

**Lightning Warning System Based on Slow Field and Fast Transient
Variations, Suitable for Oceanic Tropics**



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**Thesis submitted in partial fulfillment of the requirements of the degree of
Master in Science of the University of Moratuwa**

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DECLARATION

“I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university and to the best of my knowledge and belief it does not contain any material previously published or written or orally communicated by another person except where due reference is made in the text or in the figure captions or in the table captions”.

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To the best of our knowledge the above particulars are true and accurate.

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LIST OF ABBREVIATIONS

<u>Abbreviation</u>	<u>Description</u>
ac	Alternating current
AM	Amplitude modulation
DSO	Digital storage oscilloscope
EM	Electromagnetic
GPS	Global positioning system
HF	High frequency
IMPATS	Improved accuracy using combined technology
LDS	Lightning detection systems
LED	Light emitting diode
LF	Low frequency
LPATS	Lightning position and tracking system
MDF	Method of direction finding
MF	Medium frequency
RMSE	Root mean square error
SAFIR	Systeme de surveillance et d'alerte foudre par interferometrie radioelectriqu
SSE	Sum of square error
TOA	Time of arrival
UHF	Ultra high frequency
ULF	Ultra low frequency
VHF	Very high frequency



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ABSTRACT

Lightning causes a lot of property and human damage all over Sri Lanka. It has been a major requirement to develop a low cost lightning warning system.

The environmental vertical static electric field changes from 0.1 kVm^{-1} under fair weather conditions to extreme values like 10 kVm^{-1} under thunderstorm conditions. Also, lightning discharges generate electromagnetic radiation from ultra low frequency (ULF) through ultra high frequency (UHF) with peak energy emission at 10 kHz.

The work discussed in this thesis uses both the static field variation and the electromagnetic radiation emitted by lightning discharges to predict a thunderstorm. A portable transient detector using an envelope detector tuned to 1600 kHz is used to detect electromagnetic radiation emitted by lightning discharges. An operational amplifier circuit having a slow response with a horizontal plate antenna is used to detect the static field variation. Final decision is made by a third circuit and three levels of alarms are released accordingly.

Using the transient detector only, a warning can be released 25 minutes before the close by thunderstorm with 95% level of confidence. With the entire system, the confidence of the warning further increases.

The cost of the transient detector is about 2500 Sri Lankan rupees with a rechargeable battery bank. The entire system with a battery backup costs about 5000 Sri Lankan rupees.

According to the observations made by the transient detector the delay between cloud flashes and ground flashes shows a distribution of the form of a fractional function with a maximum at 27.52 minutes.

The newly designed lightning warning system shows an acceptable grade of performance with its low cost.