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Lie Detection System with Voice Using Bidirectional Associative Memory Algorithm

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Abstract - Lie detection through voice can be detected using the algorithm bidirectional associative memory. This system is a branch of sound processing that can be used to identify the type of sound lies use some verbs like go, roads and move. This study uses an algorithm bidirectional associative memory for the process and the introduction of lie detection training through the sound use of bidirectional associative memory. The system was tested by simulating the training data and test data to generate a percentage of voice recognition and classification of these lies. Experiments performed with several changes in parameter values to obtain the best percentage of recognition and classification. The highest level of recognition contained in the verb "go" with up to 90%. Results of this research is a sound that indicated not indicated lies and deceit in the form of values are classified according to the type of sound that is known from the results of calculations of energy use bidirectional associative memory.

***Keywords* - Bidirectional Associative Memory, Lie, Voice.**

1. Introduction

Voice is a physical phenomenon generated by the vibration of an object in the form of analog signals with amplitude changes continuously with time. Voice is a wave that contains a number of parameters (amplitude, deviation, frequency, spectrum) which can lead to voice different from one another voice. In the development of today's media man voice very much used both in the field of technology or not, and the current sound development in the field of technology is very important. Many convenience offered to meet the interests of human and computer interaction, for example, in speech recognition. For humans recognize human voice is easy because humans have a very good introduction pattern. While on this computer is a difficult process because the computer must analyze in detail each incoming sound signals. Lie often involves telling a false story that makes people not to believe. Most research has focused on identifying those lies through nonverbal cues or physiological activity. The project is currently investigating a style that distinguishes between real and false stories. In an analysis of five independent samples, computer-based text analysis program correctly classified liar and the truth of the story at a rate of 67% when the topic was constant and the rate of 61% overall. Because of the multitude of people who tell lies in order to make us know how to do such scams. So that fraud can be seen from several elements:

a. Facial expressions
b. Behavior
c. Style language (verb).

Because a person tends to pay attention to facial expressions and behavior in normal interaction, then the fraudster aware of this fact and be careful to control the expression and their behavior, making the face and body are relatively poor impostor scams. And otherwise change the tone of voice received less attention in the normal interaction, fraudsters less attention to and control of this kind that makes the interrogators tend to create new ways of researching fraud. Method of bidirectional associative memory (BAM) has been widely used in various fields, especially in the neural network. BAM is able to extract a perfect shape of the shape is not perfect, it is one of the capabilities possessed by humans.

2. Literature Review

2.1. Voice Signal

a. Signal

Signals are physical quantities that change according to time, space, or other independent variables. Examples signals: speech signal, ECG, and EEG. Mathematically, the signal is a function of one or more independent variables. This process is done through modeling signal.

The signal is the phenomenon of measurable environmental or quantized, while the system is part of the environment that connects the signal with other signals or in other words to respond to incoming signals by producing output signals. Voice conversation is an example of a signal while telephone communication system it self is an example of a system that connects signals talks.

b. Voice

Voice is a physical phenomenon generated by the vibration of an object in the form of analog signals with amplitude changes continuously with time. Voice is a wave that contains a number of parameters (amplitude, deviation, frequency, spectrum) which can lead to Voice different from one another voice.

c. Voice Processing

Speech resulting from a collaboration between the lungs (pulmonary), glottis (the vocal cords) and articulation tract (mouth and nose cavity or nasal cavity). To generate a voiced sounds (speech sounds), lungs compressing air through the epiglottis, vocal cords vibrate, menginterupt air through air flow and menghassilkan a quasi-periodic pressure wave.

2.2. Frequency Concept

Most of these natural signals in analog form. To obtain a discrete signal from an analog signal to do a process called sampling. In mathematics, the sampling process is expressed by equation. Analog signal has various types, described here only for periodic signals or uniform are generally widely used in practice.

$x(n) = x_a(nT) = x(t)|t = Ts$, for $-\infty < n < \infty$ (n=integer)
where:
$x(t)$ = analog signal
$x(n)$ = discrete-time signal
$x_a(nT)$ = analog signals are sampled every period Ts

Where:
Ts = sampling time
Fs = 1/Ts, *sampling rates*

In General : $\int = \frac{F}{Fs}$

Where:
$\int$ = normalized frequency
F = information frequency
Fs = sampling frequency
To avoid frequency aliasing, the size of the smallest sampling frequency should be twice the maximum frequency of the signal information. This Nquist criteria. The correlation can be seen below:
$F_s > 2\, F_{max\ (information\ signal)}$
A sinusoidal signal can be expressed by $x(t) = A \sin \Omega_0 t$
Analog sine signal can be expressed mathematically as follows:

$$x(t) = A \sin(\Omega t+\theta)$$
$$= A \sin(2\pi f+\theta)$$
$$\text{with } \Omega = 2\pi f$$

