phrases. The existing software to learn languages is most commonly based and related to the language native to the user; however there are some concepts which are presented independently. This survey demonstrates that there are not completely independent presentations of natural languages.

The software control for knowledge of languages involved the user's discrete choices, i.e. point-and-click capability. We proposed to learn languages by means of the user's continuous actions, i.e. by means of drag-and-drop capability [6].

[1]The International University of Kyrgyzstan, Bishkek, Kyrgyzstan,
e-mail: pps50@rambler.ru
[2]Eurasian Faculty of Innovation Technologies of the Jusup Balasagyn Kyrgyz National University, Bishkek, Kyrgyzstan,
e-mail: bayachorova@rambler.ru
[3]Institute of Theoretical and Applied Mathematics of the National Academy of Sciences of Kyrgyzstan, Bishkek, Kyrgyzstan,
e-mail: ajrv@mail.ru
Manuscript received March 2011.

Vygotsky L.S. & Saharov L.S. [16] demonstrated similar things having various attributes together with calling them in any artificial "language" (with nouns and adjectives only) to children. If the child called other things in this "language" properly then s/he was asked why s/he had used these words. Asher J. [18] proposed the way to learn languages by means of fulfilling commands. Such approach meant (latently) a set of situations related to any notion but it has not been implemented on a computer. Winograd T. [17] proposed giving commands to a robot with such words as "table", "box", "block", "pyramid", "ball", "grasp", "moveto", "ungrasp".

By using these ideas and opportunities of the current computer equipment, we [7] proposed the following principle: guessing and performing the only natural action possible in the environment. That is, the pupil begins with thinking in the learned language.

We proposed a method of independent presentation of some notions in [8]. The syntax of an auxiliary algorithmic language for such presentation with random choice of additional objects was developed [9]. The outlines of such presentation as whole were published in [2], with the definition of a computer interactive presentation of the "notion". We proposed a structure of examination [10], discussed mathematical aspects of language presentations [11].

In [12] we introduced the definition of an affectable object and the corresponding definition of the concept "language" as the system of influences that any such subject can achieve desired consequences from other one. Also, we put forward the following hypotheses: on possibility of check-up of human's understanding of a text by means of human's actions; on sufficiency of up-to-date multimedia means to fulfill such check-up for vital of language's notions including abstract ones; on existing of the minimal mathematical model for every notion.

We consider Turkic languages by the following reasons:

- basic mathematical operations and relations are expressed more clearly in Turkic languages;
- some word stems and grammatical constructions are similar in them and can be considered simultaneously;
- they have unified algorithms of word formation and inflection;
- Prof. H. Hilmi Hacisalihoǧlu put the task to publish a dictionary of common vocabulary and terminology of the countries in the Turkic World; we hope that this paper is aimed to this task.

The list of publications on such algorithms (including ours in Kyrgyz and Kazakh languages) is too vast to be given here. We shall mean these algorithms only.

In this paper, for words in Turkic languages, we shall use Turkish alphabet (capital letters) with four additional letters ∂, X, Ķ and Ģ. Turkic languages will de denoted by two capital letters.

The purpose of this paper is proposal on outlines of software presenting foundations of any Turkic language (or some Turkic languages together): phonetics; reading texts; main grammar forms and notions.

The further sections contain

- necessary hypotheses and definitions;
- a sample of definition of a mathematical model of a notion (with the only controlled object);
- hierarchy of notions for successful mastering them;
- reference to unified algorithms of word inflection;
- examples of mathematical models of notions with Zadeh's fuzzy logic.

2. Main hypotheses and definitions

Definition 2.1. *If low energetic outer influences can cause sufficiently various reactions and changing of the inner state of the object then it is said to be an affectable object, or a subject, and such outer influences are said to be commands (these reactions and changing are implemented by means of inner energy of the object or of outer energy entering into object besides of commands).*

Remark 2.1. *In programming languages, statements subdivide into declarations and commands usually. But all declarations also may be considered as commands. Also, narrative and interrogative sentences in natural languages are implicit imperative ones.*

Example 2.1. *A typical declaration in programming languages: "let Z be a natural number". A command: "let Z be 2012".*

But this declaration is also a kind of command: "Reserve a piece of memory in computer, give name Z to this piece and consider records in this piece as natural numbers in future."

