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PHONETIC WAYS OF AUTOMATIC TEXT RECOGNITION

Abstract. Phonetic-phonological methods and models of automatic text recognition are considered in the article, the phonemic principle of the Kazakh language is shown. An overview of the works of scientists who first discussed the adaptation of Kazakh texts to the computer, substantiated the theory, implemented the practice and demonstrated it in practice was also made. Today, computer and information technologies, artificial intelligence are constantly updating the process of their development in accordance with the new trends of time. Such information technologies include computers, smartphones, gadgets, etc. and these devices are actively used by consumers in everyday life. That's why automatic text recognition needs to be improved and updated day by day. Today, sound automation opens a new facet of Kazakh science. In the written language, the phonemic principle is of special importance. According to this principle, only one grapheme should always be used for each phoneme in the writing system. Such a position will undoubtedly make the letter more coherent and easy to read. Thanks to this, new possibilities of the Kazakh language will be considered. The main results of automatic text recognition can already be seen in the development of the National Corpus of the Kazakh language, which is ready to satisfy the various requests of any reader.

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МӘТІНДІ АВТОМАТТЫ ТАНУДЫҢ ФОНЕТИКАЛЫҚ ЖОЛДАРЫ

Аңдатпа. Мақалада мәтінді автоматты танудың фонетика-фонологиялық жолдары мен үлгілері қарастырылып, қазақ тілінің фонематикалық принципі көрсетілген. Сондай-ақ қазақша мәтіндерді компьютерге икемдеуді алғаш рет сөз етіп, теориясын негіздеп, практикасын жүзеге асырып, іс жүзінде көрсетіп берген ғалымдардың еңбектеріне шолу жасалған. Компьютерлік және ақпараттық технологиялар, жасанды интеллект бүгінгі күні заманның жаңа ағымына сай өзінің даму үдерісін тоқтатпай жаңару үстінде. Мұндай ақпараттық технологиялардың қатарына компьютерлер, смартфондар, гаджеттер т.б. жатады және бұл құрылғыларды барлық тұтынушылар күнделікті тұрмыста қолданады. Сол себепті де мәтінді автоматты тануды күннен-күнге жетілдіріп, жаңартып отыру қажет. Қазіргі кезде дыбыстарды автоматтандыру қазақ ғылымының жаңа бір қырын көрсетуде. Фонематикалық принцип жазба тілде ерекше маңызға ие. Бұл принципке сәйкес жазу жүйесінде бір фонема үшін әрдайым бір ғана графема қолданылуы қажет. Мұндай ұстаным жазуды бірізділікке келтіруге және оқуды жеңілдетуге мүмкіндік беретіні сөзсіз. Сол арқылы қазақ тілінің жаңа мүмкіндіктері қарастырылмақ. Мәтінді автоматты танудың негізгі нәтижелерін қазірдің өзінде кез келген оқырманның тілге қатысты алуан түрлі сұранысын өтеуге дайын Қазақ тілінің ұлттық корпусынан көруге болады.

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ФОНЕТИЧЕСКИЕ СПОСОБЫ АВТОМАТИЧЕСКОГО РАСПОЗНАВАНИЯ ТЕКСТА

Аннотация. В статье рассмотрены фонетико-фонологические способы и модели автоматического распознавания текста, показан фонематический принцип казахского языка. Также сделан обзор работ ученых, которые впервые обсудили адаптацию казахских текстов к компьютеру, обосновали теорию, реализовали практику и продемонстрировали ее на практике. Сегодня компьютерные и информационные технологии, искусственный интеллект постоянно обновляют процесс своего развития в соответствии с новыми тенденциями времени. К таким информационным технологиям относятся компьютеры, смартфоны, гаджеты и т.д. и эти устройства активно используются потребителями в повседневной жизни. Вот почему автоматическое распознавание текста необходимо совершенствовать и обновлять день ото дня. Сегодня автоматизация звуков открывает новую грань казахстанской науки. В письменной речи фонематический принцип имеет особое значение. Согласно этому принципу для каждой фонемы в системе письма всегда должна использоваться только одна графема. Такая позиция, несомненно, сделает письмо более связным и легким для чтения. Благодаря этому будут рассмотрены новые возможности казахского языка. Основные результаты автоматического распознавания текста уже можно увидеть в разработке Национального корпуса казахского языка, который уже готов удовлетворить разнообразные запросы любого читателя.

