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Ragachurina Nozima Akmalovna
TUIT, Senior Lecturer, of the department "Electronics and radio engineering"
nozima_yadgarova@mail.ru

Musadjanova Nargiza Abduvoxid qizi
TUIT, assistant of the department "Electronics and radio engineering"
nmusadjanova1122@gmail.com

Musadjanova Dilobar Abduvaxidovna
TUIT, assistant of the department "Artificial intelligence"
dilobarmusadjanova@gmail.com

ANALYSIS OF SPEECH-LIKE SIGNALS FOR THE UZBEK LANGUAGE.

Annotation. This article is devoted to the analysis of speech-like signals for the Uzbek language. Questions such as methods of formation and processing of speech-like signals, the main features of the similarity of voice-speech signals with speech, and typical parameters of their signals are considered.

Solutions are proposed for the formation of speech-like signals for the Uzbek language, taking into account the difference in the probability of the appearance of a syllable in different digital forms in the formation of speech-like signals by inviting the unconditional probabilities of the letters of the Uzbek alphabet.

Key words: *speech-like signals, phonetic noise, masking, noise.*

Anotatsiya. Ushbu maqola, oʻzbek tili uchun nutqga oʻxshash signallarini tahlil qilishga bagʻishlangan. Nutqga oʻxshash signallarini shakllantirish va qayta ishlash usullari, ovozli-nutq signallarining nutq bilan oʻxshashligining asosiy xususiyatlari, signallarining tipik parametrlari kabi masalalar koʻrib chiqilgan.

Oʻzbek alifbosi harflarining shartsiz ehtimolliklari tahlili orqali nutqga oʻxshash signallarini shakllantirishda turli raqamli koʻrinishda soʻz boʻgʻinning paydo boʻlish ehtimolidagi farqni hisobga olgan holda oʻzbek tili uchun nutqga oʻxshash signallarini shakllantirish uchun yechimlar taklif etilgan.

Kalit soʻzlar: nutqga oʻxshash signallar, fonetik shovqin, maskirovka, shovqin.

Аннотация. Данная статья посвящена анализу речеподобных сигналов для узбекского языка. Рассмотрены такие вопросы, как способы формирования и обработки речеподобных сигналов, основные признаки сходства голосово-речевых сигналов с речью, типичные параметры их сигналов.

Предлагаются решения по формированию речеподобных сигналов для узбекского языка с учетом разницы вероятности появления слога в разных числовых формах при формировании речеподобных сигналов путем анализа безусловных вероятностей букв узбекского алфавит.

Ключевые слова: Рече подобные сигналы, фонетический шум, маскирование, шум.

Nowadays, we often hear about such an expression as the synthesis of speech-like signals (SLS). This occurs both in everyday life and in the specialized field of technology. When we talk about the synthesis of speech-like signals, we first understand what speech, synthesis, noise are. And we must understand about the permissible noise standards.

By tacit agreement, SLS already used in these areas are understood to be signals that are phonetically similar to speech, but do not carry semantic information that is accessible to traditionally used simple means of obtaining it (primarily when these signals are directly listened to by the subscriber). In psychological experiments, speech-like signals are formed, in particular, by frequency inversion of the spectrum of ordinary speech signals. When protecting (masking) information with the help of SLS, the latter are obtained by summing three arbitrary speech signals.

Both in the first and in the second case, the use of the term “speech-like signal” does not seem to be quite correct, because in both cases the generated signals contain in a hidden form the semantic information of the original speech signals. With proper processing of such SLS, this information can be extracted. There are cases when operators understood the main meaning of speech inverted along the spectrum, without explicitly converting the listened acoustic signals into the original speech ones. At the levels hidden from consciousness, the operator, regardless of his desire, carried out, as it were, the reverse inversion of the spectrum of the received signals, and from the received material the semantic content of the original speech was distinguished in the mind.

It is advisable to give the term SLS an independent meaning, independent of the methods of their formation and processing. To do this, we will understand such signals as acoustic signals, which, in terms of their temporal and spectral characteristics, as well as auditory perception, resemble speech, but do not contain semantic information in any form.

Despite sanitary standards, SLS do exist. In order to broadly consider the topic of interest to us, let's first consider the terms and definitions of the rule for establishing sanitary standards.

Sound pressure is the variable component of air pressure resulting from sound vibrations.

Intermittent noise is noise that fluctuates over time, the sound level of which changes continuously over time by more than 5 dBA (for example, the noise of motor vehicles).

Equivalent sound level, dB, of intermittent noise - the sound level of constant noise, which has the same SLS sound pressure as this intermittent noise for a certain time.

The permissible noise level is the level that does not cause significant anxiety and significant changes in the functional systems of the body and analyzers that are sensitive to noise.

Broadband noise is noise with a continuous spectrum more than 1 octave wide. Tonal noise is noise in the spectrum of which there are pronounced discrete tones and, when measured in 1/3 octave frequency bands, there is an excess over neighboring ones by at least 10 dB.