Discrete sine signal can be expressed mathematically as follows:

$$x(n) = A \sin(w_n+\theta) \quad ,$$
$$\text{where} w_n = 2\pi f/f_s = 2\pi f_n$$
$$= A \sin(2\pi f_n+\theta)$$

Where n is an integer, the value of n states nth sampling. A discrete signal with period N can be expressed by:

$\int = \frac{N}{n}$ or $\frac{N}{n}$,

where/k = integer.
Angular Frequency $\Omega_0 = 2\pi f_0 = \frac{2\pi}{To}$ rad/sec

Period $T_o = \frac{1}{F_0} = \frac{2\pi}{\Omega o}$ sec
Frequency $F_0 = \frac{1}{T_0} = \frac{\Omega o}{2\pi}$ Hz
Digital Frequency $w_0 = 2\pi \frac{F_0}{Fs}$ rad $= \Omega_0 T_s$
Nquist = $F_s > 2F_{information}$

2.3. Lie

Lying often involves telling a good story false or do not believe that individual. Most research has focused on the identification of such lies through nonverbal cues or physiological activity. This project investigates the style of language that distinguishes between right and wrong story. In the analysis of five independent samples, computer-based text analysis program correctly classified liars and truth-tellers at a rate of 67% when the topic was constant and the rate of 61% overall. Compared with the truth-teller, a liar used fewer self-references, other-reference, and exclusive words and more "negative emotion" and "motion" word.

No mortal can keep a secret. If lips silent, he chatters with his fingertips; betrayal oozes out of him at every pore. Fraud is not an easy task. Deceiver might be careful to try to structure what they say, just to give everything away by how they say it-by their tone of voice, body language or facial expressions. A large body of research has examined these nonverbal channels to determine which are most predictive of fraud. Despite the fact that the message

deceive require manipulation of linguistic content, relatively little attention has been devoted to the pattern of deceptive use of language in communication.

Lying is a complex cognitive effort. Based on previous studies of emotional writing, one would assume that a liar will have more difficulty making a difference in their stories. From a cognitive perspective, the truth-teller is more likely to tell about what they do and what they did not do. That is, they make a distinction between what is in the category of their stories and what not. Many strategies to detect fraud operates under the assumption that the individual proof of increased anxiety when lying, and that the signs of this passion will leak out through one or more communication channels. This assumption is consistent with research on self-control, which shows that people have a limited ability to control their behavior. When people try to deceive others, some clues as possible to their concerns and their deception must be controlled at the same time. However, people do not have the necessary resources to monitor all possible channels of communication. As a result, fraudsters must strive to control a small number of channels.

Liars use verbs of motion, such as "running," moving, "and" go "at a higher level than the truth-teller. This is a specific marker of deception has no precedent in the literature, and although it is a significant predictor, we hesitate to interpret them. Liars may have used this verb on a higher level because they speak in general. However, future research should investigate the predictive power of the words of the motion before firm conclusions can be drawn.

2.4. Bidirectional Accosiative Memory

Bidirectional Associative Memory (BAM) neural network model has two layers and connected completely from every other layer. That is, there is a feedback connection from the output layer to the input layer. However, the weight of the connection between two neurons is given of the various layers of the same. You might even consider to be a single two-way relationship with a single weight. Weighting matrix for connection of the output layer to the input layer simply transpose of the matrix weights to the relationship between the input and the output layer. If we show the matrix for connection to front weights by W, the WT is the weighting matrix for the output layer to the input layer connection. As you will recall, the transpose of the matrix obtained simply by interchanging the rows and columns of the matrix.

There are two layers of neurons, the input layer and output layer. There is no lateral connections, ie, no two neurons in the same layer are connected. Recurrent connections, which is a feedback connection to the neurons of itself, may or may not exist. This architecture is quite simple. Analog common case. Input to the network BAM is a vector of real numbers, usually in the set {-1, 1}. Output also vectors of real numbers, usually in the set {-1, 1}, with the same dimensions or different from that of the input. The vector can be considered a pattern, and the network makes heteroassociation pattern. If the output is required to be the same as the input, then you ask the network to make autoassociation, which is not, and it becomes a special case of the general activity of the type of neural network.

