SherLock: A CNN, RNN-LSTM Based Mobile Platform for Fact-Checking on Social Media

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Abstract: Today, false news is easily created and distributed across many social media platforms. Due to that, people find it difficult to choose between right and wrong information on those platforms. Therefore, a strong need emerges to develop a fact-checking platform to overcome this problem. Fact-checking means the process of verifying information. A CNN, RNN-LSTM based mobile solution has proposed from this study to verify information on social media including many features. CNN, RNN-LSTM based hybrid model ables to capture the high-level features and long-term dependencies from the input text. Some of the features of the mobile application includes fact-checking, daily news updates, news reporting and social media trends etc. The mobile solution is developed using Flutter as the front-end framework and Firebase as the back-end framework including REST APIs to gather daily news articles. The hybrid model achieved a 92% accuracy when checking the information circulating on social media.

Keywords Fake News Detection, Fact-Checking, Deep Learning, Natural Language Processing, Hybrid Approach

Introduction

Today out of 8 billion people worldwide 3.8 billion people are social media users. With the development of new social media platforms, people are moving from traditional news media to those social media platforms. Because they can easily get to know about the things which are happening around the world just surfing through social media news feeds. As a consequence of the freedom and simplicity gives from those social media platforms anyone can express anything at any time and this leads to create and distribute false information comfortably through those platforms. Due to that, people find it difficult to choose between right and wrong information on those social platforms.

Most of the time due to the lack of verified news sources and fact-checkers on social media platforms in Sri Lanka social media users are failed to identify false information in their news feeds. As a consequence of that, people are sharing those news stories without checking and this leads to spreading a lot of misinformation through social media platforms in Sri Lanka during the year of 2019. For example, after the Easter Sunday attacks in Sri Lanka government decided to block social media access due to alleged false information circulating on social media occurring lot of misunderstanding between people and religions('Sri Lankan Government Blocks Social Media Access Over Alleged Fake News', 2019). Not only that, before and after the presidential election in Sri Lanka in 2019, a lot of false information has also created and spread through social media platforms to change the mindset and opinion of people(Wong, 2019).

Many instances have recorded from different countries regarding the widespread impact of false information on social media platforms. During the US presidential election in 2016, "Pizzagate" fake news is widely spread on Twitter by creating more than one million tweets('Pizzagate

conspiracy theory', 2019) and during the Gubernatorial campaign in Jakarta back in 2016 governor, Ahok sentenced to two years in prison for criticizing a verse of Quaran(Lamb, 2017).

These incidents have clearly indicated that a strong need emerges to develop a fact-checking platform to overcome this problem. From this study, we propose a mobile platform called 'SherLock' that can use as a platform for fact-checking on social media using a CNN, RNN-LSTM based hybrid model(Goonathilake and Kumara, 2020) and including many other features such as daily news updates, news reporting and social media trends etc.

Literature Review

Hoaxy(Shao *et al.*, 2016) is an online tool that can collects and tracks misinformation. Then it can visualize that misinformation by using the technologies like web scraping, web syndication, Twitter API and RSS parser. FakeNewsTracker(Shu, Mahudeswaran and Liu, 2019) is another tool to collect and visualize false news on social media using some of the deep learning mechanisms like LSTM, auto-encoder etc. Using Hoaxy API, a tool called 'dEFEND' has developed to provide a news propagation network including trending news and top claims. It also can provide some explainable insight into user comments on Twitter. News Verify(*Real-Time News Certification System on Sina Weibo*, 2019) has developed to detect the credibility of news using the techniques like feature extraction, sentiment analysis and web crawling etc. Authors (Conroy, Rubin and Chen, 2015) have developed an extension for both Chrome and Mozilla browsers called 'B.S. Detector' to check unreliable sources against a manually compiled list of domains.

According to (Ahmed, Traore and Saad, 2017) they used machine learning techniques to detect false information and proposed a method using word-based n-grams. Authors (Aldwairi and Alwahedi, 2018) have proposed a method using WEKA machine learning classifiers. Fake News Pattern Detector(*Fake News Patterns Detector*, 2019) used a deep learning network to detect the patterns in fake news by applying several techniques like CNN, word2vec word embeddings and feature extraction etc. TRACEMINER(Wu and Liu, 2018) also used an LSTM-RNN model to provide high classification accuracy on real-world data sets. Authors (Kaliyar, 2018) have proposed several deep learning networks to detect false information. Rather than using classical models, they proposed a combination of neural networks to use in fake news detection.

