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Ameliorating the image matching algorithm of Sikuli using Artificial Neural Networks

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Abstract: Testing an application prior to its release has always been the most important step in the software development lifecycle. Various tools and techniques are available for the same in the market nowadays. But every tool comes with some problems along with the advantages over other tools. Sikuli is one among that long list of software testing tools available. Sikuli permits the user to take a screenshot of a GUI element and interrogate the system using a screenshot rather than using the element's name. The problem was encountered when a change occurred in colors, fonts and desktop backgrounds posing challenges to screenshot search engine in image matching. In this paper, an improved image matching algorithm for Sikuli testing tool has been proposed which overcomes the problem encountered in the actual tool while running test scripts. In this algorithm we used Artificial Neural Network which imitates the learning process of the human brain which makes it one of the most efficient techniques in image tallying.

Keywords: Grayscale; Neural Network; Automation testing; Manual testing; Sikuli IDE; Test script

I. INTRODUCTION

Most of the software applications today are written as web-based applications. In an era of highly interactive and responsive software processes, automated testing i.e. using a software tool to run repeatable tests is becoming an important requirement for software projects. Sikuli is one of the widely used tools in this field. This tool tests graphical user interfaces using images. There are several drawbacks of this tool which will be discussed in the paper. An improved image matching algorithm has been proposed which will remove one disadvantage of this tool and hence enhance the functionality of the tool.

II. MOTIVATION

The increasing demand for delivering reliable and quality software within the constraints of schedules and budgets is the reason for emerging popularity of software testing. Testing can be done either manually or automatically but automation testing has several advantages over the manual testing technique.

Various advantages of automation testing over manual testing include:

- Manual tests take more effort and cost.
- Automated tests are reusable.
- Automated tests ensure that you do not miss any test.
- Manual testing ends up being an integration test while automated tests have varying scopes (one can test a unit, a module or a complete system).

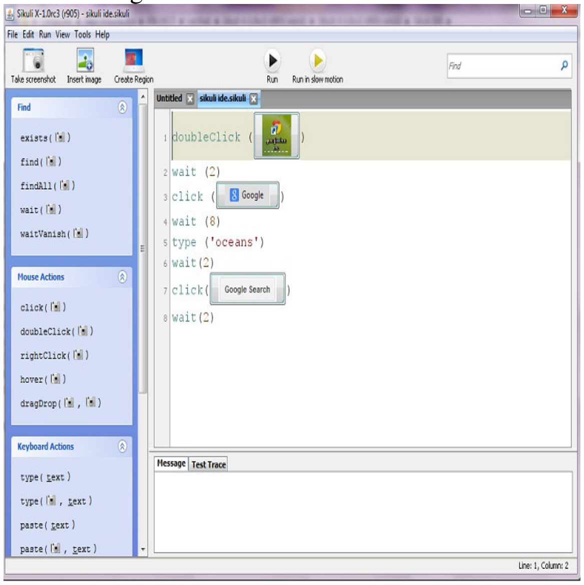
This demand for delivering a quality product in market after testing it thoroughly through automated testing tool motivated us to enhance the existing tool.

III. BACKGROUND

A. Sikuli Testing Tool

Sikuli is a visual testing tool dedicated to search and automation of graphical user interfaces using screenshots. It permits the user to take a screenshot of a GUI element (such as a toolbar button, icon, or dialog box) and interrogate the system using a screenshot rather than using the element's name. It provides a visual scripting interface for automating GUI interactions, using screenshots to direct mouse and keyboard events. [4]

Sikuli includes an integrated development environment (IDE) for writing visual Sikuli scripts with screenshots. The figure shown below is an example of a test script written using Sikuli IDE.



```
doubleClick ( )
wait (2)
click ( Google )
wait (8)
type ('oceans')
wait(2)
click( Google Search )
wait(2)
```

Figure 1. Sikuli IDE

This small test script helped in discovering a few drawbacks of Sikuli testing tool which are discussed in the next section of the paper.

IV. PROBLEMS ENCOUNTERED

- The problem encountered is that Sikuli screenshot search engine couldn't match the Google chrome icon due to the change in the desktop wallpaper timely. Therefore the first drawback of Sikuli is: change in background color and appearance pose challenges to a screenshot search engine. This makes sharing of scripts a difficult task.
- Sikuli script operates only in the visible screen space and does not work on invisible GUI elements, such as those hidden beneath other windows, in another tab, or scrolled out of view. [4]

In this paper, we are proposing a method to remove the first problem mentioned above.

V. PROPOSED TECHNIQUE

The technique which we have used to solve the encountered problem is Artificial Neural Network that is based exactly on the functionality of our brain. Our brain can easily recognize the similarity between two images even if a few changes like change in the color or appearance of background has been done. If the image matching in Sikuli is done using this technique, the test script will run properly without posing any problems when run in different environments. Therefore we decided to use this technique for image matching.