Step 1: The relationship between the pair pattern stored in memory in the form of bipolar binary vector with entries -1 and 1.

$\{(a^{(1)}, b^{(1)}), (a^{(2)}, b^{(2)}) \ldots\ldots (a^{(p)}, b^{(q)})\}$

Step 2: The weight is calculated by

$$W = \sum_{i=1}^{p} a^{(i)} b^{(i)t}$$

Step 3: Test vector pair a and b are given as input.

Step 4: In the forward pass, b is given as input and is calculated as

Step 5: Vector a now given as input to the second layer for backward pass.

Step 6: If there is no longer updating the process stops. If no steps 4 and 5 are repeated.

2.5. Wav

WAV is a standard audio format Microsoft and IBM's personal computer (PC), typically using a coding PCM (Pulse Code Modulation). WAV is the data is not compressed so that the entire sample audiodisimpan everything on my hard drive. Software that can create WAV from analog sound example is Windows Voice or Sound Recorder. This audio file is rarely used on the internet due to the relatively large size with a maximum limit for the WAV file is 2 GB.

2.6. Neural Network

Artificial Neural Network (ANN) is a computational engine that is designed to simulate how a biological brain or behavior in performing various tasks or specific functions. As a computing technology, ANN is an information processing technique which uses quantitative models of biological neural computing inspired the

creation of a process that is identical to the working of neurons in the human nervous system.

JST consists of processing elements called neurons, which is associated with other processing elements by a rule and weight. Generally. JST is a collection of analog signal processing are connected through a link called interconnections or connections simple. Schematically, JST digambar¬kan in the form of a graph that has a direction toward a knot of processing elements. Arrows indicate the direction of the normal direction of a flow signal. Signal processing in the network is done through a process of computing. Therefore. JST is a computational technique in software or hardware that emulates biological neurons in conducting information retrieval operation. A neuron consists of three main parts, namely the soma (the parent bodies of neurons), axon (output path from the soma) and dendrites (input path for soma). Relationship one neuron to the next neurons called synapses.

Because synapses are where one neuron relationship with the next neuron then the place was very profitable as a regulator of signal conduction. Some synapses deliver signals from one neuron to another neuron with ease, while other synapses difficult to deliver the signal. Besides some post-synaptic neurons react with a large number of impulses while others only react to some impulse alone. So synapses perform a selective action, for example by blocking the signal is weak but continuing strong signal, selects and amplifies weak signals specific and often distribute signals to various directions, not just to one direction only. JST study of samples called training set. Because the study of the samples, JST has the potential to build computing systems as a result of input and output mapping relationships that exist in the system. Training set is known as a training pattern in the form of a vector and is obtained from sources such as images, voice signals, and various other information.

2.7. Learning Neural Network

JST learning process is classified into two:
1. Learning with supervision
2. Learning without supervision

Supervised learning, the network responded by getting a specific target. Before changing the network's own weight to achieve the target download, interconnection weights initialized. JST learning process is supervised learning process by providing training to achieve a defined output targets. JST get training to recognize certain patterns. By providing a target output, input changes will be adapted by the output by changing the weight of the interconnection follow the prescribed learning algorithm. Set the training are selected from each state maximum output function parameters changed. By initializing the weight of each cell, JST will seek smallest error, so the shape of the output function approaching the desired target.

3. Research Method

Methodology lie detector system constructed in this study is illustrated in Figure 1.

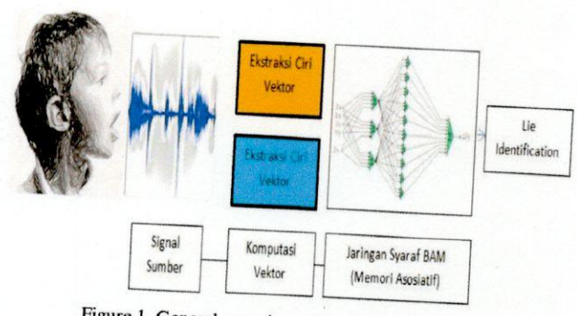

Figure 1. General overview of the methodology.

The stages were carried out after the actor or the voice source is a signal feature extraction stage vector or vector computing, then testing voice recognition through BAM neural networks and will ultimately result in the identification of lies.

4. Result and Discussion

In the design process of computer-based systems, problem analysis plays an important role in making the details of the application to be developed, the analysis of the problem is a step in understanding the issue before taking any action or decision final settlement. System analysis aims to identify the problems that exist in the system, in which applications built include the operating environment, the user and associated elements. This analysis as a basis for the system design stage. The system designed in this study of a lie-detector system in which the system can detect lies someone memalui verb pronounced. Sample the lie is taken from several interviews in which every sentence containing verbs such as go, move around and there is a tendency can be detected someone is lying or not.

