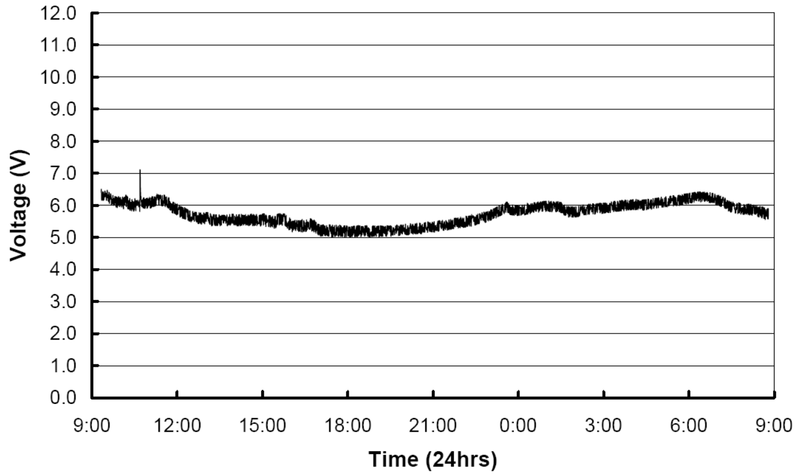
CHAPTER 5

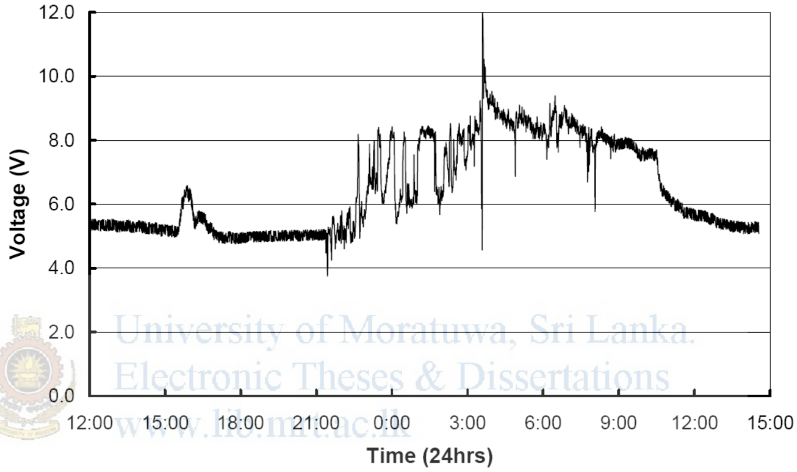
RESULTS

5.1 Observations Made with Static Field Detector

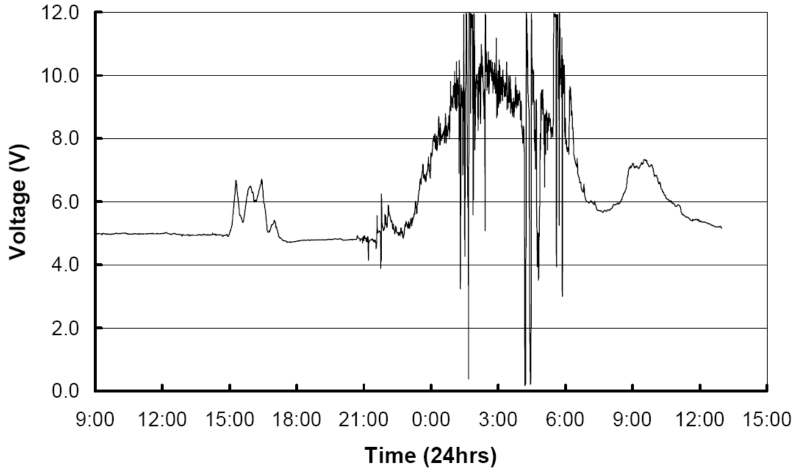
Some observations made with the static field detector with different conditions are shown in the following figures. Figure 5.1 shows the variation of the output of the device under fair weather conditions, when there is a close by thunderstorm and when there is an overhead thunderstorm.



(a)



(b)



(c)

Figure 5.1 – Observed output variation of the static field detector under different weather conditions.

(a) Under fair weather conditions (26th September 2006)

(b) When there is a close by thunderstorm (1st October 2006)

(c) When there is an overhead thunderstorm (10th October 2006)

5.2 Observations Made with the Transient Detector

In this sub section, observations made during the period of 190 days from November 8, 2006 to May 16, 2007 in three sites, Colombo, Madapatha (12/4/2007 to 16/05/2007) and Kandy (12/4/2007 to 16/05/2007) using the transient detector are discussed. Table 5.1 shows a brief of the data collection.

