

# **Multilingual Android Forensic Tool for Cyberbullying Investigations on Facebook and Instagram**

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## Declaration

I declare that, to the best of my knowledge and belief, this paper does not contain any previously written or published material of my own or any other person, with the only exception of situations where proper referencing is provided within the text. Moreover, does not include any previously submitted material for a degree or diploma at any university without acknowledgment.

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## **Abstract**

This research project is focused on developing a CLI-based Android forensic tool for social media applications. This research project will mainly focus on two widely used social media platforms in Sri Lanka, which are Facebook and Instagram. This tool can extract data from the above-mentioned social media platforms, process the data with NLP for analyzing in Sinhala and English, detect hate speech leading to cyberbullying and cybercrimes in both languages with a keyword filtering feature, and finally provide a detailed report that can be used as digital evidence in cybercrime investigations in Sri Lanka. This is helpful in cybercrime investigations in Sri Lanka, which is vastly spreading throughout the years, victimizing the youth mainly. Moreover, this research is mostly focused on cyberbullying and harsh speech on social media, which are quite common cybercrimes in Sri Lanka at present.

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# **Chapter 1 Introduction**

## **1.1. Background study**

### **1.1.1. Usage of mobile phones in Sri Lanka**

Technology evolves rapidly daily, and Sri Lanka, being a small developing country, moves forward with the rapidly growing technology. With that, people globally are more exposed to the evolving technology trends. Electronic devices are vastly updating with new features, influencing human life making day-to-day activities easy. Mobile phones are such electronic devices, with various types and brands of mobile phones in the world. Apple, Samsung, Huawei, Pixel, Nokia, etc., are some of the mobile phone brands commonly used at present. Furthermore, there are different mobile phone operating systems used in the world, like iOS, Android, Linux, etc., and out of those, the most used operating systems are iOS and Android. However, according to the statistics, Android is leading the mobile operating systems global market share including Sri Lanka.

### **1.1.2. Usage of social media in Sri Lanka**

After the corona outbreak, people had to digitalize some of their daily work. Similarly, in Sri Lanka the corona outbreak influenced in digitalization of many fields, especially the education field, which was digitalized postponing all the exams and with the digitalization all the generations of people including children got on hold to electronic devices (Kim & De Silva., 2021.). Apart from that, people had to lock down themselves for their own safety, and with this lockdown, people used social media to build up connections, for entertainment, and to spend free time. This is a drastic turning point for social media platforms, so platforms like Facebook, WhatsApp, Instagram, TikTok, YouTube, Snapchat, etc. came into action, influencing human lives in both ways, good and bad. According to Sri Lankan statistics, the most popular social media platform is Facebook, without a doubt (Kemp, 2024). These social media platforms are advantageous in many ways, but also disadvantageous depending on the way people use it (Jayasinghe et al., 2024). The youth, especially from the ages of 18 to 35, are considered the most



active social media users but unfortunately are also the mostly targeted victims of cybercriminals, bullies, and malicious attackers.

### 1.1.3. Rise of cybercrimes in Sri Lanka

With the growth of all these technological advancements the rate of cybercrimes rise frequently twisting and influencing human life badly, one such cybercrime is cyber bullying. Using hate speech, inappropriate media, personal information to bully a person online is considered cyber bullying which is a quite common cybercrime at present. Most young adults from the age 16 to 30 are common the common targets especially the ages of 16 to 25(NapoleonCat, 2024). The cybercrime division of Sri Lanka are more active and new cybercrime laws are implemented to reduce such crime cases at present. However, with Artificial intelligence coming into frame it is hard for a country like Sri Lanka to control the number of cybercrimes but can handle a situation better than earlier with the help of the Sri Lankan cybercrime division.

