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Journal of Theoretical and Applied Information Technology
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Title:	EVALUATING USERS SATISFACTION FACTORS OF THE CUSTOMER RELATIONSHIP MANAGEMENT SYSTEM: A STUDY OF KHEDMAH SYSTEM AS A SINGLE SERVICE PLATFORM
Author:	SHAFIQ DARWISH ALABRI , SUZILAWATI KAMARUDIN
Abstract:	This study investigates the factors that influence user satisfaction of Khedmah's system in Oman. The Information Systems Success Model (ISSM), Technology Acceptance Model (TAM), and Theory of Planned Behavior model (TPB) are integrated to form the theoretical framework for this study. This study investigates the impact of the individual's computer skills, perceived ease of use, and perceived usefulness have on the user satisfaction of Khedmah's system. These constructs were derived from the three models. Data were collected from the users of Khedmah system through a self-administered questionnaire. The researchers relied on the judgmental technique to identify the research sample. Using SPSS v25 and SmartPLS 3, a total of 164 questionnaires were analyzed. The findings revealed that generally the users are satisfied with the Khedmahâ€™s performance. The findings also illustrated that the individual's computer skills, the perceived ease of use, and the perceived usefulness positively and significantly affect the level of user satisfaction of the system. The findings of the study would enhance the performance of Khedmah system, which will reflect positively on the level of user satisfaction. It would enrich the knowledge of the managers and system developers to further develop the system in order to achieve high levels of usersâ€™ satisfaction. Also, the findings of this study provide insight for the developers of similar systems in other institutions. The study findings confirm that combining ISSM, TAM, and TPB models is applicable to CRM. The findings of the study would enrich the CRM literature. Based on the researchersâ€™ knowledge, this study is the first of its kind in CRM literature that combines these three models.
Keywords:	Information Systems Success Model (ISSM), Technology Acceptance Model (TAM), Theory of Planned Behavior model (TPB), Customer Relationship Management (CRM), Khedmahs System
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020
	Full Text

Title:	ENHANCEMENT OF SINGLE-HANDED BENGALI SIGN LANGUAGE RECOGNITION BASED ON HOG FEATURES
Author:	TASNIM TABASSUM, IQBAL MAHMUD, MD. PALASH UDDIN, EMRAN ALI, MASUD IBN AFJAL, ADIBA MAHJABIN NITU
Abstract:	Deaf and dumb people usually use sign language as a means of communication. This language is made up of manual and non-manual physical expressions that help the people to communicate within themselves and with the normal people. Sign language recognition deals with recognizing these numerous expressions. In this paper, a model has been proposed that recognizes different characters of Bengali sign language. Since the dataset for this work is not readily available, we have taken the initiative to make the dataset for this purpose. In the dataset, some pre-processing techniques such as Histogram Equalization, Lightness Smoothing etc. have been performed to enhance the signsâ€™ image. Then, the skin portion from the image is segmented using YCbCr color space from which the desired hand portion is cut out. After that, converting the image into grayscale the proposed model computes the Histogram of Oriented Gradients (HOG) features for different signs. The extracted features of the signsâ€™ are used to train the K-Nearest Neighbors (KNN) classifier model which is used to classify various signs. The experimental result shows that the proposed model produces 91.1% accuracy, which is quite satisfactory for real-life setup, in comparison to other investigated approaches.
Keywords:	Deaf and Dumb, Bengali Sign Language Recognition, Skin Segmentation, HOG Features, Bengali Sign Language Dataset
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020

[Full Text](#)