Table 5.1 – Observation brief made with the transient detector

Description	Number of Days
Total period	190
Total thunder days reported in all sites	65

Figure 5.2 shows the distribution of the time between the time at which the alarm was released for the first time, *i.e.* detectable cloud flashes, and beginning of the close by thunderstorm, *i.e.* ground flashes during the entire period.

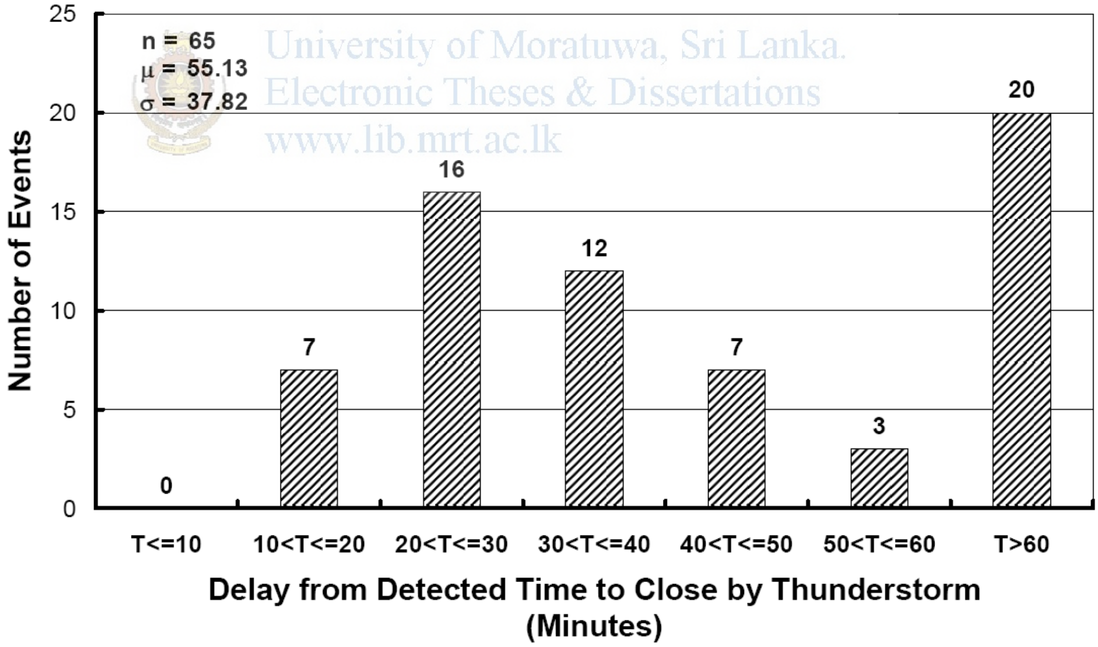


Figure 5.2 – Distribution of the time between the time at which the alarm was released for the first time and beginning of the close by thunderstorm (entire period).

Figure 5.3 shows the distribution of the same excluding the extreme delay readings observed during a low pressure system.