Figure 1 represents some of the related software and comparison of their features. From the proposed mobile platform covers all the features mentioned below.

Software	Filter Fake News Articles	Send Alerts about Fake News and Breaking News	Check credibility and validity of social media posts	Add a crowdsource fact-checker	Leverage app usage statistics for users
Oigetit	✓	✗	✗	✗	✗
WatchDog	✗	✓	✗	✗	✗
Fact-Bounty	✗	✗	✗	✓	✓
Listle	✗	✓	✗	✗	✗
SherLock	✓	✓	✓	✓	✓

Figure 1. Comparison of features in related software

Design and Implementation

A. The High-Level Architecture of the System

The proposed system consists of several parts including MVVM architecture which represents the model-view-view-model pattern of the mobile application. The mobile application has developed including many features namely, daily news updates, fact-checking, news reporting, social media news trends and daily COVID19 report. Then cloud database has used by including several crud

operations for each feature of the mobile app. REST APIs and web scraping method have used to collect information from different news sources to build the hybrid deep learning model. After that, the same cloud database has used to store the hybrid deep learning model.

Figure 2 represents the overall system architecture of the proposed system. As for the front-end of the proposed system developed a mobile application including the above-mentioned features. And for the back-end of the proposed system used a cloud database to store the hybrid deep learning model and included several crud operations according to the features of the mobile application.
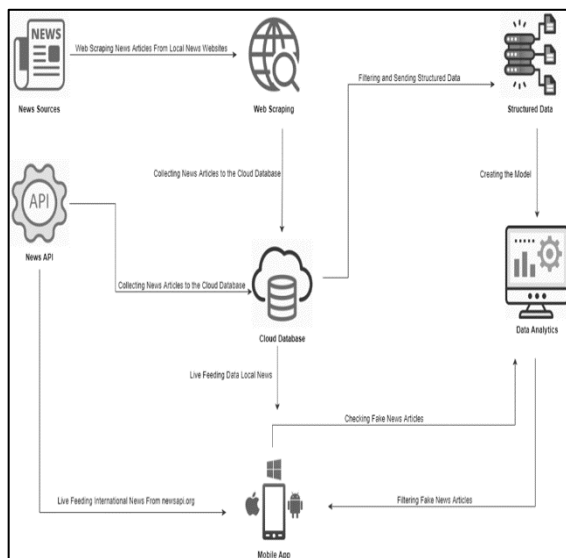

Figure 2. The overall system architecture of the proposed system

B. Software Process Model of the System

The incremental software process model is consisted of breaking down requirements into subsystems and modules ('Software Engineering | Incremental process model', 2018). Therefore, the proposed system applied a software process model as Incremental.

Figure 3 indicates three subsystems of the main feature of the proposed solution. The first subsystem includes data collection part to develop deep learning model and next

subsystem includes checking the social media posts using the hybrid deep learning model. And the final subsystem is about checking the status of the posts using the mobile application. If it is verified news it represents using green colour and if it is fake news it represents in red colour.
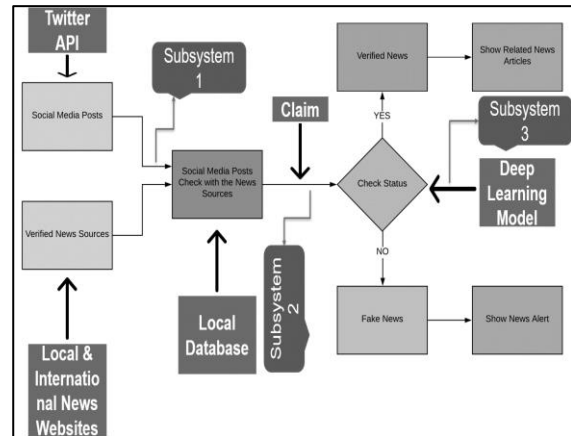

Figure 3. Software process model for the main feature

C. Design Diagrams for Proposed System

All the design diagrams of the proposed system have drawn using an open-source online tool called 'Lucidchart' (*Online Diagram Software & Visual Solution*, 2020).

High-level use case diagram includes different use cases of the proposed mobile application. Target stakeholders for the proposed mobile application are news agencies, daily news reporters, daily newsreaders and social media users of Sri Lanka. News agencies have the admin authority of the mobile application and other stakeholders have provided with different features according to their preferences.