Example 2.2. *"It is hot" means "Remember that it is hot now" or "Remember that it is hot and you have obtained this information from me".*

Definition 2.2. *A system of commands such that any subject can achieve desired consequences from other one is said to be a language.*

These definitions unite humans and computers and their languages.

Hypothesis 2.1. *A human's genuine understanding of a text in a natural language can be elucidated by means of observing the human's actions in real situations corresponding to this text.*

Usually a notion is defined as a mental image or representation. But there is a more definite hypothesis in pattern recognition: various images corresponding to a same object form a 'compact' set (the term 'compact' is understood informally, as 'tightly packed'). We propose

Hypothesis 2.2. *A child or a human learning a natural language without references to known languages hearing a word (may be, one of words of same stem) in various situations begins to form a kind of mathematical model in mind corresponding to this concept by means of trial and error method and attempts to lead operations similar to mathematical closing and compactification. Successful completion of the said operations helps the learner to feel that they have "mastered" this concept.*

The following hypothesis enlarges Church thesis:

Hypothesis 2.3. *Current (multimedia) computer equipment is sufficient to model situations necessary to teach and detect genuine understanding of vital notions in natural languages.*

Definition 2.3. *Let any "notion" (word or word stem of a language) be given. If an algorithm acting at a computer:*

- processes (generated randomly) sufficiently large amount of situations covering all essential aspects of the "notion" to the user;

- gives a command involving this "notion" in each situation;

- perceives the user's actions and illustrates their results clearly on a display;

- detects whether a result fits the command (according to a native speaker's understanding), then such algorithm is said to be a computer interactive presentation of the "notion".

Remark 2.2. *Certainly, commands are to contain other words too. But these words must not give any definitions or explanations of the "notion". Random generation of auxiliary objects and their positions is necessary to distinguish the "notion" among other words being used in the command and arising circumstances which are not sufficient for the "notion".*

Remark 2.3. *By such a way not only notions presenting real objects but notions presenting imaginary objects can be presented; we [13-15] demonstrated natural interactive performing of abstract spaces. By the methods proposed in this paper, numerous computer games can be developed to "adequate" presenting of notions corresponding to fictional and fabulous objects.*

Remark 2.4. *A hint to a language to present the user's continuous actions (the only example before our publications) was in [16], as follows. The sentence "X moves towards the Place" is a pair "at t_i X is not in the Place", "at t_j X is in the Place"* $[t_i < t_j]$.

The following section contains more strict definitions.

3. Definition of a mathematical model of a notion

To implement Definition 3, a full mathematical model of a notion should contain formal descriptions of environment, all objects, the user's actions and the computer's reactions to them, i.e. be within the frames of the mathematical theory of control. But it would be too vast. For brevity, we shall consider only one moving object and shall not treat transformable ones. If motion of objects is executed by standard 'drag-and-drop' method then a mathematical model consists mainly of a temporal sequence of conditions.

Consider a rectangle D (display) and a family S of 'good' (smooth, connected or consisting of some connected components) subsets of D.

Each point of element of S also can have a 'color' (any element of a finite set Col).

Remark 3.1. *Modern displays are formally discrete but they are perceived as continuous. So, we can implement continuous motion.*

We shall consider:

- constant elements $\{S_i \mid i = 1..n\}$ of S (stationary objects);

- the moving controlled object A_j. We shall denote its image at a moment t as $A_j(t)$.

Constant objects can be either evident to the user or latent (without a color, used for checking conditions).

Consider two kinds of relations:

$A_j(t) \cap S_i \neq \emptyset; A_j(t) \subset S_i, i = 1..n.$

A logical function of such relations (with using operations $\vee, \wedge$ and $\rceil$) is said to be a notion-condition or an environment-condition. Particularly, the condition $A_j(t) \cap S_i = \emptyset$ means that S_i is an 'obstacle' for $A_j(t)$.

The user should complete notion-conditions; the computer bans violations of environment-conditions.

Also, consider a formalized subset of a natural language L containing the word W, names of above-mentioned objects, denotations for relations between them necessary for understanding and a command word (if it differs from the word W).

