An Investigation for Determining the Optimum Value for Fast Transition Detection in Lightning Strike

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ABSTRACT – A study about an investigation for determining the optimum value for fast transition detection in lightning strike. This study was a part of the initiation to create a system which could identify and calculate some parameters in lightning strike automatically. There were 41 data were tested with 100 until 250 samples time of interval to find the most optimum value for fast transition detection. The most optimum value for fast transition detection was 210 samples of time interval and 0.5 normalized amplitude. The values of fast transition also higher compared with previous researches.

1. INTRODUCTION

One of the characteristics in lightning is the value of the fast transition. Jerauld, J., (2007) suggested fast transition is assumed to propagate vertically up the channel from the ground level without distortion or attenuation [1] as shown in Figure 1. Slow front is followed by a fast transition. Fast transition measured from the 10% to 90% of the peak return stroke of the lightning strike [2]. This study has created software capable to read fast transition value but the problem is there was no optimum value is known until today. An optimum value from this study is expected to produce result with high accuracy. These values are the samples time of interval and normalized amplitude. Both values were needed to be installed in the software algorithm to calculate the fast transition to produce more accurate and reliable results.

The result from previous researchers [3] produced the fast transition values ranging from 2.96μs to 8.91μs. Other researchers found values of the fast transition were in the range between 0.28μs to 4.6μs [4]. On the other hand, these fast transition values were much higher compared to Weidman and Krider [5] and Cooray and Lundquist [6] which were in the range 0.2μs and 0.1μs respectively.

At the end of this paper, all the results were discussed. This study focused only on how to find the best values to serve the software to detect the fast transition of the lightning strike. Figure 1 below shows the characteristics in the lightning strike. The red circle is the fast transition phase in the lightning strike.

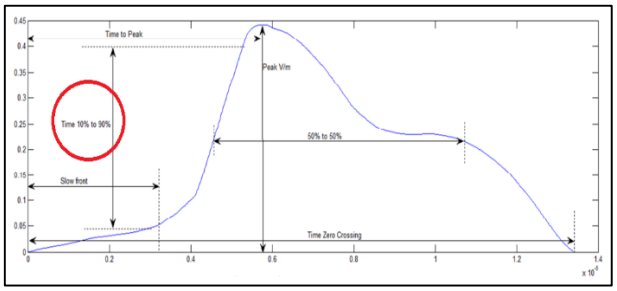

Figure 1: 10% to 90% Fast Transition (Adapted from S.N.M Arshad, (2014)).

2. METHODOLOGY

This section provides a method to find the optimum value for the fast transition detection. This study has created software to calculate the fast transition. The sampling method was used to find the optimum value in this study. The number of samples was tabulated in Table 1. The amplitudes were normalized to 1. The normalized amplitude was initially set to 0.5. This is because the normalized amplitude for the return stroke must be greater than 0.5. This action was taken to prevent failure in the system in which the system could misidentify preliminary breakdown pulses as the first return stroke if the normalized value was set below 0.5.

The sample time of interval was set from 100 until 250 samples time of interval. The value of the sample time of interval placed in the algorithm.

The study observed all the results produced based on the sample time of interval from 100 until 250 respectively. The accuracy of the result based on the number of correct fast transition detection lies in the graph. Examples of the results are shown in Figure 2 and Figure 3. Both figures are showing the graphs with 0.5 normalized amplitude with different samples. Figure 2 is showing the accurate fast transition detection with 210 samples time of interval while Figure 3 is showing false detection with 250 samples. The result and discussion were discussed in the next section.

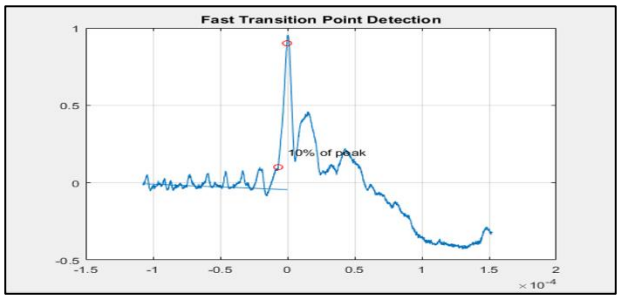

Figure 2: Accurate Fast Transition Detection with 210 samples time of interval (Both red dotted lie in the first return stroke).

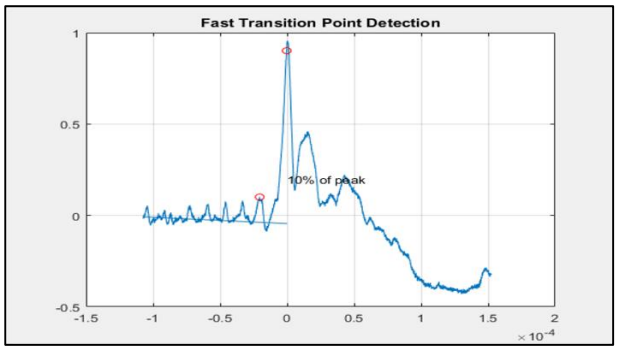

Figure 3: False Fast Transition Detection with 250 samples time of interval (The first red dotted lies outside the first return stroke).

3. RESULT AND DISCUSSION

The results from this study are discussed in this section. The results are tabulated in Table 1. From the experiment, the samples time of interval from 100 until 190 failed the test. When 200 sample of time interval was tested, the result showed the experiment succeeded with all 41 data passed the experiment. Then the experiment continued until 250 sample of time interval**.** The accuracy of the system to detect the fast transition time was recorded.

The highest accuracy belongs to 210 sample of time interval with 95% and gradually decreases as the sample time of interval increases until 250 samples. Therefore, the optimum value for fast transition detection is 210 samples time of interval with 0.5 normalized amplitude values. As for the fast transition values, this study produced the fast transitions values in the range of 3.4 µs to 19.2 µs. These values are much higher compared to previous researches [3-6].

Table 1 Result of the experiment

Sample of Time Interval	Normalized Amplitude	Result	Accuracy
100 until 190	0.5	Failed	-
200	0.5	Pass	92%
210	0.5	Pass	95%
220	0.5	Pass	87%
230	0.5	Pass	82%
240	0.5	Pass	80%
250	0.5	Pass	78%

4. CONCLUSION

This study is about an investigation to find the optimum value for the fast transition detection in lightning strike. In conclusion the study found the optimum value for the fast transition detection for 41 samples of lightning strike data. This value could be used to measure the fast transition in the lightning strike.

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