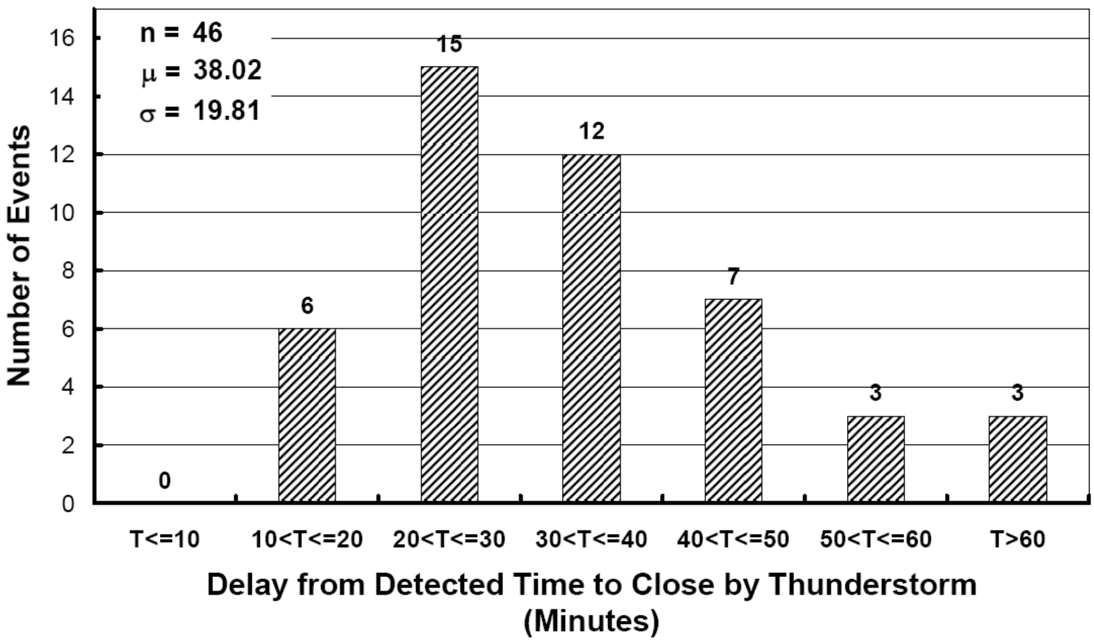


Figure 5.3 – Distribution of the time between the time at which the alarm was released for the first time and beginning of the close by thunderstorm (excluding extreme delay readings).

Figure 5.4 shows the distribution fitted to a Gaussian curve with the normal error values and goodness of the fit (a) and 95% confidence bounds for the function (b). Figure 5.5 shows the distribution fitted to a rational curve with quadratic numerator and a cubic denominator with the normal error values and goodness of the fit (a) and 95% confidence bounds for the function (b).

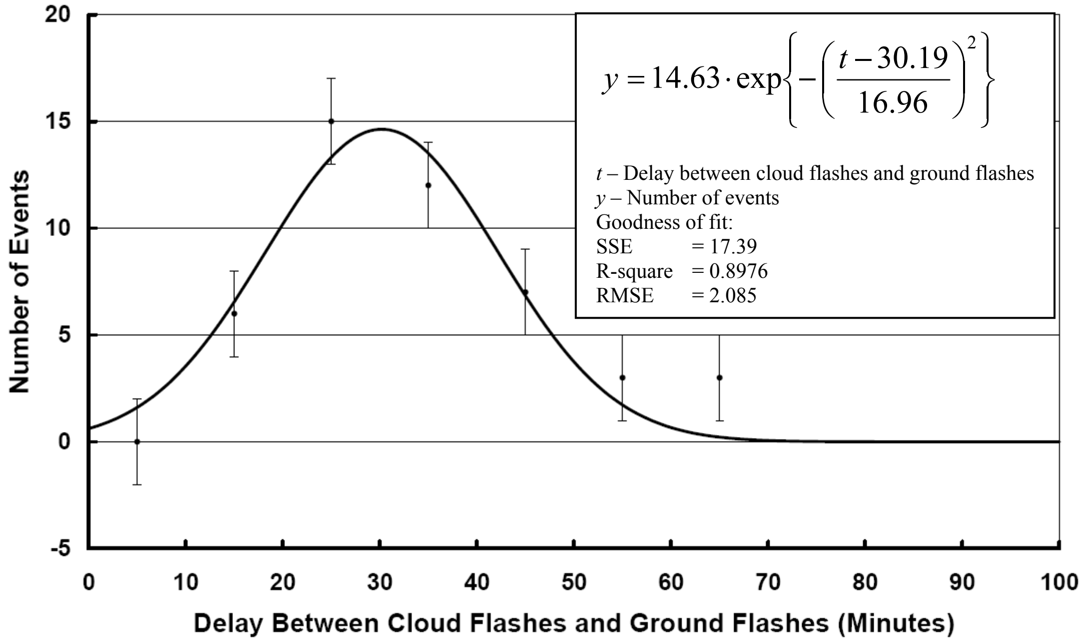
Although the 95% confidence bounds are wider for the rational fit, the parameters that give the goodness of fit, *i.e.* sum of square error (SSE), r-square value and the root mean square error (RMSE) shows that the rational fit is better than the Gaussian fit. Therefore it can be seen that the time between cloud flashes and ground flashes in Sri Lanka shows a distribution given by Equation 5.1 with a maximum at 27.52 minutes.

$$y = \frac{16.57t^2 + 4511t - 2.301\times 10^4}{t^3 - 37.4t^2 + 134.2t + 1.108\times 10^4} \qquad \textbf{(5.1)}$$