Ключевые слова: фонетика; фонология; фонема; автоматизация; национальный корпус

Introduction

The study of sounds through computer technology places linguistics among the exact sciences. Automation of Kazakh texts takes the study of word sounds to a new level. Today's information society promotes the development of the applied direction of all branches of science. Nowadays digitalization and automation are in full swing, even in the humanitarian sphere. Askar Zhubanov, a well-known scientist who noticed the need in Kazakh linguistics under the requirements of this information age half a century ago, has implemented his idea since the 70s of the XX century, creating the first models of computer presentation of Kazakh texts. Finding an effective method for text recognition is not easy. Because the text is divided into different parts, it depends on the text's language, length, font size, color, and orientation (Chen X. et al., 2021, Gupta N., Jalal, 2022).

Automation is implementing a linguistic knowledge system into an electronic tool (application, website, search resource, etc.) in the Internet space in searchable, attractive, concise, and accessible information.

To automate text, it is necessary to consider that languages have two types of sound differences. One is an autonomous difference, which does not depend on the phonetic situation. This difference is characteristic of phonemes. The second difference is due to the phonetic case, i.e., the influence of adjacent consonants. This difference is necessarily the allophones, variations of a single phoneme, it is known to all speakers of the same language. Since a phoneme is an independent sound unit, it must be connected with potential content. There shouldn't be any barriers to phonetic changes. The division of

words in spoken language into individual sounds during text automation is primarily due to the presence of morphological boundaries in their sequence. The difference between the phoneme and the morpheme is shown due to phonemes' unique independence which appears in a word chain in such cases when there are no clear boundaries.

Materials and methods

Oral subcorpus materials from the National Corpus of the Kazakh Language web page (https://qazcorpus.kz/) were used to learn the specifics of sounds for reading, recognizing, and transforming Kazakh texts. When presenting the main features of sounds, the works of A. Baitursynuly "Til tagylymy" (Baitursynov, 1992), A. Zhunisbek "Qazaq til bilimining maseleleri" (Zhunisbek, 2018), and Z. Bazarbayeva's "Qazaq fonologiasynyng negizderi" (Bazarbayeva, 2022) were used as a basis. Also, the "Qazaq tilining orfoepialyq sozdigi" (Ualiuly, Fazylzhan, Kuderinova, 2019) was used as a guide when adapting sounds to the computer.

Most research in the phonetics area of the Kazakh language is conducted from a segmental and suprasegmental perspective, and scientific data is collected using a descriptive method. The article mainly considers methods such as analysis, description, and comparison to demonstrate sound features. We rely on the mathematical linguistics method to determine the phonemic composition of the sounds of the Kazakh language. This method systematizes the correct formation of the text through models.

On the initiative of Professor A.K. Zhubanov, the methods and methodology of corpus construction were extensively studied, and the textbook "Corpus Linguistics" was published as an educational tool by A. Zhubanov and A. Zhanabekova. Based on the ideas of A. Zhubanov, a specialist in applied linguistics, is being inserted in linguistic and extralinguistic designations (Zhubanov, 1966: 37).

Literature review

The history of the study of Kazakh phonetics has its characteristics. The investigation of Kazakh phonetics consists of several historical periods. The first era covered the middle and the 19th century's second half. The works of N.I. Ilminskiy, P.M. Melioranskiy, V.V. Radlov, and many other scholars' contributions of that time were released.