Definition 3.1. *For a strictly increasing sequence* $0 < t_1 < t_2 < \cdots < t_k$*, a sequence of notion-conditions for* $A_j(t_1), A_j(t_2), \ldots, A_j(t_k)$*, is said to be a temporal sequence of notion-conditions.*

Definition 3.2. *Let any "notion" (word of a language) be given. A mathematical model of the "notion" consists of*

DO) constant objects and the moving controlled object;

DI) initial environment: arrangement of stationary objects and the object $A_j(0)$*;*

DE) environment-conditions;

DN) temporal sequence of notion-conditions;

DC) corresponding command containing the word W*, names of objects and a command word.*

If for any sequence $0 < t_1 < t_2 < \cdots < t_k$ all notion-conditions in the temporal sequence are fulfilled by the user by means of shifting the object A_j then the user has understood and 'mastered' the word W.

In some mathematical models, one of controlled objects is Avatar (an object identified with the user's person; it is also presented as a kind of cursor).

Mathematical models can be compared (formally and non-formally):

- by number of objects involved;

- by 'complexity' of objects (a convex object precedes concave one; a connected object precedes non-connected one; a constant object precedes moving one; a moving object precedes transforming one);

- by number k of members in the temporal sequence;

- by number of logical operations in notion-conditions.

Thus, the set of mathematical models of any notion is semi-ordered. Nevertheless, we propose

Hypothesis 3.1. *There exists the minimal mathematical model for some notions.*

4. Mathematical classification of notions

By the proposed approach, the set of "notions" is semi-ordered by precedence: of each two "notions" either one must be introduced before other or they can be introduced simultaneously or they can be introduced independently.

We propose the following classification of verbs as the main part of speech (as it is known, some verbs are polysemantic and can fall into different sections). Also, some verbs are introduced with the minimal number of auxiliary objects but can be used with additional (facultative) objects further.

For example:

(KG) TAŞTÎ TÜRT *(push the stone)*; TAŞTÎ TAYAK MENEN TÜRT *(push the stone with a stick).*

- Direct verbs: with *Cursor:* CÎLDÎR *(let ... shift),* AL *(take),* KOY *(put),* TAP *(find),* KAT *(hide),* KÖRSÖT *(show).*
- Tool verbs: with *Tool* or other *Object:* BOYO *(paint),* KES *(cut).*
- Avatar verbs: by means of *Avatar:* BAR *(go),* BUR *(turn),* TÜRT *(push),* TART *(pull).*
- More complex verbs: CÜGÜR *(run),* ÎRDA *(sing),* SEKİR *(jump).*

Our classification develops (with some additions) the well-known valence of verbs but with specifications of objects and addition of latent circumstances. The closest to our approach is the Lexical Conceptual Structure [17] which "is mainly organized around the notion of motion, other semantic/cognitive fields being derived from motion by analogy (e.g. change of possession, change of property)."

For constructive purposes, we cannot use analogy. We are based on the user's concrete *"actions"*.

Due to precedence ordering of notions, transitive verbs can be subdivided into "independent" of essence of direct objects: CÎLDÎR *(let ... shift),* ÖÇÜR *(cease)* and "dependent" CAZ *(write),* BAYLA*(connect),* İŞTET*(let ... work),* OTURGUZ*(let ... sit)*.

5. Reference to unified algorithms of word inflection and word presentation in Turkic languages

Existence of unified algorithms gives the opportunity to use stems of words and primary forms of affixes only in generating phrases in computer presentation of Turkic languages.

Algorithmically the word inflection in agglutinative languages can be written as follows:

$Infl(Lang, Stem, Aff)$

where $Infl$ is the name of the general algorithm and the result in the form of the word stem with the transformed affix;

$Lang$ stands for a language,

$Stem$ stands for a word stem,

Aff stands for the primary form of an affix.

The feature of Turkic languages is that the following expression is conscious under the condition that $Aff2$ succeeds $Aff1$:

$Infl(Lang, Infl(Lang, Stem, Aff1), Aff2)$

So, we may use the following abbreviation for successful adding of affixes:

$Infl(Lang, Stem, Aff1, Aff2, \dots)$

By the way, the main features of unified algorithms are the following:

- reducing of the first vowel in the affix after a vowel;
- vocalization of the last consonant in the word stem before a vowel or a voiced consonant;
- transformation of the first consonant in the affix;

- successful assimilation of vowels in the affix to the last vowel(s) in the word stem (symharmonism).