Figure 4 represents the use cases of the proposed mobile application for a common user and administrator.
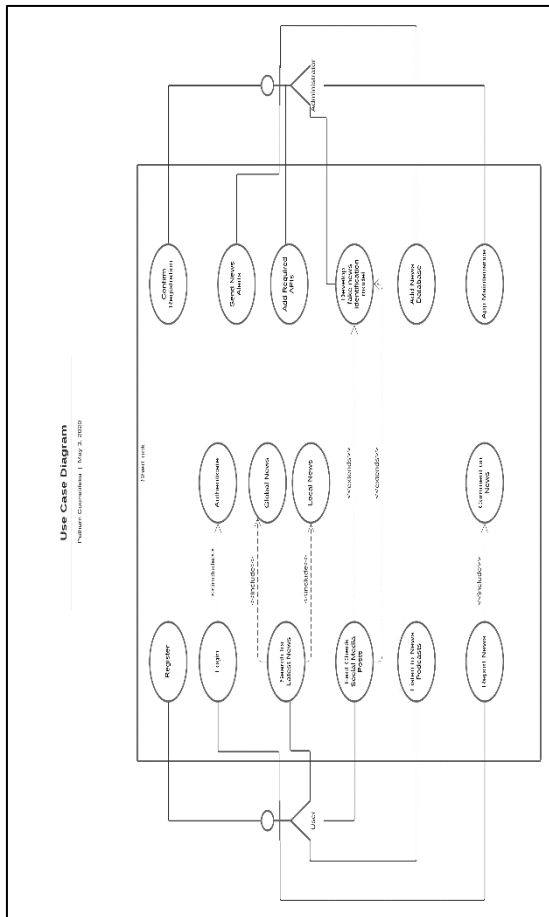
Figure 4. High-level use case of proposed mobile application

The class diagram represents the static structure of the system by describing the attributes, methods and the relationship among them ('Class Diagrams - Learn Everything About Class Diagrams', 2020).

Figure 5 indicates the class diagram of the proposed system by describing main classes like the user, news, model etc. And some of the methods like login, register, report news etc. It also includes the attributes of the system as well.

The entity-relationship diagram indicates the main entities of the proposed mobile application after doing several normalization steps.
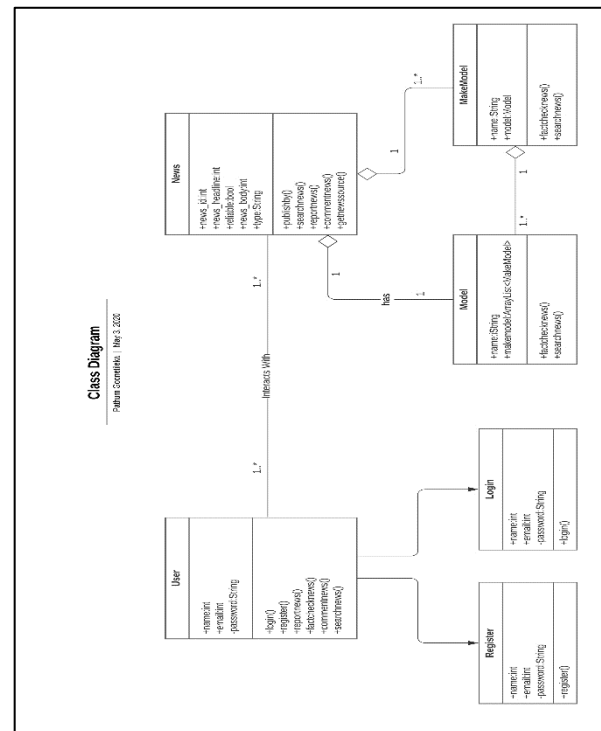