Impulse noise is noise. consisting of one or more beeps, each lasting less than 1 second. And at the same time, the sound levels in dB measured on the time characteristics "impulse" and "slow" differ by at least 7 dB.

Normalized permissible noise parameters should take into account the territorial location of a particular source. For example, the ward of hospitals, clinics and operating hospitals has a sound pressure level of up to 35 dB (from 07:00 to 23:00), while in markets, airports and hotels, the sound pressure level is allowed up to 60 dB. There are different tolerances for different areas. But if the noise is of the nature of a tonal or impulse origin, the permissible norms should be taken into account 5 dB lower.

As the main features of the similarity of RPS with speech, taking into account the available information about the typical parameters of speech signals, it is proposed to consider:

1. Burst nature of temporal changes in RPS with burst duration (15-120) ms;
2. Grouping bursts into packs of (2-8) pcs. in each, with intervals between individual bursts (10-50) ms, with an interval between bursts from 10 ms to 1 s;
3. Presence in the RPS spectrum of the main current with a frequency of (75-300) Hz;
4. Presence of RPS envelope with a spectrum concentrated in the frequency range (9-60) Hz;
5. The shape of the burst signal envelope can be specified analytically with parameter variation or randomly selected from a set of pre-prepared signals;
6. The presence in the spectrum of three to five formants that can be formed according to the law:

$$f_n(t) = A_n \exp\,(t/t_n) \sin\,(\omega_n t - \varphi_n)$$

where A_n – the amplitude of the formant ($n = \overline{1, N}$); N – the total number of formants; t – the current reference time, which changes from the beginning of the fundamental tone period to its end; t_n - the time interval during which the amplitude modulus decreases by e times (the duration of this interval lies within (1.5-30) ms); φ_n- initial phase of the harmonic carrier of the n-th formant; ω_n – the circular frequency of the formant ($\omega_n = 2\pi f n$). The cyclic frequency of formants takes values in the following approximate ranges: f_1 = (300-1000) Hz, f_2 = (1000-2000) Hz f_3 = (2000-3000) Hz, f_4 = (300(Г4000) Hz, f_5= (4000-5000) Hz. It can be seen that the data on the parameters of bursts and their bursts borrowed from the literature collide with the given numerical values of the time and frequency characteristics of the SLS envelope. However, this cannot serve as an obstacle to further consideration.

Unconditional probabilities of letters of the Uzbek alphabet. Table 1.

Space	0.175				
O	0.090	K	0.035	X	0.014
E	0.072	M	0.035	H	0.012
A	0.062	D	0.028	J	0.009
I	0.062	P	0.026	O’	0.007
T	0.053	U	0.025	Sh	0.006
N	0.053	Z	0.023	E	0.006
S	0.045	B	0.018	G’	0.003
R	0.040	G	0.018	F	0.002
V	0.038	Ch	0.016		
L	0.037	Y	0.014		

When forming a SLS based on the use of the above features, it is necessary to be guided by the following additional considerations:

- it is advisable to divide the formed implementation of the SLS into sections with a duration of 5 to 15 fundamental tone periods. It is necessary to ensure that in these sections the initial phases and frequencies of the carrier oscillations of the formants change by no more than 10% of their initial values. The nature of the change in the initial phases and formant frequencies can be the same as the change in the burst envelope;

- when moving from one section to another, the fundamental tone frequency, formant frequencies, amplitudes, decay time of formant signals can change jump by (20-70)% in any direction;

- in the transition from one surge to another, its parameters can be changed arbitrarily within the limits indicated above.

Two approaches can be used to form the SLS:

- at the signal level, i.e. directly forming some process with temporal and spectral parameters that meet the above requirements for SLS;

- at the text level, i.e. generating texts according to some specially developed algorithms, which, when voiced by means specially designed for this, give RPS.

The simplest is the formation of words using the unconditional probabilities of the occurrence of letters and spaces in the texts of the simulated language (see Table 1). The advantage of this method is the automatic splitting of the generated text into words by spaces that appear with a probability of 0.175.

Another way to form SLS is the synthesis of words based on the probabilities of the occurrence of various syllables. This takes into account the difference in the probabilities of the appearance of a given syllable with different numbers of other syllables preceding it in the word. To distinguish the syllables themselves, it is advisable to use the following assumptions:

a) it is assumed that there is one vowel in one syllable;

b) a syllable can consist of only one vowel;

c) a syllable ends with a vowel;

d) consonants at the end of the word, remaining after the formation of syllables, taking into account the first three assumptions, are considered a separate syllable.

After the formation of sequences of sounds or letters by any of the methods discussed above, it is necessary to obtain an analog representation of the RPS. To do this, in modern computers, there are a number of methods and algorithms that differ in complexity and requirements for computer memory. A subjective assessment of examples of texts formed to generate RPS can be obtained by reading them aloud. Comparative analysis of various methods of RPS synthesis is beyond the scope of this report. The current state of development of the formation and use of speech-like signals, having a probabilistic nature, indicates that they can be used to protect voice messages in communication channels by masking the gaps between transmission sessions, as noisy signals in audio systems for protecting information from leakage through acoustic channels.

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