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RemCheck: A Novel Drug Validator Application to detect fake Remdesivir, an Anti-Viral Drug for COVID-19

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Abstract-The COVID-19 pandemic has turned out to be one of the dreadful disaster mankind has ever faced. With the subsequent waves of the pandemic setting in several countries, the number of cases being reported is quite alarming. People need to stay extremely vigilant and ensure strict adherence to social distancing, hand hygiene, and usage of personal protectives like masks, hand gloves and face shields. Remdesivir, an anti-viral drug used against the COVID-19, believed to have some therapeutic effects is on a surplus demand. There have been reports of illegal hoarding of these drugs. We need to be vigilant and keep a check on the circulation of fake Remdesivir drugs in the market amidst the pandemic. The study proposed development of a novel Drug Validator Application to detect fake Remdesivir drugs. This is done by scanning the carton or the vial of the Remdesivir drug through the dedicated Android application. This is further sent to the cloud server for processing. The AI model which runs in the cloud server evaluates the genuineness of the drug image. The report comprising the recommendation as Genuine or Fake is sent to the user through his/her registered mobile number and e-mail address. This application could curb the circulation of fake drugs in the market amidst the pandemic and could help in undertaking a real-time surveillance.

Index Terms—COVID-19, Drug Validator, Fake drugs, Mobile Application, Remdesivir.

I.INTRODUCTION

The COVID-19 pandemic which originated in the Chinese city of Wuhan has almost spread to all corners of the globe. This pandemic has turned out to be one of the biggest disasters of all time. This pandemic has disrupted the socio-economic and the public health organization of the world nations. As of 17th June 2022, more than 535 million people have been infected globally, leaving over 6.3 million dead [1]. The new wave of the pandemic has begun to set in several countries. The rapid pace of infections experienced during this wave has been attributed to the evolution of new mutant strains across the globe.It is high time that the people stay extremely vigilant to eliminate this dangerous enemy, the novel coronavirus.

The COVID-19 vaccines are the only way to eradicate this disease. However, limited manufacturing facilities are a major setback in our fight against the disease. Until a large section of the population is vaccinated, no one is safe. The only weapon we have to flatten the curve is strict adherence to the practice of Social Distancing, Hand hygiene and Usage of personal protectives like mask and gloves. Several research teams around the globe have been working on a “live saving drug” which could cure COVID-19. There are some investigational drugs which prove to be beneficial in reducing the number of days spent in hospital. One such is Remdesivir, an anti-viral drug with a broad-spectrum action has been approved for emergency use by several countries [2]. There has been a surplus demand of this drug due to the enormous rise in cases. There have been reports on illegal hoarding of these drugs. There is suspicion over the possibility of sale of fake Remdesivir drugs amidst this pandemic. The government and regulatory authorities should place serious checks on such malpractices which could lead to loss of lives.

II. RELATED WORKS

An automated system for identifying drug images have been proposed. Contrary to the keyword search put forth by several automated systems developed for drug identification, this approach aims at

enabling the description of the features by the users. This includes the shape and color of the drugs. This system has found to provide superior drug information. The system has achieved a higher accuracy, evaluated with the top ten identified drugs [3]. Various retrieval methods have been compared over a dataset of 432 tablets. This was further compared with MPEG-7 shape comparison methods [4].

An integrated system was constructed for analyzing the drug interactions in in-patients. This system is deployed on a computerized drug cart. This comprises of patients' details along with the drug details. The drug details include images of the drugs, dosage, time of administration and route of administration, possible drug interactions along with the compatibility of the intravenous drugs. This system had been deployed in a clinical setting in Taipei. It is concluded that prevention of medication errors would be possible with the deployment of such automated systems [5]. The role of Deep Learning in the domain of identification is discussed.

A drug identification system has been proposed for deployment in the medication production machines. The drug name is recognized and finally the outcome is given through as an audio [6]. An Internet of Things (IoT) based model for analyzing the drug interactions have been proposed. The paper revolves around analyzing Adverse Drug Reactions, Allergies, contraindications, harmful effects, effects during pregnancy and lactation with the help of Internet of Things technology. This would be a boon for clinicians when they prescribe drugs. These Clinician assisting systems could help avoid complications of Adverse Drug Reactions [7].