At the beginning of the XX century, the writings of A. Baitursynuly, H. Dosmukhamedov, K. Zhubanov, and other authors began to be published.

As well as I. Kenesbayev, T. Talipov, Zh. Aralbayev, N. Turkpenbayev, and other scientists conducted these investigations during the 1950s and 1970s of the 20th century.

In the 70-90s of the XX century, and at the beginning of the XXI century, the works of S.Myrzabekov, B. Kaliyev, M. Zhusipov, A. Zhubanov, N. Uali, M. S. Isayev, Zh. Abuov, A.Zhunisbek, Z. Bazarbayeva, A. Koshkarov, S. Tatubayev, etc. were published.

The statistical method was first proposed by the Russian scientist, an outstanding mathematician V.Ya. Bunyakovskiy in the language practice study. In 1847 he noted the possibilities of statistical classification and pointed out that if it were used correctly, new opportunities would arise for philologists and mathematicians.

In 1987, at the second All-Union scientific conference in Moscow, scientists related to this field met and discussed the issue in detail. K.B. Bektayev and A.K. Zhubanov from Kazakhstan made reports about work on creating a machine fund for the Kazakh language. From that time until the last day of his life, Askar Kudaibergenovich Zhubanov looked for ways to automate the text, improved it, left a lot of work on it, made an invaluable contribution to Kazakh science, and trained several students. Among them we can highlight: the "Kumano-Kazakh Frequency Dictionary" compiled by A.K. Kuryshzhanov, A.K. Zhubanov, and A.K. Belbotayev (Kuryshzhanov, Zhubanov, Belbotayev, 1978); the Frequency dictionary on Auezov's novel "The Path of Abai" developed by K.B. Bektayev, A.K. Zhubanov, S. Myrzabekov, A.B. Belbotayev (Bektayev et al., 1979); "Frequency dictionary in the texts of M. Auezov's works in 20 volumes" compiled by K.B. Bektayev, A.K. Zhubanov, S. Myrzabekov, A.B. Belbotayev (Bektayev et al., 1995); "Frequency dictionary from the collected works of M. Auezov in 20 volumes", consisting of 30515 words, developed by A.K. Zhubanov, A. Zhanabekova, B. Karbozova, A. Kozhakhmetova (Zhubanov et al., 2016). The scientists' works mentioned above were a basis for automating the Kazakh texts.

Results and discussions

Currently, the only way to automate Kazakh texts is through a large-scale database, the Kazakh National Corpus (KNC) – a large-scale collection of texts in electronic form, containing millions of words, fully covering the lexical and grammatical system of the Kazakh language (deeply annotated). This "smart", specialized knowledge base collects all information about the Kazakh language. The National Corpus of the Kazakh Language (https://qazcorpus.kz/) is a large-scale, voluminous database of Kazakh texts ready to meet the diverse language needs of any journalist-reader.

If A. Zhubanov based it theoretically, A. Zhunisbekov created the basis of the models. The concept of the linguistic model first appeared in structural linguistics. In the 60s and 70s of the 20th century, the introduction of mathematical methods into linguistics contributed to the widespread use of this term.

In modern linguistics, the scope of the term "model" is expanding daily. Modeling is also a cognitive approach in linguistics because analytical possibilities are realized through linguistic modeling. It is important to use a modeling system when teaching or learning languages profoundly that are part of the humanitarian direction.

There is a difference between a model and illustrative material (graphs, drawings, pictures, etc.) contained in phonetic scientific works. The model is not very precise. It shows approximate phonetic phenomena or regularity and has common similarities between them. Graphs, drawings, and pictures should be highly accurate because they include numerical measurements.

Modeling a knowledge system is presenting linguistic information in an infographic format. That is a systematic presentation of linguistic information in a graphic space, such as a table, diagram, etc. The simplest way to model a knowledge system is to automate it in a virtual space. The benefits of modeling and automating linguistic knowledge are that information about knowledge is easily found, and quickly stored in the reader's memory, and the search for the necessary information becomes accessible.