Figure 5. Class diagram for the proposed system

Figure 6 represents the entity-relationship diagram of the database by describing the entities and their main attributes.
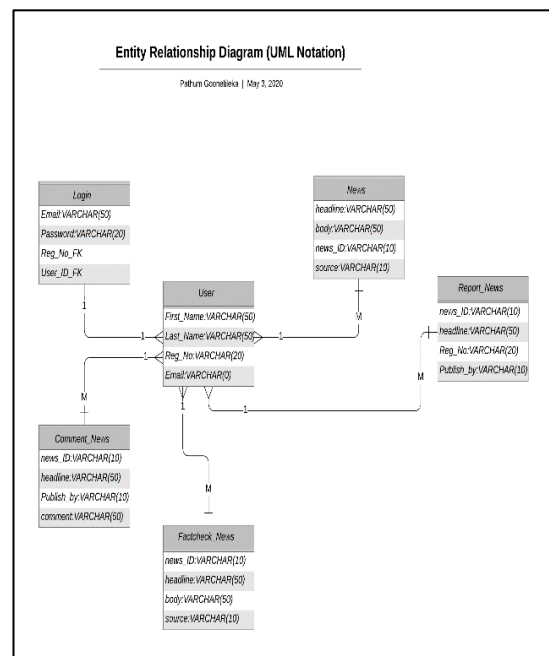

Figure 6. Entity-relationship diagram for the proposed system

Sequence diagrams interact with showing object interactions which are arranged according to time sequence ('Sequence Diagrams - What is a Sequence Diagram?',

2020). Figure 7 represents the sequence diagram for the proposed system by showing the interactions between main objects namely, mobile app, deep learning model and database.
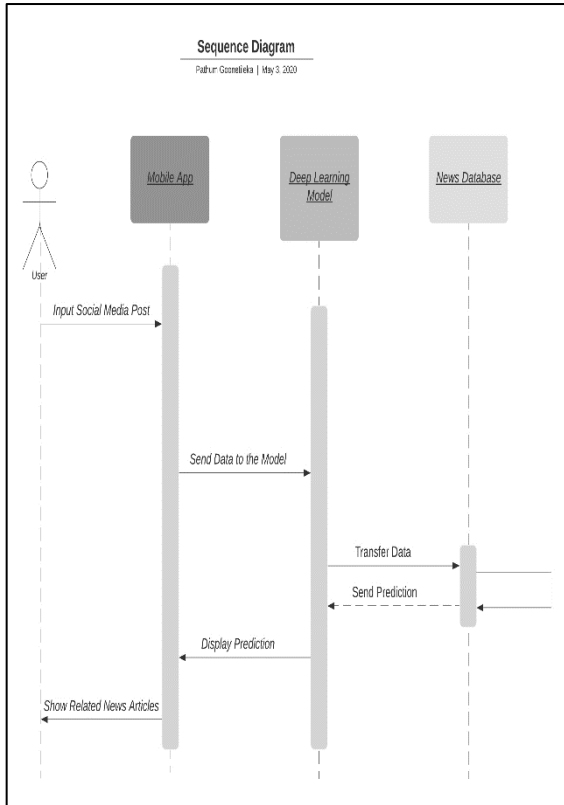

Figure 7. Sequence diagram for the proposed system

D. Design of the Proposed Mobile Application

Design of the proposed mobile application includes several screens of the mobile app such as onboarding screen, registration screen, login screen, home screen and other feature-wise screens etc. But here mentioned only the screens of the main features of the mobile application.

Figure 8 represents the home screen of the mobile application which shows the latest global news around the world by categorizing news for business, entertainment, health, science and sports etc. If the user wants to know more information about particular news they can click on the news article and it navigates to a URL where it includes more information about the news article.
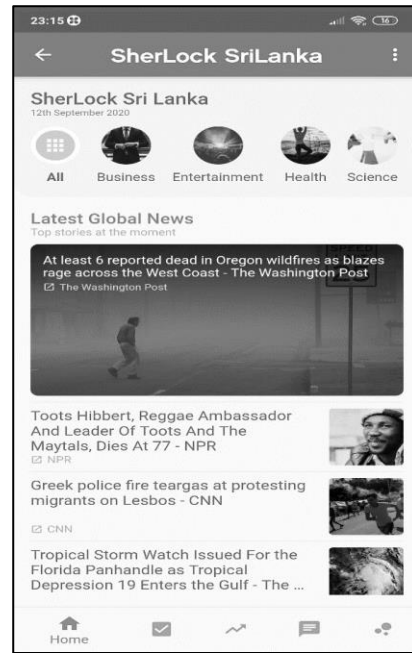