Title:	AUTOMATED MALARIA DIAGNOSIS USING OBJECT DETECTION RETINA-NET BASED ON THIN BLOOD SMEAR IMAGE
Author:	JASMAN PARDEDE, IRMA AMELIA DEWI, REZA FADILAH, YANI TRIYANI
Abstract:	Malaria diagnosis is decided based on index malaria value which calculated from the amount of normal and infected erythrocyte on thin blood smear using microscope by a clinical pathologist. This activity is done manually and wastes a lot of time. Object detection using Convolutional Neural Network (CNN) is one of approach for solving this problem. However, the traditional object detection using CNN shows inadequate classification performance in labelling classes object. This paper is focused on the implementation of RetinaNet object detection approach to diagnose malaria. First, ResNet101 and ResNet50 used as RetinaNet backend network architecture for detecting both normal and infected erythrocytes on thin blood smear image with 1000x microscope zoom. Next, count every label of detected-object and calculate malaria-index value. Finally, after malaria-index value obtained, malaria diagnosis is defined. The algorithm performance with ResNet101 backend shows average precision (AP) 0,94, average recall 0,74, and average accuracy 0,73. Then the usage of ResNet50 backend in RetinaNet algorithm show average precision (AP) 0,90, average recall 0,78 and average accuracy 0,71.
Keywords:	Convolutional Neural Network, Object Detection, Deep Learning, Malaria Detection, Thin Blood Smear Image
Source:	Journal of Theoretical and Applied Information Technology 15^{th} March 2020 -- Vol. 98. No. 05 -- 2020

[Full Text](#)

Title:	CLASSIFICATION OF FACIAL SKIN TYPE USING DISCRETE WAVELET TRANSFORM, CONTRAST, LOCAL BINARY PATTERN AND SUPPORT VECTOR MACHINE
Author:	INDRIYANI , I MADE SUDARMA
Abstract:	There are two effects cosmetics on the skin, namely positive and negative effects. The use of cosmetics in accordance with the skin type will have a positive impact on the skin while the use of cosmetics that do not fit the skin type will negatively affect the skin. Each person's skin type is not the same, therefore it is important to know the type of skin before deciding to buy suitable cosmetics. This research will build an intelligent system that can classify facial skin types by utilizing the concept of data mining. This research uses Discrete Wavelet Transform (DWT), contrast, and Local Binary Pattern (LBP) for extracting the features contained in the face image and use Support Vector Machine (SVM) as the classifier to determine the facial skin type. Based on the experimental results, it is proven that the proposed method able to properly classify facial skin types. The proposed method gives the average classification accuracy of 91.66% with the average running time of 31.571 seconds.
Keywords:	Classification, Facial Skin Type, Discrete Wavelet Transform, Local Binary Pattern, Support Vector Machine
Source:	Journal of Theoretical and Applied Information Technology 15^{th} March 2020 -- Vol. 98. No. 05 -- 2020

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Title:	SOLVING PORTFOLIO SELECTION PROBLEM USING PARTICLE SWARM OPTIMIZATION WITH CARDINALITY AND BOUNDING CONSTRAINTS
Author:	THERESA N. ABIODUN, AYODELE A. ADEBIYI, MARION O. ADEBIYI
Abstract:	The portfolio selection of assets for an investment by investors has remain a challenge in building appropriate portfolio of assets when investing hard earned money into different assets in order to maximize returns and minimize associated risk. Different models have been used to resolve the portfolio selection problem but with some limitations due to the complexity and instantaneity of the portfolio optimization model, however, particle swarm optimization (PSO) algorithm is a good alternative to meet the challenge. This study applied cardinality and bounding constraints to portfolio selection model using a meta-heuristic technique of particle swarm optimization. The implementation of the developed model was done with python programming language. The results of this study were compared with that of the genetic algorithms technique as found in extant literature. The results obtained with the model developed shows that particle swarm optimization approach gives a better result than genetic algorithm in solving portfolio selection problem.
Keywords:	Portfolio, Genetic Algorithm, Particle Swarm Optimization, Cardinality and Bounding