According to M. Wartofsky, "The model is a highly specialized part of the technical equipment of us, the peculiarity of which is also in building the future... the model is not just an individual essence, but an approach to action that presents this essence" (Wartofsky, 1988: 307).

A. Zhunisbek described the phonetic analysis of the word structure included in the corpus as follows:

Step one: show the melody (timbre) of the word. In the Kazakh language, words are divided into hard and soft melodic, depending on the hardness/softness of the vowel. The program must automatically indicate whether the words are hard or soft in the corpus. When adding endings to the root words in the Kazakh language, they are added depending on the hardness/softness of the vowel in a word. Accordingly, it is defined as a hard or soft melodic word. The following rule should be given to distinguish this sign automatically in the program. *If the vowels in the first syllable of a word (or in a composition of a word) are hard sounds like а, ы, у, о, then that word from the viewpoint of synharmony is considered a hard melodic one.* If the vowels in the first syllable of a word (or in a composition of a word) are soft (ә, і, ү, ө), then this word is considered soft-melodic from the point of view of *synharmony*.

Second step: Divide the word into syllables and describe them. The number of syllables in a word is decided by its number of vowels in the Kazakh language. There are as many syllables in a word as there are vowels in a word. For example:

Alippe (Әlinne/– Primer). There are 3 vowels, corresponding to 3 syllables: *A-lip-pe.*

Ana (Ана/ – Mother). There are 2 vowels, corresponding to 2 syllables: *A-na.*

Bala (Бала/ – son). There are 2 vowels, corresponding to 2 syllables: *Ba-la.*

Zhangbyr (Жаңбыр/ – rain). There are 2 vowels, corresponding to 2 syllables: *Zhang-byr.*

Quttyqtady (Құттықтады/ – congratulated). There are 4 vowels, corresponding to 4 syllables: *Qut-tyq-ta-dy.*

It can be said that syllable theory is one of the most complex and significant issues in the area of Phonetics. In this regard, the theoretical founder of the Kazakh language, the scientist, professor Kudaibergen Zhubanov said: "To understand the nature of the Kazakh language correctly, it is

necessary to understand the system of syllables. If you don't know syllables well, you won't know the orthography either: you can't understand the basis of morphology, such as word formation and word transformation unless you know the syllables, and you won't understand the secrets of language phenomena related to the sentencing system, such as word stress (stress), word tone (intonation), you can't take classes like "impressed speech", "expressive reading" properly; If you are not familiar with the position of syllables, you will not be able to properly familiarize yourself with the basis of the structure of the poem..." (Zhanabekova, Karshigayeva, 2019: 21).

To describe the construction of syllables, we take the sign of the vowel/consonant in the international system. They are V (vocalism) – vowels; C (consonantism) – consonants. To identify syllables based on sounds (letters), the computer program for phonetic notation should list and mark the letters of the Kazakh alphabet according to the above-mentioned V and C characteristics. For example А – V; Ә – V; Ы – V etc. Similarly, consonants Р – С; В – С; М – С, etc.

There are usually 3 types of syllables in the Kazakh language: open syllables, closed syllables, and stop syllables. A. Baitursynuly did not interrupt but interlinked them continuously at speech and sentence, sentence and word, word and syllable, syllable and sound network. Having considered the method of dividing words into syllables, he distinguishes between the types of syllables as the following: "If a syllable gets stuck among others, call this syllable a "closed"; if the end of a syllable rests on a syllabic letter, call this syllable "open"; if a syllable rests on another letter, except for a syllabic letter, this syllable is called "stop" syllable (Baitursynuly, 1992: 65). Our "syllabic" letters are vowels. It is said that the meaning of vowel letters in the formation of syllables cannot be "a syllable in which these letters do not enter".