## 1.2. Significance of the study

This research addresses the critical need for a cost-efficient forensic tool localized to specifically fit the unique context of Sri Lanka supporting both Sinhala and English languages. Moreover, such tool is a strong asset for the cybercrime departments of Sri Lanka to carry out strong investigation strategies and provide a better solution for the rapidly rising cybercrime rates in Sri Lanka. The tool will have a specific approach to Sinhala language which is quite unique research in the current situation for existing tool which are more expensive and does not effectively support our unique language in Sri Lanka. Furthermore, this cli tool will be simple and user friendly where the cybercrime legal officers can easily handle even with less experience on cli tools. Apart from being useful in cybercrimes the tool will contribute to creating a secure digital environment while providing valuable insights into cybercrime trends in Sri Lanka.

## **Chapter 2 Problem Statement**

### **2.1.Problem definition**

At present the rate of cybercrimes in Sri Lanka is on the rise, in which only about 30% of cybercrimes are officially reported while the rest 70% are the unreported cybercrime cases, most commonly in rural areas of the country like Monaragala(Heshan Maduranga, 2024). There are three main institutions in Sri Lanka to carry out cybercrime investigations namely Sri Lanka Computer Emergency Readiness Team (SLCERT), Computer Crime Investigation Division (CCID) and National Child Protection Authority (NCPA)(Sampath, 2023). These units carry out investigations using various forensic tools and these forensic tools are expensive. Moreover, most forensic tools are not quite efficient with the Sri Lankan mother tongue, Sinhala which is a complex language to analyze. Additionally, at present the new generation do not use the Sinhala letters to type the message in Sinhala, they use English letters to type Sinhala words according to the pronunciation of the Sinhala word, mixing both languages which is even more complex(Muthuthanthri and Smith, 2024). This situation up brings a need for a digital forensic tool to analyze, filter and detect harsh speech, cyberbullying attempts in multilingual languages with low budget specifically customized for Sri Lanka.

### **2.2.Research questions**

In this research providing a solution for this issue in Sri Lanka, we specifically hope to answer the following research questions;

- Identification of techniques for effective data extraction and analysis of social media data.
- Analysis of the social media platforms chosen to be addressed in the research and justification for the selection.

- Investigation of the cybercrimes most commonly reported on Facebook and Instagram in Sri Lanka.
- Comparison of the accuracy of the proposed tool in detecting hate speech in Sinhala and English with the existing hate speech detection systems.
- Evaluation of the effectiveness of NLP (Natural Language Processing) models in detecting cybercrime evidence in Sinhala and English.
- Optimization of the structure of the generated PDF reports to ensure clarity, usability and easy interpretation by law enforcement and legal professionals.

## **2.3.Research objectives**

### **2.3.1. Primary objectives**

The main objective of this project is to develop an Android social media forensic tool to help in detecting cybercrime evidence in both Sinhala and English tailored to unique requirements in Sri Lanka.

### **2.3.2. Other specific objectives**

Apart from the primary objective there are few more special other objectives of this project, they are;

- To develop the tool to extract data from popular social media platforms like Facebook and Instagram on Android devices.
- To integrate Natural Language Processing (NLP) capabilities to analyse and process content in both Sinhala and English languages.
- To further develop the forensic tool to detect cyberbullying, hate speech, and other cybercrimes from extracted social media data.
- To enable filtering of data based on user-defined keywords and categories to focus on specific investigations.
- To generate detailed and structured PDF reports summarizing:

- Extracted data.
  - Detected hate speech and cyberbullying instances.
  - Keyword-related evidence.
- To ensure the tool addresses unique cybercrime patterns and trends in Sri Lanka.

To develop a user-friendly and easy-going interface with much less complexity suitable for law enforcement officers.