	Constraints.
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020

Full Text

Title:	THE IMPACT OF INNER-PARAMETERS B-MAC PROTOCOL BY TAGUCHI METHOD FOR WSN
Author:	ALAA KAMAL YOUSIF, M.N.MOHD WARIP, MOHAMED ELSHAIKH
Abstract:	The MAC protocols play an important role in the performance of wireless sensor network (WSN). MAC protocols are controlled with set of parameters from being dragged to undesired situation such as reduce the power consumption, listening idle, and overhead. This inner- parameters have direct impact on the efficiency of a MAC protocols and overall network performances. The impacts of theses parameters on reduce the power consumption are less considered. In the literature, a lot of studies concentrates on introducing a new protocols to reduce the power consumption for WSN. This paper aims to analysis the inner-parameters of MAC protocols for WSN power consumption by using Taguchi Delta Analysis (TDA). Moreover, the measure of inner - parameters is very important to find the optimal values to reduce the power consumption. This paper utilized Taguchi method to analysis the impact of B-MAC protocol parameters in WSN scenarios by exploits Taguchi delta analysis. Further, four inner - parameters are investigated in a simulation platform. Moreover, simulation experiments are carried out by OMNET++5 to prove the work in this paper. The obtained results show that inner- parameters B-MAC inner- protocol reduce the power consumption of WSN for two different scenarios.
Keywords:	B-MAC, Taguchi Delta analysis (TDA), Power consumption, Taguchi method, WSN
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020

Full Text

Title:	FACE RECOGNITION FOR ONLINE USERS AUTHENTICATION
Author:	FIRAS AJJOUR, DR. MHD BASSAM KURDY
Abstract:	In the last decade, advancement in Artificial Intelligence attracted a lot of experts that lead to massive growth and advancement in all human life aspects. Therefore, one of the key fields to point at, which attracted a lot of attention and development lately, is Face Recognition. In recent years, Face Recognition tends to be one of the most widely used technologies in many different domains and workspaces, such as emotional recognition, security, health sector, marketing, and retail, etc. this approach will consist of an online system with real-time functionality (close to real-time), that will be responsible for the declaration of users to be recognized later. Based on the recognition results, the system will then grant the users the needed authentication. In this research, various different challenges related to the development and the use of Face Recognition, including the variations in light conditions, camera resolution, processing power, facial changes over time, number of users to be recognized, etc... During this work, â€œViola and Jonesâ€ and â€œMTCNNâ€ were used for face detection, and â€œFaceNetâ€ was applied for facial features extraction. Also, similarity neural network (Similarity Net) has been created to regress similarity percent between userâ€™s featuresâ€™ vectors, beside it has been trained on userâ€™s features by exploiting the Euclidian distance between embeddings. This approach was tested on a group of datasets - personal, Kaggle and LFW dataset. The tests returned 100% successful recognitions on personal and Kaggle dataset, and 99.5% on LFW dataset.
Keywords:	Face Detection, Face Recognition, Facenet, MTCNN (Multi-Task Cascaded Convolutional Neural Networks for Face Detection), Embeddings, Feature Vectors, Kaggle (Website for AI Contests), LFW (Labelled Faces in The Wild), CNN (Convolutional Neural Network), CLAHE (Contrast Limited Adaptive Histogram), Histogram Equalization, Face Authentication.
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020

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Title:	FAST OBJECT DETECTION FRAMEWORK BASED ON MOBILENETV2 ARCHITECTURE AND ENHANCED FEATURE PYRAMID
Author:	HOANH NGUYEN