A. Zhunisbek is called an open syllable consisting of one vowel at the beginning of a word – a vowel syllable (Zhunisbek, 2018: 37). Thus, the Kazakh language shows four types of syllables: *voiced, open, closed, semi-closed syllables.*

The vowel phoneme <a> in the Kazakh language is pronounced closer to the variant [á] after some phonemes, such as <w> and <j>, and the written version retains the basic tone: shai, jaibaraqat, jaibasar.

Similarly, the phonemes <e>, <o>, and <ö> are pronounced as [ie], [uo], and [uö] at the beginning of a word. For example, ерке – [^{й}ерке], егін – [^{й}егін], есік – [^{й}есік], отан – [^{у}отан], оқиға – [^{у}оқұйға], орама – [^{у}орама], орман – [^{у}орман], отын – [^{у}отұн], омырау – [^{у}ом^{у}рау].

In the words: өмір – [уөмұр], өлең – [уөлөң], өтініш – [уөтүнүш], өсімдік – [уөсүмдүк], өркениет – [уөркөнүйет] (өркениет), өзара – [уөзара], өкпе – [уөкпө], өкіл – [уөкүл] the phonemes <e>, <o>, <ö> are pronounced as [ıe], [uo], [uö]. These phonemes are pronounced as monophthongs in the middle or at the end of a word: себеп (себеп), керек (қажеттілік), молда, сез, кел, тес, көлік. In conclusion, the phonemes <e>, <o>, <ö> are pronounced as [^{i}e], [^{u}o] [^{u}ö] at the beginning of a word. When some vowel phonemes are found in weak positions, they lose their phonemes features and get the characteristics of other phonemes, for example: phonemes <y>, <i>, <e > are partially changed to the phonemes [u], [ü], [...]. For example, if we use another phoneme instead of one phoneme, it changes the meaning of the word, which shows the function of two phonemes. This feature is observed in the phonemes [a] and [y]: in the word qar, if the phoneme [a] is replaced by the phoneme [y], a new word like qyr appears.

There are several main reasons for sound changes in the Kazakh language: assimilation (combinatorial), marginal (positional), and non-assimilation (spontaneous). This is important to avoid writing problems, and it is necessary to recognize Kazakh texts on an automatic machine.

A phoneme can be considered in three aspects: physical aspect, physiological aspect, and linguistic aspect. A phoneme's physiological and physical aspects include its acoustic-articulatory nature, while the linguistic aspect considers its functional side. The phonological series of a language is reflected in the sounds that occur in continuous speech flow. Instead of some positions in that speech flow, sounds that have phonological significance are encountered. They correspond to individual phonemes of the phonological series. In spoken language, along with the functions of transforming meaning, sounds that have no phonological significance can also be found. Also, each sound in a speech flow is represented as a set of phonological and non-phonological properties.

It is known that phonemes have different positional and combinatorial tones in the speech flow. These tones (variant, variation) manifest in a certain phonetic environment. For example, when [n] is pronounced at the beginning of a word, next to both sonorous, and along with hard, soft, labial, and non-labial vowels, it has different tones, depending on phonetic conditions. In short, no matter how many phonetic positions there are the phoneme will have as much sound tone. Among them, the ones that are more independent of the phonemic enclosure will be the main tone, and the rest will be the additional tone. For example, the phonetic dependence of [n] in the words *bugin* (today), and *bugingi* (today's) is not the same. [N] in the word "bugingi" has a much stronger dependence on the sound enclosure than [n] in the word "bugin". Of course, there is no point in showing all tones of sounds in writing, if not in the orthoepy. In the writing, only the main tone of the phoneme, which performs a lexical function, is marked. This is how we can understand the meaning of writing while preserving the phonemic value of a morpheme.