## **Chapter 3 Literature Review**

### **3.1. Analysis of cybercrime trends, challenges and social media in Sri Lanka.**

At present the growth of cybercrimes are rising worldwide daily, new trends like cyberbullying and stalking on social media are common types of cybercrime at the peak. Over the past few years, the population using social media in Sri Lanka has widely grown. Facebook and Instagram are two of the most popular social media applications in Sri Lanka. The usage of these two platforms have increased on average within the last five years according to the social media statistics in Sri Lanka there are 9,405,900 Facebook users in by the end of the year 2024, which is 43.1% of the entire population in Sri Lanka and people within the age limit of 25 to 34 are 2,900,000 making it the largest Facebook user group(NapoleonCat, 2024). Moreover, according to the social media statistics there are 1,837,000 Instagram users by the end of 2024, which is 8.4% of entire population in Sri Lanka and the largest set of users of it is 835,400 aged between 18 to 24 (NapoleonCat, 2024). This excessive usage of social media has ultimately led to increase cybercrimes in Sri Lanka, according to H. Maduranga in(Heshan Maduranga, 2024), CERT has recorded over 8,000 incidents which is only about 30% of the whole rate of cybercrimes in Sri Lanka. Unfortunately, the rest 70% of the incidents are unreported and (Ariyadasa, 2019) states that 61% of the unreported incidents are due to fear, lack of awareness or belief in inefficiency of law enforcement.

As mentioned earlier among these cybercrimes, cyber bullying is a trending crime at present. Cyber bullies target the most active generation of social media users frequently which are the youth, the young adults of the age from 18 to 34. A. Ariyadasa in (Ariyadasa, 2019)states that approximately 90% of university students have faced cyberbullying and social media platforms like Facebook host 80% of the reported incidents. Moreover, it is stated that such victims frequently experience psychological distress, including depression and anxiety which sometimes lead the worst case of suicides(Ariyadasa, 2019). Gohal et al states that sending offensive or threatening messages (harsh speech), spreading false information, excluding someone from online

groups and sharing private information without consent are considered as the forms of cyberbullying(Gohal et al., 2023). Among them, sending threatening messages like harsh criticisms, insults, trolling, disparaging comments etc. and offensive messages like direct, implied, social threats, extortion, cyber stalking etc. are the most common form of cyberbullying which is faced by most of the social media users at present.

With the rise of all these cybercrimes having a strong cybercrime department facilitated with essential digital forensic tools is important. Compared to other powerful countries Sri Lanka is far behind in cybercrime investigations. Sri Lanka is a culture enriched country with a unique language which is not used in any other country except for Sri Lankan natives. Sinhala the mother tongue of Sri Lanka is a complex language which it hard for the existing tools to analyze the language when gathering cybercrime evidence. There are several social media forensic tools that have strong capabilities to investigate these crime trends.

### **3.2. Analysis of existing social media tools and research approaches**

There are several existing social media forensic tools such as Cellebrite, Oxygen Forensic Suite etc. equipped with strong capabilities in retrieving digital evidence, including multimedia files, chat histories, and user metadata, from social media applications like Facebook and Instagram(Cellebrite, 2025; Oxygen, 2025). Moreover, according to the research of Adeyinka et al. social media forensic tools like Magnet AXIOM, ADB, and SQLite Browser are effective in analyzing digital artifacts and in recovering multimedia from apps such as Instagram and TikTok (Femi-Adeyinka et al., 2024). However, despite their capabilities, there are certain limitations that affect when using those tools in Sri Lanka. The language is one of the primary issues, the tools are capable of gathering digital evidence extractions but analyzing Sinhala language is complex hence, ineffective, bringing up the necessity for a localized tools adjusted for the Sri Lankan context (Gohal et al., 2023). Furthermore, considering their expensive budgets

and maintenance costs, it further creates a chance for a localized tool with low budget (Cellebrite, 2025).