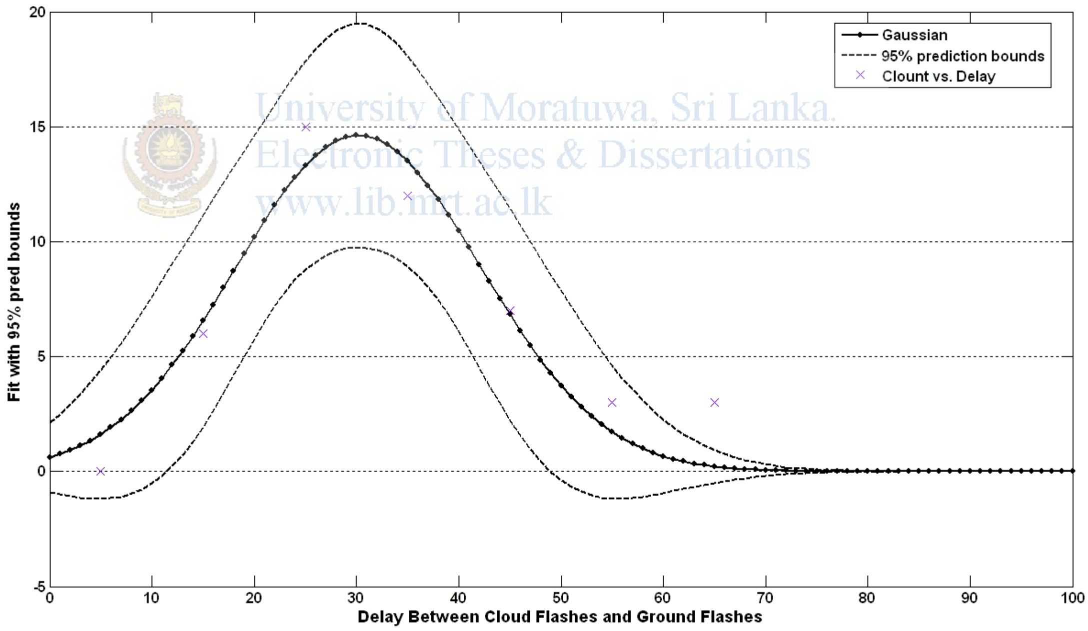
where, t – time between cloud flashes and ground flashes

y – number of events

If normal distribution is assumed, 0.95 cumulative probability occurs at 25.31 minutes. Therefore the transient detector can release a warning 25.31 minutes before the close by thunderstorm with 95% level of confidence.

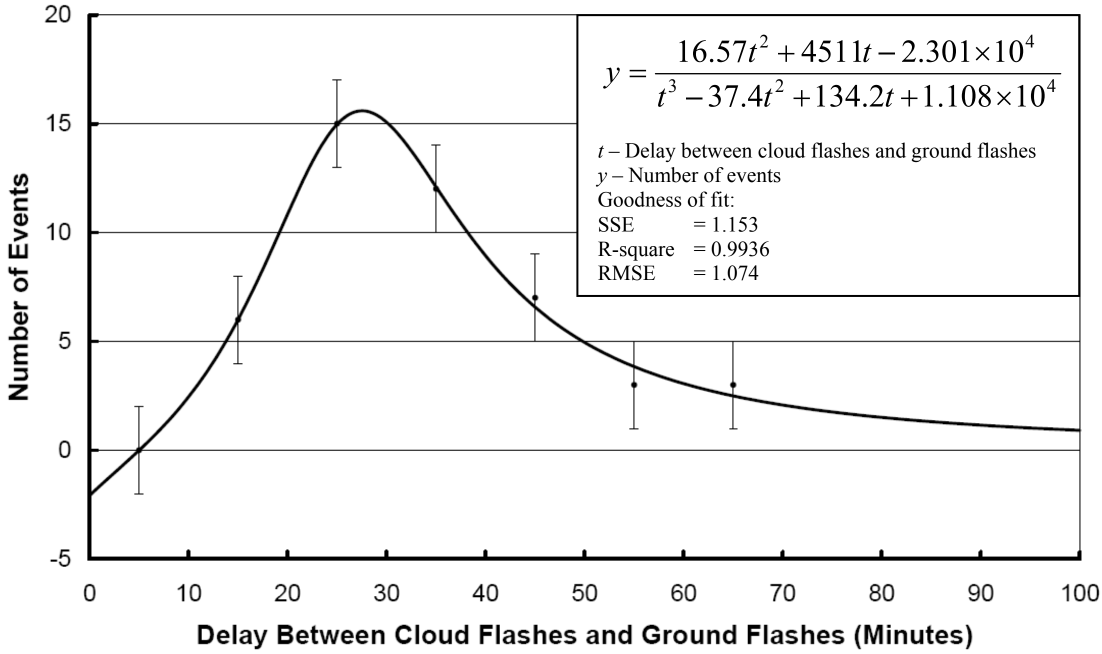


(a)