Figure 8. The latest global news screen

Figure 9 indicates the latest news trending on Twitter and the latest fact checks from the websites like AFP news. If the user wants to know more information like the above screen they can click and navigate to find more information on each news.
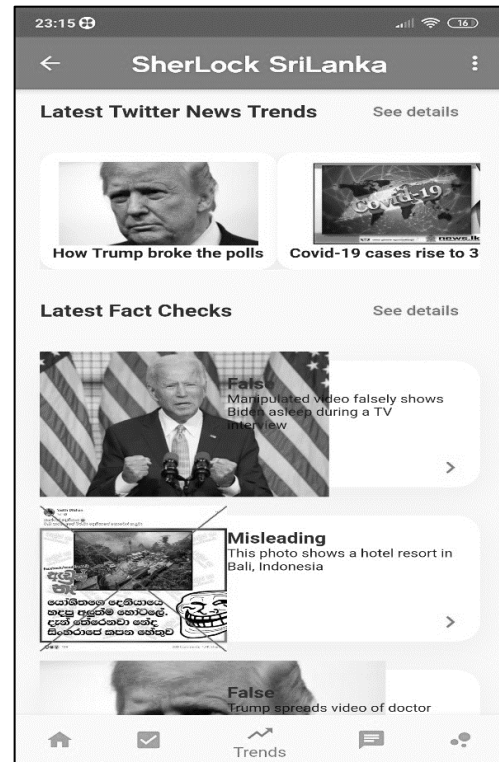

Figure 10 represents the news reporting screen where news reporters can report the news to the platform

Figure 10. News reporting screen

Figures 11 represents the daily COVID-19 report screen where users can see information according to their language preferences. Localization has added to the feature for languages English, Sinhala and Tamil.
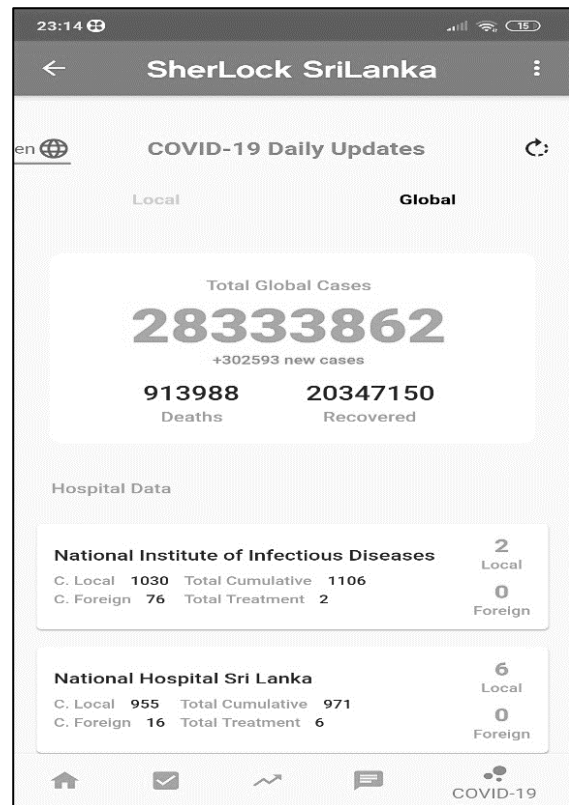

Figure 11. COVID-19 updates using English language

Figures 12 represents the daily COVID-19 report screen in the Sinhala language.

Figure 12. COVID-19 updates using Sinhala language

Figure 13 represents the main feature of the mobile application which is about the fact-

checking of social media posts. User can input the text of the social media post and it classifies as verified news or fake news from the hybrid model. As an example, if the user inputs the text as 'Dalada Maligawa website comes under cyber-attack' then from the hybrid model it checks and gives a message as verified news by showing the text in green colour. If the user inputs a message like 'All the universities and schools remain closed for two months due to the coronavirus outbreak in the country' then from the hybrid model it labels as a fake one by showing the red colour with the text. This screen is used to fact-check the social media posts using the CNN, RNN-LSTM based hybrid model.
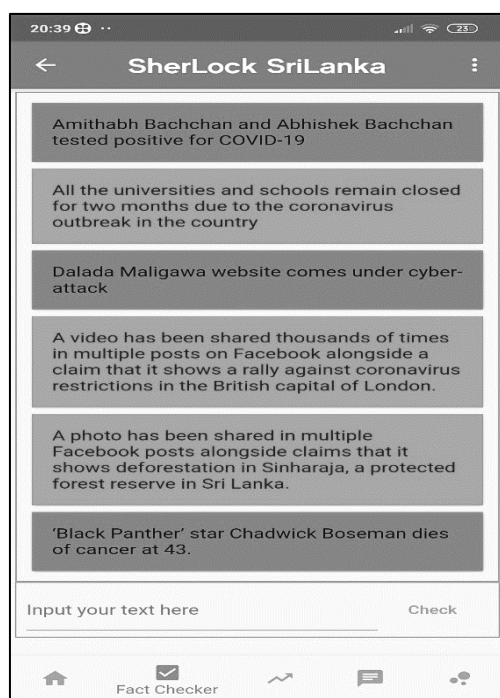