Abstract:	Recently, many object detectors based on deep convolutional neural networks such as Faster R-CNN, SSD, RetinaNet, and so on have been proposed and showed significant improvements over traditional object detectors. However, these deep learning-based object detectors usually focus on detection accuracy. This paper proposes a one-stage deep learning-based object detection framework to improve the inference speed and achieve real-time object detection in outdoor scene images without compromising on accuracy. To improve the inference speed, this paper adopts MobileNet v2 architecture at first to generate the base convolution feature maps. MobileNet v2 achieved comparable performance compared with other state-of-the-art networks while being simpler and faster. To improve the detection accuracy, an enhanced feature pyramid generation module is used to construct rich and multi-scale feature maps from a single resolution input image. Each feature level is a high-level semantic feature map and can be used for detecting objects at a different scale. Finally, a detection network which includes a classification subnet to predict the probability of object presence and a box regression subnet to regress the offset from each anchor box to a nearby ground-truth object is attached to each feature level in the enhanced feature pyramid to locate objects at different scales. In addition, focal loss function is used in the classification branch of the detection network to dedicate the class imbalance problems for the one-stage object detector. Experimental results on public datasets show that the proposed approach achieves nearly as performance as other state-of-the-art approaches, while the inference speed is significant improved.
Keywords:	Deep Learning, Object Detection, Convolutional Neural Networks, MobileNets, Feature Pyramid
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Title:	AN EFFICIENT INTRUSION DETECTION APPROACH USING LIGHT GRADIENT BOOSTING
Author:	HAYEL KHAFAJEH
Abstract:	Nowadays, network security has been received more attention from researchers. Intrusion detection systems (IDSs) serves as an essential element of network security. In order to increase the networkâ€™s security, machine-learning algorithms may be utilized for the detection and prevention of the attacks that launched against the network. The researcher of this study used LightGBMâ€™s algorithm for training a model in order to detect several types of network attacks. The proposed approach was compared with classical machine learning in terms of performance on the same dataset. The experimental results show that the proposed approach achieves a detection rate of 97.4% with a false-positive rate of 0.9%.
Keywords:	Network security, IDS, Machine learning, LGBM.
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Title:	INFORMATION RISK BEFORE AND AFTER XBRL (EXTENSIBLE BUSINESS REPORTING LANGUAGE) IMPLEMENTATION: A STUDY ON LQ45 INDEX OF INDONESIAN STOCK EXCHANGE
Author:	ADHITYA AGRI PUTRA, NANDA FITO MELA
Abstract:	This research is aimed to examine effect of XBRL implementation by LQ45 companies on information risk. Research samples are 108 companies listed in LQ45 index of Indonesian Stock Exchange 2013-2016. Information research is measured by event return volatility, information efficiency, change of standard deviation of daily return, and bid-ask spread. Data analysis uses common-effect regression for event return volatility, change of standard deviation of daily return, and bid-ask spread; and random-effect regression for information efficiency. The result shows that XBRL implementation by LQ 45 companies has negative effect on information risk. It indicates that XBRL implementation reduce information risk by decreasing of return volatility, standard deviation of stock return, change of standard deviation of daily stock return, and bid-ask spread. XBRL implementation is useful for improvement of information accuracy, reducing of information asymmetry, reducing of error, and allows investor to make stock investment decision rapidly, accurately, and low cost.
Keywords:	Information Risk, XBRL Implementation, LQ45 Index, Indonesian Stock Exchange, XBRL based Financial Reporting
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Title:	COMPUTATIONAL ANALYSIS OF DNA SEQUENCES BASED UPON AN INNOVATIVE MATHEMATICAL HYBRIDIZATION MECHANISM OF PROBABILISTIC CELLULAR AUTOMATA AND PARTICLE SWARM OPTIMIZATION
Author:	WESAM M. ELSAYED , MOHAMMED ELMOGY , B.S. EL-DESOUKY
Abstract:	The deoxyribonucleic acid (DNA) sequence reconstruction problem is a very complex issue of computational biology. In this paper, we introduce a modified procedure for the reconstruction process based on probabilistic cellular automata (PCA) integrated with a particle swarm optimization (PSO) algorithm. PSO is utilized to detect the optimal and adequate transition rules of cellular automata (CA) for the reconstruction process. This integration makes our algorithm more efficient. The evolution of organisms occurs due to mutations of DNA sequences. As a result, we attempt to model the evolutions of DNA sequences using our proposed system. In Particular, we determine the impact of neighboring DNA base pairs on the mutation process. We used CA rules for analysis and prediction of the DNA sequence. Our innovative model leans on the hypothesis that mutations are probabilistic events. As a result, their evolution can be simulated as a PCA model, and this enables us to discover the effects of some neighborhood base-pairs on a DNA segment evolution. The main target of this paper is to analyze various DNA sequences and try to predict the changes that occur in DNA sequences during evolution (mutations). We use a similarity score as our measure of fitness to detect symmetry relations, which in turn makes our method appropriate for comparison of numerous extremely long sequences. Phylogenetic trees are exhibited in order to view our investigated samples. Unlike using Markov chains, our proposed technique does not reveal biases in mutation rates that depend on the neighboring bases, which indicates the effect of neighbors on mutations. Incorporating probabilistic components in our proposed technique helps to produce a tool capable of foretelling the likelihood of specific mutations.
Keywords:	DNA Sequence Reconstruction, Computational Biology, Mutation Rates, Probabilistic Cellular Automata (PCA), Particle Swarm Optimization (PSO).
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Full Text

