Performance of BAM algorithm and Viterbi algorithm for lie detection system using voice

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Abstract. Lie detection systems using voice can be detected using the Bidirectional Associative Memory (BAM) algorithm. However, the accuracy of the system by using BAM is still low, where the true detection results obtained show a small percentage and this is also influenced by the number of training voice samples. In this study, the authors propose solutions using the Viterbi algorithm in detecting lies through sound. This research carried out the process of introducing and training lie voice samples on the word go, walk and move and then tested by simulating it in the exercise data and test data to generate the percentage of recognition and classification of the voice of the lie. The results showed that the lam detection system using the BAM algorithm has a true detection range of 67% for the word go, 72% on the word walk and 69% on the word moved. While using the Viterbi algorithm has a true detection range of 92% on the word go, 90% on the word path and 88% on the word moved. The results of this study show that Viterbi algorithm is quite effective applied to voice recognition system, can be seen from the relatively good level of accuracy and the use of low memory resources.

1. Introduction
Compared to an honest person, the liar shows a lower cognitive complexity, less use of self-references and other references, and uses more negative emotional words. His research shows that liars can be identified by their words, not about what they say but how they say it [1].

In voice recognition technology used Hidden Markov Models method to recognize sound. HMM uses the concept of statistics and probabilities [2]. In the Bidirectional Associative Memory (BAM) algorithm as a neural network, the model has the advantage of being able to process incomplete input or input with noise. The BAM's weakness lies in its very small memory capacity[3].

In previous research, the lie detector system through sound using the BAM algorithm still has a low level of accuracy. In this study, the authors want to compare the performance of both algorithms based on some parameter value changes to get the best percentage of recognition and classification.

2. Theories
2.1. Voice Recognition
Voice recognition (also known as Automatic Speech Recognition (ASR), or computer voice recognition is the process of converting voice signals to word order, through algorithms that are implemented into computer programs [4].

2.2. Sampling
In sampling process will be taken some sample data from the analog signal. Each sample will represent a value where the position of the graph movement at a certain time. The value of the sampling result is entered into the function:

\[ g(t) = n \] (1)

2.3. Frequency
In mathematics, the sampling process is expressed by equations. The Analog signals have various types, described here only for periodic or uniform signals are generally widely used in practice.

\[ x(n) = x_a(nT) = x(t)|t = Ts, \text{for } -\infty < n < \infty \text{ (n=integer)} \]

In generally:

\[ f = \frac{F}{F_s} \] (2)

2.4. Lie
Liars may lack the ability, motivation, emotion, confidence, or the ability to create spontaneous expressiveness or manage conscious behavior [5].

2.5. Artificial Neural Network
Artificial Neural Network (ANN) is a computational machine that is designed to simulate how the biological brain or behavior in performing various tasks or specific functions.

2.6. Bidirectional Associative Memory (BAM) Algorithm
The BAM model has a neural network of two layers and is fully connected to every other layer. That is, there is a mutual relationship between from the output layer to the input layer [6]. Artificial Neural Network (JST) Bidirectional Associative Memory (BAM) has the ability as associative memory or content addressable memory is a memory that can be called using part of the information stored in it [7].

The input of the BAM network is a vector of real numbers, usually in the set \{-1, 1\}. The output is also a vector of a real number, usually in the set \{-1, 1\}, with dimensions equal to or different from the input. Weight is calculated by:

\[ W = \sum_{i=1}^{p} a^{(i)} b^{(i)t} \] (3)

2.7. Viterbi Algorithm
The Viterbi algorithm was introduced by Andrew J. Viterbi in 1967. The Viterbi algorithm is a dynamic programming algorithm to find the possibility of hidden status sequences (commonly called Viterbi paths) generated in the event observation sequence. To find the best status sequence, q = (q1, q2, ...... qr), for the observation circuit O = (O1, O2, ......... Or), it is necessary to define the quantity:

\[ \delta t(i) = \max P[q1, q2, ... qt-1, qt=i, O1q1, q2....qt-1 o2....ot | \lambda] \] (4)

3. The Scheme of System
The scheme of this study is divided into several stages, which are described in the following:
The stages performed after the actor issued a verb or signal source is the vector computation or vector computation extraction steps to calculate the resulting sound signal value, then perform the calculations using the Bidirectional Associative Memory (BAM) algorithm and the Viterbi algorithm. In the main process Viterbi algorithm, computations using Mellin transformations, sound samples will be trained to derive an energy value and segment value, which is then used as a value in the Viterbi algorithm.