If there are word stems or affixes in various Turkic languages of same mathematical model then they can be considered as implementations of a single notion. We shall use lower-case letters for such notions and introduce the function $Impl(Lang, Notn)$ which transforms a notion $Notn$ into a word or affix of $Lang$.

Correspondingly, we shall understand

$Infl(Lang, Notn1, Notn2)$ as $Infl(Lang, Impl(Lang, Notn1), Impl(Lang, Notn2))$.

Four examples:

Infl(AZ, flower, dat_case) = Infl(AZ, GÜL, A)=GÜL∂

Infl(KG, flower, dat_case) = Infl(KG, GÜL,GA)=GÜLGÖ

Infl(TR, flower, dat_case) = Infl(TR, GÜL, A)=GÜLE

Infl(KZ, flower, dat_case) = Infl(KZ, GÜL, ÇA)=GÜLGE

6. Independent presentation of phonetics and reading texts in Turkic languages

Such presentation is not difficult and is given here for completeness.

Software and equipment (including speech recognition) for studying and checking-up pronouncing in many languages are well-known and used widely.

Independent presentation of rules of reading can be performed as follows.

- Demonstration of the alphabet.
- Demonstration of letters and combinations of letters with corresponding pronouncing.
- Demonstration of arrangement of the alphabet on the keyboard (the user is to guess to make corresponding labels on keys) or presenting a virtual keyboard on the screen.
- Tasks on spelling pronounced words.
- Tasks on pronouncing written words.

Success of such approach depends on existing of one-to-one correspondence between spelling and pronouncing.

Such approach is convenient for most of Turkic languages.

For example, consider Kyrgyz language. On the level of letters, there are two ambiguities (in transliteration from Cyrillic-based Kyrgyz alphabet):

$K \leftrightarrow [k] \mid$ [ķ]; $G \leftrightarrow [g] \mid$ [ǵ];

But on the level of two-letter combinations, there is such correspondence:

$KA \leftrightarrow$ [ķa];$KO \leftrightarrow$ [ķo]; KE $\leftrightarrow$[k e]; Kİ $\leftrightarrow [ki] \ldots$

$GA \leftrightarrow$ [ǵa]; $GO \leftrightarrow$ [ǵo]; $GE \leftrightarrow [ge]$; Gİ$\leftrightarrow [gi] \ldots$

Remark 6.1. *Letters learned by such a way can be used as convenient auxiliary objects as well as things in mathematical models for verbs, see below.*

7. Examples of mathematical models of notions in Turkic languages

Define constant objects on a rectangle D.

S_1 is a small circle;

S_2 is a greater circle with the same center;

$S_3 := S_2 \backslash S_1$;

$S_4 := D \backslash S_2$;

$S_5(\alpha)$ is a part of boundary of S_1 (an arc with the central angle α);

S_6 is a segment in S_4.

S_7 consists of two opposite sides of any rectangle;

(latent) S_8 and S_9 are two other sides of this rectangle;

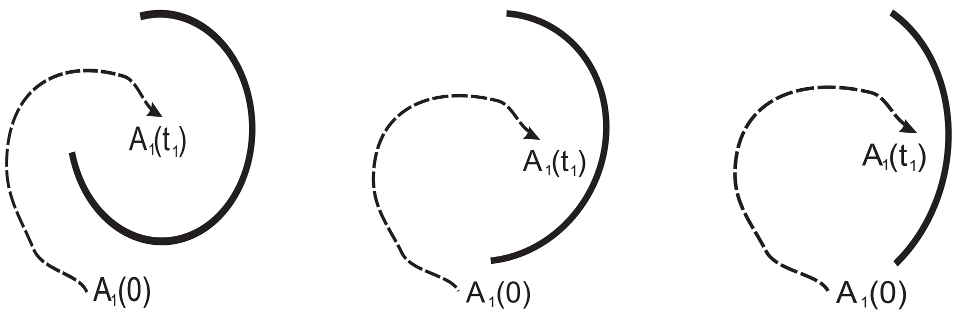
(latent) S_{10} is the exterior of this rectangle.