Apart from these popular social media forensic tools there are few existing localized research and approaches to address this issue of detecting harsh speech in Sinhala language. Among those localized researches, the research of Samarasinghe et al. is a brilliant Machine Learning approach to detect hate speech in Sinhala Unicode text, this approach of using Convolutional Neural Networks (CNNs) and FastText word embeddings to classify text as hateful or non-hateful and to determine the level of hate speech with a high level accuracy of 83% for classification but is limited due to the small and imbalanced datasets (Samarasinghe, Meegama and Punchimudiyanse, 2020). Even though this approach is not fully aligned with the proposed tool the part of detecting harsh speech is useful and can be aligned with the proposed tool to detect hate speech in extracted social media data. Similarly, the research of Muthuthanthri et al. on hate speech detection for transliterated English and Sinhala code-mixed data from social media platforms like Facebook is another unique localized approach stating that BERT is the most effective model with 82% of accuracy and a 90% of ROC AUC value, outperforming the models like CNN (Convolutional Neural Networks)(Muthuthanthri and Smith, 2024). Moreover, it states that the tool is designed to detect hate speech in Sinhala-English code-mixed texts automatically and uses a combination of machine learning and deep learning models to classify text as either hate speech or non-hate speech(Muthuthanthri and Smith, 2024). However, this tool too has certain limitations like imbalances in datasets affecting the model's performance in detecting minor cases (Muthuthanthri & Smith, 2024). This approach contains useful information for the proposed tool and is more planned out with additional features other than hate speech detection in social media.

Furthermore, Ruwandika et al. states about another similar tool to detect hate speech in online comments but this tool cannot fit the unique context of Sri Lanka as this tool was proposed for English language (Ruwandika and Weerasinghe, 2018). Moreover, the tool has number of limitations like limited data set of only 1,000 annotated comments

were used restricting generalizability of the tool (Ruwandika and Weerasinghe, 2018). However, all these research and development approaches are useful for the development of the proposed android forensic tool with unique features to detect multilingual (Sinhala and English) hate speech in social media applications like Facebook and Instagram and provide well-structured documentation for crime investigations.

### **3.3.Research gaps and justifications**

- a. Most popular social media forensic tools like Cellebrite, Oxygen Forensic Suite, and Magnet AXIOM are strong tools which are highly effective in social media forensic analysis, but these tools are not much effective in Sinhala language which is the mother tongue of Sri Lanka. This creates a challenge for the investigators to carry out investigations, collect, analyze and document all the findings.

Justification – Developing the Android Forensic tool for social media applications like Facebook and Instagram with the localized feature of detecting and analyzing evidence in Sinhala which is essential for addressing cybercrimes and carrying out strong cybercrime investigations in Sri Lanka.

- b. Strong digital forensic tools are expensive to buy and maintain mostly. Moreover, some tools are complex and quite inconvenient to use. Specially in Sri Lanka, with an unstable economy, daily rising cybercrimes, newly emerging cybercrime trends and limited number of experienced cyber security, digital forensics personnel using these types of tools are inconvenient.

Justification – The proposed tool will be customized to fit the Sri Lankan context. Localized tools are comparatively not costly, and maintenance cost is low. In some cases, it will not cost at all. Moreover, simplicity of the cli based structure of the forensic tool will be easy for the personnel with less experience to handle proposed tool.



- c. Most of the existing tools and research have the common limitation of limited dataset availability and imbalanced datasets. This limitation affects the ability of the tools to generalize and detect hate speech accurately. Sinhala language datasets are rare and limited so to raise the accuracy of the tool, availability of much enough datasets are crucial.

Justification – Expanding the available datasets will help to enhance the accuracy and the reliability of the proposed tool, providing valuable and accurate digital evidence for crime investigations.

- d. Detailed documentation of the findings or the digital evidence collected is helpful in crime investigations. Most of the tools are focused on the performance of the tool and not much concerned about the small details like documentation of the digital evidence.