Figure 13. Fact-checking screen

Technology Adopted

A. Use Flutter as Front-End Framework

The reason for using Flutter('Flutter - Beautiful native apps in record time', 2020) as the front-end framework of the proposed mobile application is to build beautiful, natively compiled mobile application for both Android and IOS from a single codebase.

The best thing about Flutter is free and open-source by providing native interfaces. When compare with other mobile development frameworks Flutter has a fast development methodology by providing some easy infrastructure for developers.

B. Use Firebase as Back-End Framework

For the proposed system, had to deal with a lot of unstructured data types. Therefore, choose Firebase(*Firebase*, 2020) as the back-end framework of the proposed system. Firebase authentication has used to authenticate users from the login screen. And Firebase Database and Firestore have used to store news reports. Then Firebase Storage has used to store images of the news reports. Finally, used Firebase Machine Learning to store the hybrid deep learning model.

C. Use Scrapy to collect data

Before building the hybrid deep learning model collected data from different news sources using the web scraping method. For that, Scrapy('Scrapy | A Fast and Powerful Scraping and Web Crawling Framework', 2020) which is an open-source web scraper is used.

D. Use TensorFlow to build the model

The hybrid deep learning model has used TensorFlow(*Keras | TensorFlow Core*, 2020) to build the model and Python as the programming language. Because it has rich support to both front-end and back-end frameworks and also it has a flexible and comprehensive ecosystem.

E. Use GitHub to maintain the project

For the proposed system, GitHub(Build software better, together, *2020)* used to maintain the project repository. And also GitHub Actions(Features • GitHub Actions, *2020)* used to build the CI/CD(Continuous Integration/Continuous Delivery) pipeline and deploying the mobile application.

F. Use IntelliJ IDEA as a platform to build the project

IntelliJ IDEA(IntelliJ IDEA: The Java IDE for Professional Developers by JetBrains, 2020) has used as the platform to develop the mobile application because it has rich support to both front-end framework Flutter and back-end framework Firebase as well.

G. Use PyCharm as a platform to build the model

PyCharm(PyCharm: the Python IDE for Professional Developers by JetBrains, 2020) has used as the platform to build the data collection method. After that added some of the Natural Language Processing techniques like tokenization, pre-processing and word embeddings etc. Finally, build the hybrid model after doing the above steps.

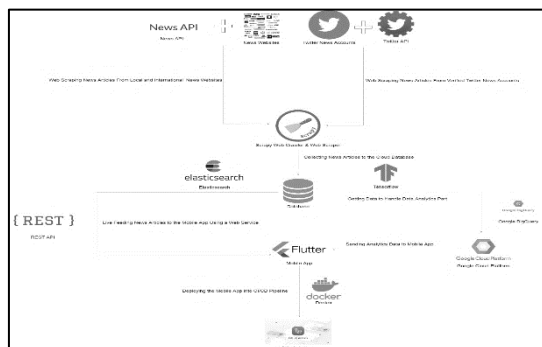Figure 14 represents overall technology map of the system.

Figure 14. Technology map for the proposed system

H. Use Kaggle kernels/Google Colab to run the model

The hybrid deep learning model needed more power to execute with the dataset size and the complexity of the model. Therefore, choose Kaggle kernels(Kaggle: Your Home for Data Science, 2020) and Google Colab(Google Colaboratory, 2020) cloud environments with built-in TPUs to run the model.

Testing and Evaluation

Test driven development methodology has used throughout the project. Different automated tests help to ensure the performance of the mobile app. Unit tests have used to test the functions of the mobile app. And widget tests have applied on UIs to test the widgets of the mobile app. After that, integration tests and end-to-end tests have used to test the complete mobile app. GitHub Actions CI/CD pipeline used to run tests automatically when pushing new code changes to the repository.