A. Neural Network

A neural network (NN) is a tool which can represent complex input/output relationships. Neural network can perform intelligent tasks like human brain. There exist several similarities between NN and our brain. A few of them are listed below:

- A neural network acquires knowledge through learning.
- Inter-neuron connection strengths store the NN's knowledge and are referred to as synaptic weight.

B. Biological neural networks

A neuron is a biological cell that processes information. A neuron receives signals from other neurons by its dendrites (receivers) and transmits signals along the axon (transmitter). A synapse is the functional unit between two neurons (an axon strand of one neuron and a dendrite of another). When the impulse reaches the synapse's terminal, certain chemicals called neurotransmitters are released. The neurotransmitters diffuse across the synaptic gap, to enhance or inhibit, depending on the type of the synapse, the receptor neuron's own tendency to emit electrical impulses. The synapse's effectiveness can be adjusted by the signals passing through it so that the synapses can learn from the activities in which they participate. This dependence on history acts as a memory, which is possibly responsible for human memory.

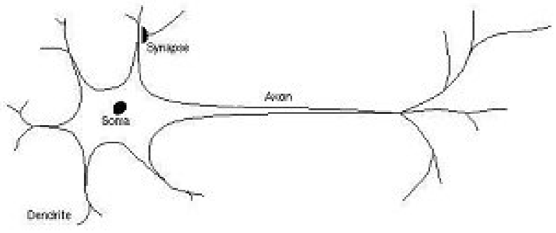


Figure 2. Biological Neuron

C. Artificial Neural Networks

The concept of biological neurons is directly transferred to artificial neural networks. Artificial neural networks consist of various neurons. Neurons receive information from the neurons of previous layer and pass it on further. The strength of the connection between the neurons is corresponded by a weight value and this value stores the knowledge of the neural network. The learning procedure of a neural network is determined by its change of weight values between the neurons. The change of weight values depends on the used learning rule. We will use Back propagation algorithm for adjusting the weights.

D. Back Propagation Algorithm

This algorithm is an iterative process which is divided into three steps. In the first step, computed values for each input are propagated through the network. In the second step, error is calculated by comparing the actual output value with the desired output value. Lastly, error is propagated backwards and the weights are adjusted. This process continues until the error is below a specified value or another exit condition (e.g. number of learning iterations) is reached.

The proposed technique can be explained through the following steps:

1.) First, the image is converted into grayscale. A grayscale digital image is the one which carries only the intensity information for each pixel. There exist several algorithms like lightness method, average method, luminosity method etc. to convert an image into grayscale. Our algorithm uses luminosity method as this algorithm accounts for human perception. An image is converted into grayscale due to the following advantages:

- It saves processing time by resizing images, analyzing only portions of images, and eliminating color channels one doesn't need.
- It converts each pixel to just one number which can then be used as one input to the network.

2.) These pixel values act as input patterns for the neural network.

3.) Further Back Propagation Algorithm is used for the purpose of learning.It uses controlled learning, which means that we provide the algorithm with examples of the inputs and outputs we want the network to calculate, and then the error (difference between actual and expected results) is computed. The idea of the back propagation algorithm is to minimize this error, until the ANN learns the training data. The training begins with random weights, and the goal is to minimize the error by adjusting those random weights. [12]

VI. PROPOSED ALGORITHM

1.) Convert the image into grayscale using luminosity method. This method accounts for human perception. Human eyes are more sensitive to green than other colors, so green is weighted most heavily. The formula is :

$$0.21R+0.71G+0.07B \qquad (1)$$

Where,
R: Red
G: Green
B: Blue

2.) The pixel values obtained in the previous step are the input patterns for the ANN.

3.) The activation function 'A' of the artificial neurons in ANNs implementing the back propagation algorithm is:

$$A_j (x, w) = \sum_{i=0}^{n} (x_i * w_{ji}) \qquad (2)$$

The sum of the inputs 'x' ('x' represents pixel values) multiplied by their respective weights 'w'.

4.) In this step, we calculate the actual output 'O'. The most common output function is the sigmoidal function:

$$O_j (x, w) = 1/ (1+e^{Ai(x,\, w)}) \qquad (3)$$

5.) Next the neural network is trained with the help of error function. The goal of the training process is to obtain a desired output when certain inputs are given. Error function can be defined as:

$$E_j (x, w, d) = (O_j (x, w) - d_j)^2 \qquad (4)$$

6.) Now we calculate how the error depends on the output, inputs, and weights. Once this relationship is found, we can adjust the weights using gradient descendent:

$$\Delta w_{ji} = -2\text{ŋ} (O_j - d_j) O_j (1-O_j) x_i \qquad (5)$$

Where 'ŋ' is a constant. [12]

7.) This whole process is repeated unless output is very close to the desired target.

8.) Compare the image to be matched with the output of the neural network to calculate the matching percentage.

VII. REFERENCES

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