Define controlled objects:
A_1 is Avatar (a smaller circle);
A_2 is a random small object (a geometric figure or a letter).
Their diameters are shorter than the chord of $S_5(\alpha)$ and the segments S_8 and S_9.
The environment-conditions for all this section:

$$A_j \cap S_5(\alpha) = \emptyset, A_j \cap S_6 = \emptyset, A_j \cap S_7 = \emptyset. \quad (1)$$

7.1. The verb (AZ) G∂L, (TR) GEL, (KG; KZ) KEL *(come)*
The minimal mathematical model:
DO) A_1, S_1, S_3, S_4.
DI) $A_1(0) \subset S_4$.
DE) (1) and $A_1 \cap S_1 = \emptyset$.
DN) $A_1(t_1) \subset S_3$.
DC) Infl(Lang, Name(S_1), dat_case)+Impl(Lang, come)+"!"
Two examples.
Infl(TR, circle, dat_case)+Impl(TR, come)+"!"="DAİREYE GEL!"
Infl(KG, circle, dat_case)+Impl(KG, come)+"!"="TEGEREKKE KEL!"
Also, if obstacles are absent, the verb G∂L-GEL-KEL means that the function
$F(t) := dist(S_1, A_1(t))$ decreases 'quickly' (fuzzy logic).
Consider an environment with an obstacle:
DO) A_1, S_1, S_3, S_4, S_6.
DI) $A_1 \subset S_4; S_6$ is between A_1 and S_3.
Here the function $F(t)$ can increase (during bypassing the obstacle S_6) but the way $A(t)$ must be 'close' (fuzzy logic) to the shortest one to be perceived by a native speaker as a true fulfilling of the command.

7.2. The verb (AZ;TR) GİR, (KG;KZ) KİR *(come_in)*
DO) $A_1, S_1, S_4, S_5(\alpha), \alpha$ is 'large'.
DI) $A_1(0) \subset S_4$.
DE) (1).
DN) $(A_1(t_1) \subset S_2)$.
DC) Infl(Lang, Name(S_1)), dat_case)+Impl(Lang, come_in)+"!"
For example,
Infl(KG, yard, dat_case)+Impl(KG, come_in)+"!"="KOROOGO KİR!"
Here we have a fuzzy logical statement: if $\alpha > 270^0$ then all native speakers agree with the correctness of the command but if $\alpha < 180^0$ then some native speakers doubt.



GİR-KİR: does fit fits? doesn't fit.

Hence, the verb GİR-KİR means a certain fuzzy class of sets 'with sufficient interior'.
We propose the following

Definition 7.1. *(fuzzy). Consider a plane set M. If there exists such outline L (with interior V) of M that all connected parts of $L \backslash M$ are not 'too wide' and some parts of $V \backslash M$ are 'wide' then M is said to be a set with sufficient interior.*

Remark 7.1. *Such outline L is not sure to be the boundary of the convex hull of M.*

7.3. The verb (AZ) ÇÎX,(KG;TR) ÇÎK, (KZ) ŞÎĶ (*go_out*)
DO) $A_1, S_1, S_4, S_5(\alpha), \alpha$ is 'large'.
DI) $A_1(0) \subset S_1$.
DE) (1).
DN) $A_1(t_1) \subset S_4$.
DC) Infl(Lang, Name(S_1), abl_case)+Impl(Lang, go_out)+"!"
For example,
Infl(KG, yard, abl_case)+Impl(KG, go_out)+"!"="KOROODON ÇÎK!"
As well as the verb GİR-KİR, the verb ÇÎX-ÇÎK-ŞÎĶ means a set with sufficient interior.
7.4. The verb (TR) ET, (KG) ÖT (*pass*)
One of mathematical models:
DO) $A_1, S_7, S_8, S_9, S_{10}$.
DI) $A_1(0) \subset S_{10}$; $A_1(0)$ is near S_8.
DE) (1).
DT) $A_1(t_1) \cap S_8) \neq \emptyset; A_1(t_2) \cap S_9) \neq \emptyset; A_1(t_3) \subset S_{10}$.
DC) Infl(Lang, Name(S_7)), abl_case)+Impl(Lang, pass)+"!"
Examples.
Infl(TR, bridge, abl_case)+Impl(TR, pass)+"!"="KÖPRÜDEN ET!"
Infl(KG, bridge, abl_case)+Impl(KG, pass)+"!" = "KÖPÜRÖDÖN ÖT!"
In general, the verb ET-ÖT means a 'passable' set. The following definition seems strict:

Definition 7.2. *Consider a non-connected plane set M. If at least two connected components of it have non-empty intersections with the boundary of the convex hull of M then M is said to be passable.*

7.5. The verb KOY (in some languages) (*put*)
The minimal mathematical model:
DO) A_2, S_1, S_4.
DI) $A_2(0) \subset S_4$.
DE) (none).
DN) $A_2(t_1) \subset S_1$.
DC) Infl(Lang, Name(A_2), acc_case)+ Infl(Lang, Name(S_1), dat_case)+Impl(Lang, put)+"!"
For example,
Infl(TR, book, acc_case)+Infl(TR, chair, dat_case)+Impl(TR, put)+"!" =
"KİTABÎ SANDALYEYE KOY!"
7.6. Inanimate nouns which can be presented as constant objects are introduced as names of auxiliary objects during studying verbs. They do not require special mathematical models.
7.7. Mathematical models of nouns denoting transformable objects (including animate nouns) and pronouns are subsets of mathematical models of verbs. Certainly, such models for same noun and different verbs are different too. For example, the verb (KG) BAR (*put*) means motion of the human's feet; the verb (some languages) AL (*take*) means motion of the human's hand.
An example of introducing an adjective by means of double mention (after introducing the verb KOY).
7.8. The adjective (TR) YEŞİL, (KG) CAŞÎL (*green*)
Let S_{11} and S_{12} be equal figures with empty intersection.
A mathematical model:
DO) A_2 (green), S_{11} (green), S_{12} (yellow).
DI) $A_2(0)$ has empty intersections with S_{11} and S_{12}.
DE) (none).
DN) $A_2(t_1) \subset S_{11}$.

DC) Impl(Lang, green)+ Infl(Lang, Name(A_2), acc_case)+ Impl(Lang, green)+ Infl(Lang, Name(S_2), dat_case)+Impl(Lang, put)+"!"

For example,

Impl(TR, green)+Infl(TR, ball, acc_case)+Impl(TR, green)+Infl(TR, chair, dat_case)+Impl(TR, put)+"!" = "YEŞİL TOPU YEŞİL SANDALYEYE KOY!"

7.9. Mathematical models of grammar forms are introduced during studying verbs too. For instance, see Dative, Accusative and Ablative cases above.

8. Conclusion

The examples listed above demonstrate that common words implicitly mean sufficiently complex mathematical models and these models are same for different Turkic languages. We hope that successful implementation of this approach would yield independent description of Turkic languages and an objective base for comparison of notions and grammar forms of different languages.

We considered such notions only that could be presented geometrically and with only moving object. Certainly, other notions demand transformable objects and additional multimedia capabilities. Nevertheless, we hope that all difficulties would be overcame and interactive independent presentations of foundations of Turkic languages would be built. Also, we hope that such approach can be used for controlling a computer in Turkic languages which would promote human-computer interaction.

References

[1] Asher, J., (1965), The strategy of total physical response: An application to learning Russian, International Review of Applied Linguistics, 3.

[2] Bayachorova, B.J., Pankov, P. (2009), Independent Computer Presentation of a Natural Language, Varia Informatica, Lublin, pp.73-84.

[3] Borubaev, A.A., Pankov, P.S., Chekeev, A.A., (2003), Spaces Uniformed by Coverings, Hungarian-Kyrgyz Friendship Society, Budapest (Chapter 4. Constructive and computer presentations of uniform spaces).

[4] Kustova, G.I., Paducheva, E.V., (1994), Semantic Dictionary as a Lexical Database, EURALEX-1994, Proceedings, Amsterdam, Netherlands.

[5] Pankov, P.S., Ismailov, B.D., Asilbekov, A.B., Karasev, V.B., Parahin, V.A., (1991), Controlling-teaching program on word inflection in Kazakh language on PC, Abstracts of republican conference "Scientific-practical aspects of improving of quality of preparing teachers of mathematics and informatics", Kazakh State Pedagogical University, Almaty, part 2, pp.64-65 (in Russian).