Title:	AN IMPROVEMENT OF SIMILARITY IN CASE BASED REASONING USING SUBJECTIVE-GENERALIZED WEIGHT FOR TRADITIONAL INDONESIAN CUISINE
Author:	SETYAWAN WIBISONO, WIWIEN HADIKURNIAWATI, HERNY FEBRUARIYANTI, MARDI SISWO UTOMO
Abstract:	In this study, a system for providing recommendations from a traditional Indonesian food recipe consultation using the CBR (Case Based Reasoning) method was designed. A recommendation is given based on the similarity of the input in the form of ingredients for cooking compared to the ingredients for cooking from a recipe that has been stored in the database. Increasing the accuracy of the similarity value is the goal to be achieved in this study. This method used is intented to give the weight to each food-forming material, then the Dice algorithm is used to calculate the value of similarity. Weighting is determined subjectively but takes into account the principle of appropriateness in general. Test the validity of the weight value using the weighting principles in the AHP (Analytical Hierarchy Process). This makes the value of the similarity of a recipe suggestion more accurate because it considers proportional weighting of the ingredients forming the recipe.
Keywords:	consultation similarity value, CBR, weighting, Dice algorithm, AHP
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Title:	METHODS AND ALGORITHMS OF ANALYZING SYLLABUSES FOR EDUCATIONAL PROGRAMS FORMING INTELLECTUAL SYSTEM
Author:	D. KAIBASSOVA, L. LA, A. SMAGULOVA, L. LISITSYNA, A. SHIKOV, M. NURTAY
Abstract:	This article reviews using methods of intellectual data analysis for educational program formation in the context of determining the sequence of studying disciplines in the direction by consideration. The model of the forming educational programs that satisfy given competencies is described on the basis of text documents processing through their vector representations. Proposed model performs clustering of text documents taking into weights coefficient of individual words in the corpus. The article succinctly describes the developed software application that allows extract information from text documents, process, analyze, and visualize data. Testing was carried out according to data obtained from 350 syllabuses

	of disciplines for conformity with 120 competencies in the areas of IT-specialists training. This research solves the issues of intellectual support for the educational programs disciplines of higher education with a view to diminish the complexity of developing new educational programs and improve the quality of academic content.
Keywords:	Educational Program, Information Extraction, Vectorization, Text Mining, Cosine Similarity, Hierarchical Clustering.
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020
	Full Text