3.2. Bidirectional Associative Memory (BAM)
Flowchart for BAM are developed based on Figure 2:

![Flowchart for BAM](image)

**Figure 2.** Flowchart proses Bidirectional Associative Memory (BAM)
3.3. Viterbi

Flowchart for Viterbi are developed based on Figure 3:

![Flowchart Viterbi process](image)

**Figure 3.** Flowchart Viterbi process

4. User Interface

4.1 The Test Result

The image below shows the results of testing a lie detector system using the Bidirectional Associative Memory (BAM) algorithm.

![Testing lies in words away with the BAM algorithm produces a lie voice](image)

**Figure 4.** Testing lies in words away with the BAM algorithm produces a lie voice
After the training on a number of sound samples, then conducted the testing process for the introduction of each type of sound that there are words go, walk and move. This stage serves as the output and climax of the whole process. From these calculations, the energy value is obtained to facilitate the introduction of lie sound types from some lie sound samples trained input into the system. Furthermore, these values will be processed in order to obtain results that indicate the success rate of recognition of lie type sound.

Figure 5. Testing lies in words away with the Viterbi algorithm produces a lie voice

Table 1. Detection rate overall on BAM algorithm and Viterbi algorithm

| No | Words | Sampliing Training | Sampling Testing | Detection Rate |
|----|-------|--------------------|------------------|----------------|
|    |       |                    |                  | BAM           | Viterbi  |
| 1  | GO    | 3                  | 100              | 66%           | 65%      |
|    |       | 5                  | 100              | 67%           | 82%      |
|    |       | 10                 | 100              | 62%           | 86%      |
|    |       | 15                 | 100              | 57%           | 92%      |
| 2  | WALK  | 3                  | 100              | 68%           | 67%      |
|    |       | 5                  | 100              | 72%           | 85%      |
|    |       | 10                 | 100              | 60%           | 89%      |
|    |       | 15                 | 100              | 61%           | 90%      |
| 3  | MOVED | 3                  | 100              | 60%           | 70%      |
|    |       | 5                  | 100              | 69%           | 79%      |
|    |       | 10                 | 100              | 67%           | 84%      |
|    |       | 15                 | 100              | 65%           | 88%      |

Based on the table 1, it can be concluded that the level of accuracy obtained by using the BAM algorithm successfully detected based on 100 test samples from the word go by 66% with 3 training voice samples, 67% with 5 training voice samples, 62% with 10 training voice samples and 57% with 15 vocational training samples. On the road word of 68% with 3 training voice samples, 72% with 5 training voice samples, 66% with 10 training voice samples and 61% with 15 training voice samples. In 60% of the word moved with 3 training
voice samples, 69% with 5 training voice samples, 67% with 10 vocational training samples and 65% with 15 vocal training samples.

While the accuracy level obtained by using Viterbi algorithm was successfully detected based on 100 test samples from the word go by 65% with 3 samples of training voice, 82% with 5 sample of training voice, 86% with 10 sample of training voice and 92% with 15 sample votes training. On the road word of 67% with 3 vocational training samples, 85% with 5 training voice samples, 89% with 10 training voice samples and 90% with 15 training voice samples. In 70% of the word moved with 3 vocational training samples, 79% with 5 training voice samples, 84% with 10 vocational training samples and 88% with 15 vocal training samples.

5. Conclusions
The conclusions of this study are as follows:

- The results showed that the lie detection system using the Bidirectional Associative Memory (BAM) algorithm has a true detection range of 67% on the word go, 72% on the word path and 69% on the word moved. While using the Viterbi algorithm has a true detection range of 92% on the word go, 90% on the word path and 88% on the word moved.
- The true detection percentage indicates that the Bidirectional Associative Memory (BAM) algorithm and the Viterbi algorithm can be used as one of the approaches for lie detection by voice. Viterbi algorithm is able to show more optimal results in detecting lies than BAM algorithm.
- Based on the tests that have been done in the previous chapter, it can be concluded that the performance of detection rate system is strongly influenced by the amount of lie voice training.

6. References
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