According to the phonetic principle, the words: бесжылдық, жұмысшы, мұзжарғыш, басшы, сенгейсің, сенбісің, лажсыз are not written as [бешшылдық], [жұмұшшұ], [мұжжарғыш], [башшы], [сеңгейсің], [сембісің], [ылашшыз]. The aim of writing in this way is to preserve the "root" of the word. If one keeps the "root" of some words, for example, *basshy* (leader), *zhumysshy* (worker), *ak alma* (white apple), then there will be no noticeable influence of [s] on [sh], [z] on [zh], <a> on <k>. And why should one consider the influence of vowels on consonants when writing words ak – agar, zhok – zhogal, tep – teuip, tebin, taraq – taragy? The root words are not ag-, zhog-, teu-, teb-, tarag-, etc., in other forms, it is not written as they are pronounced but they are written according to the main tone of the phoneme (beszhyldyq, leader, icebreaker), thus, the significant parts of the word are not affected. The phonemes [z], [zh], [c] in the words muzhzhargysh, khushshugur, and oshshu are changed under the influence of adjacent sounds and pronounced as [zh], [sh], [sh]. These are sound variants of the phonemes <z>, <zh>, <s> because it is found that in a different phonetic situation, they will keep their main tone: mu[z]ga, [zh]iger, o[s]shi.

Only the basic meaning (tone) of phonemes can be the semantic "cover" of a word. Therefore, we recognize the word by the basic meaning of phonemes. Although we physically understand the secondary meaning of phonemes, our psyche automatically ignores sounds that don't have functional meaning. In our psyche, the word is represented in its basic "cover" (in the form of *өсуі*, not [өшші]).

Also, a set of sounds is adapted together and forms a certain number of phonemes. For example, let's compare the pair of words [jon-j'ön']; [tūs-t'üs']; [syz-s'ız']. They are distinguished by the hardness and softness of consonants and vowels, although their hard and soft phonological significance is identified by vowels in the Kazakh language. The reason is that the hardness and weakness of consonants were caused by the influence of neighboring vowels around them, more precisely, the hardness and weakness of consonants have no phonological meaning in the Kazakh language. So [j] and [j'], [n] and [n'] in the first pair, [t] and [t'], [s] and [s'] in the second pair, and [s] and [s'], [z] and [z'] consonants in the third pair, despite their acoustic-articulatory difference, form a single phonological unit. Phonemes influenced by neighboring sounds, being in a perceptually weak position, change their sound and manifest themselves as variations. They do not serve as a phonological distinction but differ acoustically and articulately.

Automation and consolidation of the language knowledge system based on a computer program is significant in a digital society. So, to automate the knowledge system on Kazakh phonetics, the basic rules and phonological concepts and terms were systematized, and the linguistic module ARKT (Automatic recognition of the Kazakh text) was created. In the studies until now, the transformation of A sound into Ә was recognized as a variant. However, based on linguistic data, its variational character was revealed. The variant and variation of each phoneme are summarized as a module and given below in the table (Table 1).

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Table 1 – The module of the strong and weak positions of the [A] phoneme (extract)
Кесте 1– [A] фонемасының әлді және әлсіз позициясының модулі (үзінді)
Таблица 1 – Модуль сильной и слабой позиции фонемы [A] (выписка)

1	The strong position of the <A> phoneme	
[A]	[ASTANA]	ASTANA
2	The weak position of the <A> phoneme through the [Ä] phoneme	
[Ä]	[ŞÄI]	ŞÄI
[Ä]	[JÄILY]	JAILY
[Ä]	[ÄIGŐLŐK]	AIGŐLEK
[Ä]	[QÄZIR]	QAZIR

As we can see from Table 1, the weak position of the phoneme <A> is represented by the phoneme [Ä].

Table 2 – The module of the strong and weak positions of the [E] module (extract)
Кесте 2– [E] фонемасының әлді және әлсіз позициясының модулі (үзінді)
Таблица 2 – Модуль сильной и слабой позиции фонемы [E] (выписка)

1	The strong position of the <E> phoneme	
[E]	[KEREMET]	KEREMET
2	The weak position of the <E> phoneme through the [^{1}E] phoneme	
[^{1}E]	[^{1}EKPIN]	EKPIN
[^{1}E]	[^{1}EGEMEN]	EGEMEN
[^{1}E]	[^{1}ELEK]	ELEK
[^{1}E]	[^{1}EMLE]	EMLE

Table 2 shows that the weak position of the [E] phoneme variation is represented by the phoneme [^{1}E].