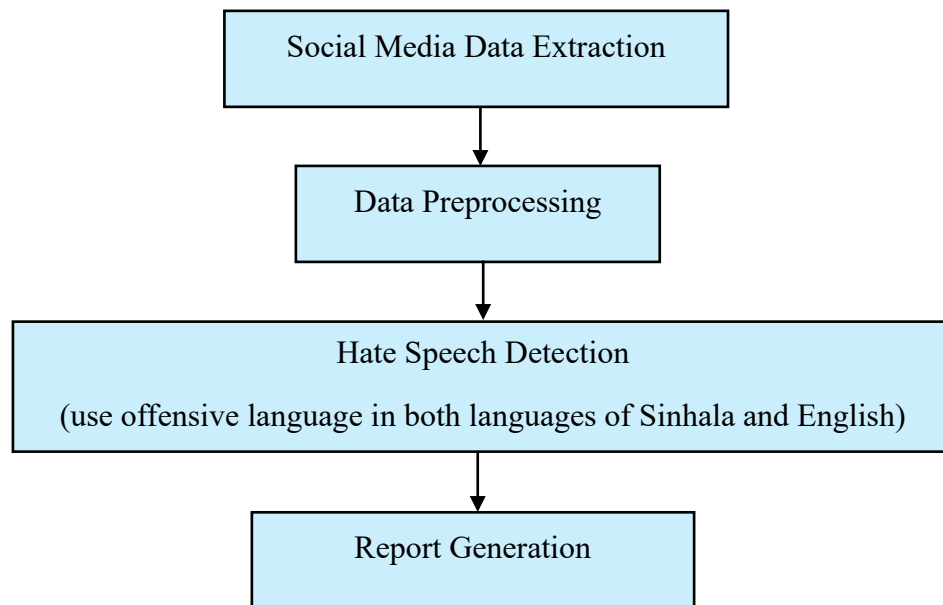
Justification - The proposed tool will have the capability to detect hate speech, extract digital evidence from social media platforms like Facebook and Instagram and create detailed reports for crime investigations including all the findings and detected cyber bullying attempts. Moreover, this approach will provide significant value to law enforcement in Sri Lanka.

## Chapter 4 Proposed Methodology

### 4.1. Proposed solution

The proposed solution to address the problem statement is developing a localized Android Forensic Tool for Social Media Applications. This proposed tool is mainly focusing on two platforms which are Facebook and Instagram. This tool will extract the data from the social media applications on android mobile phones, analyze them to detect cyberbullying attempts like using offensive harsh speech etc. and enables to filter the output with keywords entered. Moreover, the tool will provide a well-structured report with all the findings and data analyzed which can be presented as digitally analyzed evidence for the crime investigations.

### 4.2. Proposed flow of the tool



*Figure 1 - Proposed flow of the tool*

#### 4.2.1. Social media data extraction

This is the first stage of the tool which includes retrieving or extracting data from social media platforms on android mobile phones. This research is mainly focused on two social media platforms throughout this research with the hope to expand it to other platforms as well in future. Moreover, the extraction process mainly focusses on gathering text messages, multimedia files, metadata and time stamps.

#### 4.2.2. Data preprocessing

This is the next stage where the extracted raw data is cleaned and arranged for analysis. We view the extracted data in the cli interface in text format. This stage ensures that the extracted raw data is transformed into a structured and analyzable format.

#### 4.2.3. Hate speech detection

This is the stage where the raw data is analyzed. The tool will use language models to detect cyber bullying attempts by determining the tone of emotions in messages. Moreover the use of hate speech, offensive language, stalking, trolling, spreading racism, spreading war, spams etc. will be detected in both languages of Sinhala and English, furthermore such detected attempts will be flagged.

#### 4.2.4. Report generation

This is the final stage of the tool, creating an automated structured report summarizing the results and key findings of the analysis. These generated reports can be used as evidence and will be quite helpful during crime investigations.

### **4.3. Proposed outcomes of the tool**

- The tool will efficiently detect hate speech, offensive speech, threatening speech, stalking, trolling etc. forms of cyberbullying attempts on social media platforms.

- The tool will support for English and Sinhala language enabling the analysis of social media content in primary languages of Sri Lanka.
- The tool will be a cost-effective alternative to expensive existing tools.
- The tool will generate structured report pdfs summarizing the extracted data, flagged and key findings of the analysis.
- The tool will have the ability to extract and analyze text messages, multimedia files, metadata etc. from platforms like Facebook and Instagram.
- The tool will have a simple user friendly cli-based interface with very much less complexity and good efficiency.
- The tool will strengthen the capabilities of Sri Lankan cybercrime units to address rising cybercrime rate effectively.
- The tool will contribute to reduce cyberbullying and hate speech, creating a safe, inclusive digital media space for all Sri Lankan social media users.