CoforDes, a feature extractor is proposed as a novel application to classify the drugs based on feature such as shape and color. This could prevent the complications arising due to erroneous consumption of drugs [8]. An automated pill recognition system which works based on pill imprints is proposed. This is based on the concept of imprint partition which separates based on noise points and separated strokes. This would reduce the unwanted complications arising due to intake of wrong drug [9]. A drug identification system based on the Distance Sets has been proposed. This recognition is principally done using the imprint information which is processed further [10].

A drug pill matching system has been proposed which takes into account a host of features like color, shape, imprint to analyse the drug. Descriptors like SIFT and MLBP have been used in this study. This system could match the drug images with missing features [11]. An application to detect fake currency notes has been proposed. This study utilized the Support Vector Machine (SVM) algorithm for this purpose. This is a novel application which could help in curbing of circulation of fake currency notes within a country [12]. The issues arising due to the utilization of counterfeit anti-malarial drugs has been discussed. The prime issue of developing artemisinin resistance due to repeated intake of sub-clinical doses is addressed [13]. An automated detection of counterfeit Viagra and Cialis medications has been proposed using advanced image processing techniques. It has proved to be successful in detecting the counterfeit drugs [14]. A review of usage of Information and Communicating Technology in combating the menace of counterfeit drugs has been detailed in [15].

III. Materials And Methods

The motive of this work is to develop a robust Drug Validator Application to detect fake Remdesivir Drugs, which are used to treat COVID-19. The architecture of the proposed model is depicted in Figure 1. The proposed model involves development of an Android application. The Android application accesses the Camera of the smartphone. The user should scan the Remdesivir drug via the application. The application will house two modes: one, through which the user could scan the carton of the Remdesivir drug and the other, through which the user could scan the vial of Remdesivir drug. The application records the clear image of the carton or the vial. The sample images of original and fake cartons of Remdesivir drugs are shown in Figure 2. This image is then sent to the cloud server for processing. The processing at the cloud server level begins as soon as the image is received from the mobile application.

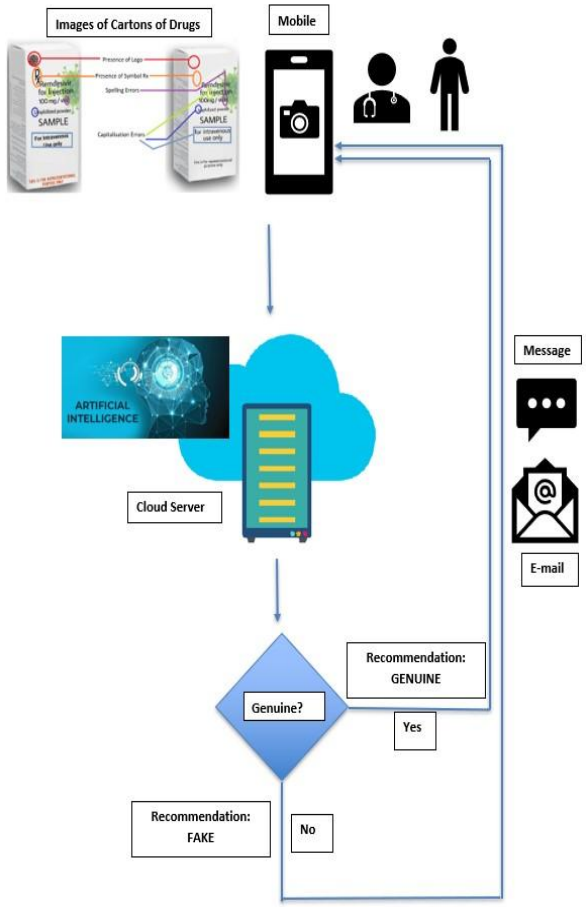

Fig. 1. Architecture of Proposed Model

An Artificial Intelligence model is deployed in the cloud server. This model is trained with the 360° view images of both the carton and the vials. The model is kept updated with the images of Remdesivir drugs produced by various manufacturers from time to time. The 360° view images of both the carton and the vials enables the users to scan any side of the carton or the vials and is provided with an opportunity to scan even more than one side. The model is tested with the images acquired from the mobile application. The various features the AI model compares for ensuring the genuineness of the drug are given in Figure 3.