It was in this sample that the variational resource of vowels and consonants was determined.

During the study, a fund of variants of Kazakh phonemes was created:

The strong position of the phoneme <Z> is realized through four tones: hard-unrounded, soft-unrounded, hard-labial, and soft-labial.

[z]	[qazan]	qazan
[z^1]	[kez^{1}ek]	kezek
[z^0]	[z^{0}or]	zor
[z^{10}]	[söz^{10}]	söz

The weak position of the variants of the <Z> phoneme is realized through [S], [S], and [J] tones: hard-unrounded, soft-unrounded, hard-labial, and soft-labial.

The strong position of the <S> phoneme is realized through four tones: hard-unrounded, soft-unrounded, hard-labial, and soft-labial. It is demonstrated in Table 3.

Table 3 – The module of the strong position of the <S> phoneme (extract)
Кесте 3 – [S] фонемасының әлді позициясының модулі (үзінді)
Таблица 3 – Модуль позиции фонемы [S] (выписка)

[S]	[MYSYQ]	MYSYQ
[S^1]	[KIS^{1}ILIK]	KISILIK
[S^0]	[S^{0}ORPA]	SORPA
[S^{10}]	S^{10}ÜBELI	SÜBELI

Phonemes and sounds do not always correspond to each other. A phoneme can consist not only of one sound but also of two sounds. Sometimes two phonemes are pronounced as one sound. For example, in the word *el* (ел), the phoneme *e* is pronounced as a diphthong in the main position as *jel (йел),* on the contrary, in the word *aitsa (айтса),* the phonemes *t* and *s* form the sound *[ts]*.

Recently, as knowledge and technology develop, their capabilities are also increasing. This is a natural phenomenon associated with the development of society and its language. The development of information technology has become relevant in providing a person with complex computer programs for speech communication. This applied area requires specialists in the field, and the phonetic properties of words are being studied using technical tools. It is currently very necessary to study the problem of automatic word recognition and synthesize word signals based on data from general phonetics. As a result, mastering general phonetic information is necessary for multidisciplinary doctors and speech therapists, specialists who restore speech and hearing in patients, and for correcting children's speech.

Conclusion

In conclusion, in the automatic recognition of the Kazakh text in the fields of phonetics and phonology, it is necessary to ensure the correct rendering of the smallest unit of the text – the letter and to be guided by the conclusions of the scientists mentioned above. A. Zhunisbek was the first to create an algorithm based on the phonetic-phonological model of automatic recognition of Kazakh texts. Currently, Z. Bazarbayeva, A. Fazylzhan, A. Amanbayeva, Zh. Zhumabayeva and other scientists and researchers are improving and adapting it to the computer.

The phonetics-phonology knowledge system for automatic recognition of the Kazakh text was described in the article. The phonemes' differentiating signs, strong and weak positions were given. It is spoken about distinctive signs of sounds in the language, closely related to their acoustic and articulatory characteristics. It is shown that each phoneme is a set of its distinguishing features as an invariant. It was given that a set of distinctive features constitutes the phonological content of phonemes. The phonological content of each phoneme was defined and described, unlike other phonemes. Variants and variations of phonemes were described in significant (distinguishing meaning) and perceptually weak positions. In the speech flow, phonemes undergo various modifications and changes, and it was mentioned that combinatorial and positional allophones were realized.

Sound study through computer technologies makes linguistics one of the exact sciences. Automation of Kazakh texts raises the study of sounds to a new level. Knowing the features of sounds is important to reading, recognizing, and converting Kazakh texts.

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