#### **4.4.Required facilities for the proposed tool**

Hardware Requirements	A laptop or desktop with good processing power and memory for running resource-intensive tasks like virtual machines or forensic tools Android smartphone for testing the social media forensic tool.
Software Requirements	Python Programming language
Networking Requirements	Secure internet connectivity for accessing APIs and libraries.
Datasets	Multilingual datasets (English and Sinhala) for training hate speech detection models. Real world or simulated social media data for testing.
Tools	Tools for report formatting.

	Tools for cloning Android devices to avoid directly working on original evidence.
Research, Reference Materials	Academic Papers, Books, Journal Articles, Online Sources, Research articles, Conference papers etc.

*Table 1 - Required Facilities for the Proposed Tool*

## **Chapter 5 Testing and Evaluation**

The testing methodology of the proposed tool will involve Unit testing and integration testing to ensure the functionality of the individual components and the smooth interactions between modules. The combined testing approach of unit testing and integration will ensure that the tool operates reliably, as a complete tool, reducing the likelihood of errors during real-world application.

### **5.1.Unit testing**

Unit testing is the testing technique where each individual component and function of a tool is tested separately to ensure their functionality is as expected. Performing unit testing for the proposed tool will validate the functionality performance and accuracy of each individual component of the tool like data extraction, harsh speech detection, language analysis, report generation etc. Moreover, the testing will be documented manually, and the test cases will be included in the report.

### **5.2.Integration testing**

Integration testing is the testing technique in where interaction between two or more components or modules are tested and evaluated ensuring that individual units, tested independently in unit testing, work together accurately as a combined system. Performing integration testing after the unit testing will ensure that each individual module like data extraction, hate speech detection, language analysis, report generation etc. of the tool is coordinated smoothly to give an accurate output as a well-structured report.

## **Chapter 6 Feasibility Analysis**

### **6.1. Technical feasibility**

The tool will be integrated with pre trained natural language processing (NPL) models for Sinhala and English language data analysis and a pretrained model will be used for the detection of harsh speech and cyberbullying attempts. Moreover, for data extractions of Facebook and Instagram the available APIs will be used. Furthermore, cloud services like Google Colab will support model training, making the solution scalable and adaptable to future needs.

### **6.2. Operational feasibility**

The proposed tool is designed for legal use, and it is not available for general public. The tool will be designed with a simple cli based interface hence legal technical officers with less work experience will have the ability to handle the tool. Moreover, less manual effort is needed as it automates hate speech detection and report generation.

### **6.3. Financial feasibility**

This solution is cost-effective, as it uses open-source tools and free programming environments. Moreover, this tool is a cost-effective localized tool that fits the Sri Lankan context effectively compared to the expensive existing tools.

### **6.4. Legal and ethical feasibility**

This project complies with the Data Protection Act No. 9 of 2022 of Sri Lanka, ensuring secure handling and privacy of sensitive data. Moreover, the project ensures legal compliance by extracting data only through authorized procedures, such as obtaining appropriate permissions from law enforcement prior to investigations. However, the tool

is specifically for the use of authorize personnel in cybercrime division of Sri Lanka and will be secured from unauthorized access maintaining the data integrity and privacy.

## 6.5. Timeline feasibility

### 6.5.1. Work plan

Activities	Duration of the Activities											
	2024/2025											
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug		
Topic Selection												
Topic Research												
Topic Selection Submission												
Research Study												
Project Proposal Preparations												
Project Proposal Submission												
Proposal Presentation Preparation												
Data Collection												
NPL Model Development												
Testing and validating												
Tool Development												
Design the Cli Interface												
Integrate Components												



Unit Testing												
Integration Testing												
Documenting Test cases												
Final Report Preparations												
Final Presentation Preparations												
Final Submission												

*Table 2 - Work Plan*

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