As for the evaluation of the mobile application, Docker(Empowering App Development for Developers | Docker, 2020) has used to enhance the performance of the app. Then app bundle packages have applied to reduce the size of the app. The proposed mobile application is compatible on both Android and IOS versions when using Flutter as the front-end framework.

How System Works

The proposed mobile application has several main features such as daily news updates, fact-checking, news reporting, social media news trends and daily COVID19 report. First, the user needs to register to the system by providing correct details. Only the admin user has full access to all features of the mobile app. Other users have access to specific defined features only. Which means according to the target stakeholders, the news agency has the full access of the system and other users like daily news reporters, daily newsreaders and social media users can access specific defined features only. As an example, daily news reporters have the access to news reporting screen but other two users do not have access to that screen. For restricting the access for specific features, role-based authorization has used to manage users. Let's see how the main features of the proposed mobile application work.

A. Latest Global News Feature

After logging to the system by giving correct credentials user navigates to the home page where user able to see the latest global news articles. Users can navigate between different categories of news according to their preferences. This screen shows the

latest global news around the world by categorizing news for business, entertainment, health, science and sports etc. If the user wants to know more information about particular news they can click on the news article and it navigates to a URL where it includes more information about the news article. This feature is visible to all the users. News API(*News API - A JSON API for live news and blog articles*, 2020) has used here to fetch live news articles to the mobile application using a JSON API.

B. Fact-Checking Feature

After navigating to the home screen user able to see the bottom navigation bar. From that, the user can shift between different features. After clicking the fact-checking feature user navigates to a screen where they can fact-check social media posts using the CNN, RNN-LSTM based hybrid model. User can input the text of the social media post and it classifies as verified news or fake news from the hybrid model. As an example, if the user inputs the text as 'Dalada Maligawa website comes under cyber-attack' then from the hybrid model it checks and gives a message as verified news by showing the text in green colour. If the user inputs a message like 'All the universities and schools remain closed for two months due to the coronavirus outbreak in the country' then from the hybrid model it labels as a fake one by showing the red colour with the text. The hybrid model has an accuracy of 92% and it includes several deep learning mechanisms. CNN, RNN-LSTM based hybrid model ables to capture high-level features and long-term dependencies from the input text. For more information about the CNN, RNN-LSTM hybrid model refers to the following study which is done by the authors(Goonathilake and Kumara, 2020). This feature is accessible only for social media users to check the validity and credibility of the social media post. TensorFlow used to develop the hybrid model then Firebase machine learning used

to store the model and REST APIs(*REST APIs: An Introduction | IBM*, 2020) used to interact with the model with front-end framework Flutter.

C. Latest Twitter News Trends and Latest Fact-Checkings Feature

This feature is visible for all the users. From this feature, users can get to know about the latest Twitter trends and latest fact-checkings. If the user wants to know more information about particular news trends they can click on the news article and it navigates to the post where it includes more information about the trending news articles. Twitter API(*Use Cases, Tutorials, & Documentation*, 2020) is used to get the latest Twitter trends and web sites like AFP Fact Check used to get the latest fact checkings using REST APIs.

D. News Reporting Feature

If the logged-in user is a news reporter they can easily navigate to the news reporting feature from the bottom navigation bar. News reporters can upload news to the system by providing the correct details such as reporters name, the title of the news, description of the news and related photo of the news. This feature is only visible to news reporters only. Firebase Database and Firestore has used to store news reports and Firebase storage has used to store related photos of the news articles.

E. Daily COVID-19 Report

User can navigate to this feature from the bottom navigation bar by clicking the last item of it. This feature represents the daily COVID-19 updates in Sri Lanka and the world. Here, the user can see information according to their language preferences. Information mainly includes total global and local cases, total deaths, total recovered and hospital data. Localization has added to the feature for languages English, Sinhala and Tamil. This feature also visible to all the

users. REST APIs have used to fetch live updates to the mobile application and Google Translate has used to add the localization.

Conclusion and Future Works

In conclusion, we have shown that the proposed mobile application is an efficient solution for Sri Lanka. Because it provides many features such as daily news updates, fact-checking, news reporting, social media news trends and daily COVID19 report. And the main feature of fact-checking is more important for daily social media users to find between real and fake news articles as well.

As for future work, the suggested mobile application hope to launch as a complete system to the public with versions for both Android and IOS. With that, hope to publish this mobile application on the Android Play Store and Apple App Store.

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