4.1. Voice System Training

Voice training samples used in this study amounted to 5 samples each voice representing verbs such as moving, road and go.

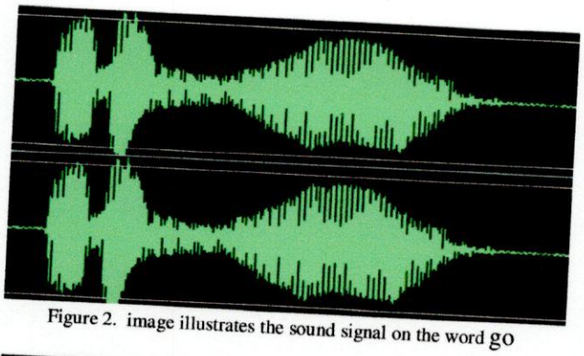

Figure 2. image illustrates the sound signal on the word go

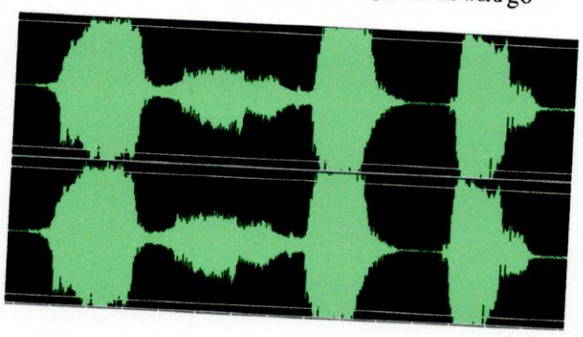

Figure 3. Image illustrates the sound signal on said moving

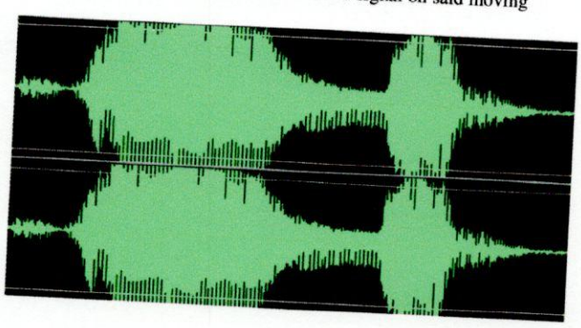

Figure 4. Image illustrates the sound signal on said road

4.2. Performance Measurement System Lie Detector

Performance measurement system is done by gradual exercise. At the sound of the voice signal contains a few who are able to be detected using the verb to be moving like move, go and roads. Lie detector system has a level of accuracy of the word go 90%. Table 13.1, 13.2, 13.3 illustrates some results pegukuran lie detection system performance. Results of the evaluation showed that the system Detection Rate increase is strongly associated with an increased amount of training. The system uses the verb lie detector street have a level of accuracy of 82%. And the verb move has the accuracy of 70% when using the verb move. Table 13.1, 13.2 and 13.3 illustrate some performance measurement results lie detection system.

Table 1. The results of the lie detector system performance "go".

Total Voice Training	Total Voice Testing	Total Detection is True	Detection Rate
5	10	6	0,6
10	10	7	0,7
15	10	8	0,8
20	10	9	0,9

Table 2. The results of the lie detector system performance "street".

Total Voice Training	Total Voice Testing	Total Detection is True	Detection Rate
5	10	5	0,5
10	10	6	0,6
15	10	7	0,7
20	10	8	0,8

Table 3. The results of the lie detector system performance "street".

Total Voice Training	Total Voice Testing	Total Detection is True	Detection Rate
5	10	3	0,5
10	10	6	0,59
15	10	5	0,69
20	10	7	0,7

At the voice of the sentence containing the containing the verb go, road and move having different accuracy of complex background, testing is done each for voice without voice orientation and orientations.

5. Conclusion

The conclusions of this study are as follows:

a. Bidirectional associative memory can be used for lie detection through voice.
b. Tests conducted on samples outside the training resulted in the recognition rate of 90%.
c. The highest level of recognition contained in the verb "go" with up to 90%.

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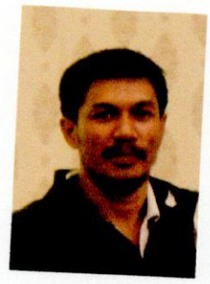

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