Table I Performance Comparison of Various Models for Fake Carton detection

Models	Accuracy	Sensitivity	Specificity
VGG-16	**95.19%**	**95.26%**	**96.11%**
DenseNet	92.17%	92.24%	93.54%
Inception-V3	87.46%	85.65%	84.16%
AlexNet	89.40%	87.04%	86.07%
ResNet-50	73.72%	74.84%	73.90%

Fig. 2. (a) Sample Image of a carton of an original Remdesivir Drug, (b) Sample Image of a carton of a fake Remdesivir Drug

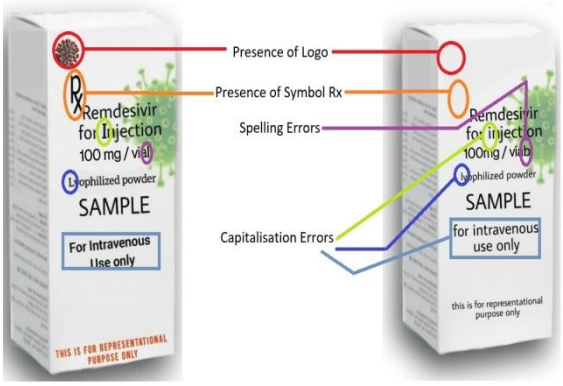

Fig. 3. Differences between the original and fake cartons of Remdesivir drugs

Table II Comparison of Manual Scrutiny and Application Based Scrutiny

Parameters	Manual Scrutiny	Application Scrutiny
Accuracy	Low	High
Chances of Miss-out	High	Low
Time Consumption	High	Low
Effect of Anxiety	Significant	Eliminated
Real-time Surveillance	Not possible	Possible
Smart phone, internet access	Not needed	Needed
Pros	Non-expensive	Highly accurate
Cons	Less accurate	Quite expensive

IV. Results And Discussion

The mobile application is able to seamlessly transfer the images captured to the cloud server through a secured channel. The image dataset for testing the model is made by intentional manipulation to the original dataset. This practice was undertaken due to the lack of images of fake drugs. The image dataset (both the original and fake images) is augmented using the Generative Adversarial Network (GAN), which comprises of Generator and Discriminator modules. This Generator module ensured significant quantity of image dataset. The quality of the image dataset is also significantly improved due to the Discriminator module of GAN. Various pre-defined models like AlexNet, VGG-16, Inception-V3, DenseNet and RestNet50 are tested with the dataset. The performance metrics of these models are evaluated.

The performance metrics of the various models are listed in Table 1. The performance metrics evaluated include Accuracy, Sensitivity and Specificity. The VGG-16 model proved to be superior amongst the tested models with an accuracy, sensitivity and specificity of 95.19%, 95.26% and 96.11%. This recommendation stating, whether the drug is genuine or fake is mailed to the user.

V. Conclusion

The comparison of manual scrutiny and the application-based scrutiny is listed in Table 2. The illegal circulation of fake drugs amidst a pandemic could become a major menace. This could potentially lead to losing many COVID-19 patients. Hence, it is absolutely important to curtail this menace right at the early stage. The regulatory authorities need to bring in a robust check mechanism for restraining these illegal practices. Deployment of such an application at the user level could be really a “game-changer” in eliminating the prevalence of fake drugs from the market. This could prevent unwanted chaos and further strengthen our fight against this invisible enemy, the coronavirus. It is also vital that the public strictly adhere to the government guidelines from time to time, ensure strict social distancing, hand hygiene and usage of personal protectives like gloves, masks and face shields.

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