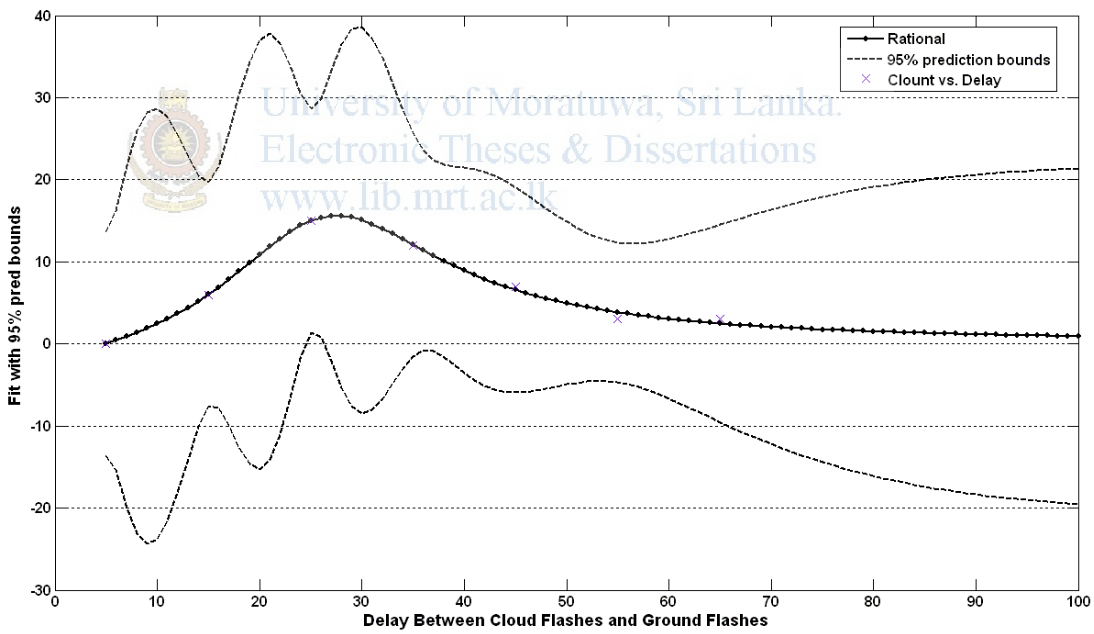


(b)

Figure 5.4 – Gaussian fit for the distribution of time between cloud flashes and ground flashes.
(a) Gaussian fit with error bars and goodness of fit
(b) Gaussian fit with 95% confidence bounds



(a)



(b)

Figure 5.5 – Rational fit for the distribution of time between cloud flashes and ground flashes.

(a) Rational fit with error bars and goodness of fit

(b) Rational fit with 95% confidence bounds

5.3 Comparison with Available Systems

The simplest lightning warning system available in the market, which can detect lightning at a distance of about 90 km away, costs about US$55 without tax, where as a hand held unit, which can detect lightning at a distance of about 60 km away, would cost about US$90 and that value is the manufacturer's price [11], [14]. Manufacture's prices for those two units in Sri Lankan Rupees are approximately Rs. 6000 and Rs. 10000 respectively. With taxes, the price would increase further. Both these units use electromagnetic radiation emitted by lightning strokes.

Similar unit costs about 15000 Sri Lankan rupees in the local market [18] and only a limited number of different products are available in Sri Lanka.

The static electric field detectors available in the market, field mills, cost about US$ 1800, *i.e.* about 200,000 Sri Lankan rupees.

The newly developed transient detector, which can predict a thunderstorm 25 minutes before the close by thunderstorm, costs about 1500 Sri Lankan rupees without rechargeable batteries and about 2500 Sri Lankan rupees with rechargeable batteries. That unit can be used as a hand held unit. The sensitivity of the transient detector can be further increased with an expense of increased false alarm probability. The entire warning system including the transient detector, static field detector, alarm unit and a battery backup, which has a further improved accuracy, costs about 5000 Sri Lankan rupees.

John Chubb and John Harbour [15] have improved the accuracy of their lightning warning system by using static electric field variation, dynamic electric field and electromagnetic noise in combination. However, as they are using a field mill to measure static electric field and a personal computer for alarm generation, the risk of direct lightning strike to the system and the cost are high.

The system designed by Fedosseeve Serghei and Samruay Sangkasaad [16] uses a computer algorithm to resolve the input signals and therefore a personal computer is incorporated. Therefore the cost of the system is very high.