[6] Pankov, P.S., (1992), Teaching and controlling program on word-formation in Kyrgyz language on PC, "Mektep" Publishing House, Bishkek (in Russian).

[7] Pankov, P.S., Aidaraliyeva, J.Sh., Lopatkin, V.S., (1996), Active English on computer, Conference "Improving Content and Approach in the Teaching of English Language in the Context of Educational Reform", Kyrgyz State Pedagogical University, Bishkek, pp.25-27.

[8] Pankov, P.S., Alimbay, E., (2005), Virtual Environment for Interactive Learning Languages, Human Language Technologies as a Challenge for Computer Science and Linguistics: Proceedings of 2nd Language and Technology Conference, Poznan, Poland, pp.357-360.

[9] Pankov, P.S., Dolmatova, P.S., (2007), Algorithmical Language for Computer-Based Presentation of Notions, 4th International Conference on Electronics and Computer, Suleyman Demirel University, Almaty, pp.274-279.

[10] Pankov, P., Dolmatova, P., (2009), Software for Complex Examination on Natural Languages, Human Language Technologies as a Challenge for Computer Science and Linguistics: Proceedings of 4th Language and Technology Conference, Poznan, Poland, pp.502-506.

[11] Pankov, P.S., Dolmatova, P.S., (2009), Geometrical Problems in Interactive Computer Presentation of Notions of Natural Languages, Actual Problems of Control Theory, Topology and Operator Equations: International Jubilee Conference at the Kyrgyz-Russian Slavic University, Shaker Verlag, Aachen, Germany, pp.85-87.

[12] Pankov, P., Bayachorova, B., Juraev, M., (2010), Computer presentation of Kyrgyz language, J. Balasagyn Kyrgyz National University, Bishkek (in Kyrgyz).

[13] Pankov, P.S., Bayachorova, B.J., (1996), Using computers to perform non-Euclidean topological spaces, The 6-th conference and exhibition on computer graphics and visualization "Graphicon-96", Saint-Petersburg, Russia, 2, p.232.
[14] Pankov, P.S., Bayachorova, B.J., Terehin, A.V., (1998), Computer Presentation of Four-Dimensional Spaces, The 8-th International Conference on Computer Graphics and Visualization "GraphiCon-98", Moscow, Russia, p.204.
[15] Sanfilippo, A. et al. (1996), Preliminary Recommendations on Semantic Encoding, Interim Report, The EAGLES Lexicon Interest Group.
[16] Vygotsky, L.S., Saharov, L.S., (1981), Investigation of creation of notions: methodology of double simulation, Chrestomathy on General Psychology: Psychology of Thinking, Moscow State University, Moscow (in Russian).
[17] Winograd, T., (1972), Understanding Natural Language, Massachusetts Institute of Technology, New York.
[18] Zadeh, L. A., (1975), The concept of a linguistic variable and its application to approximate reasoning, Information Sciences, 8, pp.199-249, 301-357; 9, pp.43-80.

Pavel S. Pankov was born in 1950. He is a head of the Department at the International University of Kyrgyzstan, principle researcher at the Institute of Theoretical and Applied Mathematics of National Academy of Sciences of Kyrgyz Republic, Doctor of Sciences, Professor, Corresponding Member of NAS KR, a recipient of Arabaev Prize (for computerization of Kyrgyz language), State prize-winner (for computer presentation of topological spaces), a recipient of Akhunbaev Academic Prize (for developing of theory of computer presentation of topological spaces).

Batyigul J. Bayachorova was born in 1949. She graduated from the Leningrad (now Saint-Petersburg) State University by the specialty "applied mathematics". Presently she is a Ph.D., Professor, Director of Eurasian Institute of Innovation Technologies at the Jusup Balasagyn Kyrgyz National University. She is an author of text-books on informatics for students of Universities. She develops methods of informatics in mathematical and linguistic investigations.

Mukhtar Juraev was born in 1936. He graduated from Osh Pedagogical Institute and got his Ph. Degree. Presently he is a principle researcher at the Institute of Theoretical and Applied Mathematics of National Academy of Sciences of Kyrgyz Republic.