Title:	A FAST PYRAMID NETWORK FOR ACCURATE LOCALIZATION OF CAR IN AERIAL IMAGES
Author:	HOANH NGUYEN
Abstract:	Although deep learning-based object detectors have achieved great success in general object detection in recent years, detecting of objects like car in aerial images is still a challenge. The main difficulty of car detection in aerial images comes from the relatively small size with multiple orientations of car in images. In addition, due to the high resolution of aerial images, the inference time of current approaches is still high. To solve these problems, this paper proposes an enhanced framework for fast and efficient car detection in aerial images. In the proposed approach, ResNet-34 architecture is adopted to create the base convolution layers. Compared with ResNet-50 and ResNet-101, ResNet-34 achieves comparable performance while being faster and simple. Then, an enhanced feature map generation module is designed to generate enhanced feature maps from input feature maps. To speed up the detection process, the detection network based on region proposal network is used to exactly locate cars in original aerial images. The detection network included region proposal networks is applied at different enhanced feature maps with different scales to detect multi-scale car in input image. Experimental results on public dataset show that the proposed approach achieves comparable performance compared with other state-of-the-art approaches.
Keywords:	Car Detection, Convolutional Neural Network, Intelligent Transportation System, Object Detection, Pyramid Network
Source:	Journal of Theoretical and Applied Information Technology 15th March 2020 -- Vol. 98. No. 05 -- 2020
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Journal of Theoretical and Applied Information Technology
15th March 2020. Vol.98. No 05

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

AUTOMATED MALARIA DIAGNOSIS USING OBJECT DETECTION RETINA-NET BASED ON THIN BLOOD SMEAR IMAGE

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ABSTRACT

Malaria diagnosis is decided based on index malaria value which calculated from the amount of normal and infected erythrocyte on thin blood smear using microscope by a clinical pathologist. This activity is done manually and wastes a lot of time. Object detection using Convolutional Neural Network (CNN) is one of approach for solving this problem. However, the traditional object detection using CNN shows inadequate classification performance in labelling classes object. This paper is focused on the implementation of RetinaNet object detection approach to diagnose malaria. First, ResNet101 and ResNet50 used as RetinaNet backend network architecture for detecting both normal and infected erythrocytes on thin blood smear image with 1000x microscope zoom. Next, count every label of detected-object and calculate malaria-index value. Finally, after malaria-index value obtained, malaria diagnosis is defined. The algorithm performance with ResNet101 backend shows average precision (AP) 0,94, average recall 0,74, and average accuracy 0,73. Then the usage of ResNet50 backend in RetinaNet algorithm show average precision (AP) 0,90, average recall 0,78 and average accuracy 0,71.

Keywords: *Convolutional Neural Network, Object Detection, Deep Learning, Malaria Detection, Thin Blood Smear Image*

1. INTRODUCTION

Malaria is one of disease which caused by plasmodium parasite that infects red blood cells [1]. Reported by Indonesian ministry of health on malaria InfoDatin, east area of Indonesia, particularly Papua, still reported as endemic area of malaria or in other words, there still a lot of malaria cases in Papua [2]. But, the cases of malaria still occur in non-endemic malaria area such as west java. One of malaria diagnosis procedure is laboratory test on red blood cells of a patient [3]. The laboratory test done on thin blood film which created from blood cells sample of patient that put on the blood film and Giemsa staining. Furthermore, the clinical pathologist calculates the index malaria value from infected and normal founded erythrocytes using microscope manually. Based on Soergadegar research about automated *parasitemia* counting in [4], counting the number of erythrocytes is time-consuming activity. If the expert found the infected erythrocyte, then the patient diagnosed malaria.

Object detection approach focuses not only on labelling different images but also try to define the form and locate the object precisely in each image [5]. The number of dataset and variant of dataset in training object detection may affect the system in recognizing the object and the location of object in each image. Big amount and more variance dataset can make the system more precisely detecting the target object and both factors may reduce the *over-fitting*. The other necessary component of object detection such as feature detector, hypothesis formation and hypothesis verification must be contained in a system [5]. Object detection framework divided into two categories. First category is region proposed based framework [5] such as RCNN, Fast R-CNN [7], Faster R-CNN [8], FPN [9], and Mask R-CNN [10]. Second category is classification-based framework [5] such as Yolo [11] and SSD [12]. Region based framework better in detecting every single object precisely, but the weakness is this method take a lot of time for define every object. On the other hand, the classification framework performance in detection object is not good enough as region proposed framework, but the time required is no long as region proposed framework need. Both techniques have pros and cons. Moreover, there is a hybrid model which designed by combine both FPN as feature extractor and classification based framework technique to define the bounding box and label of object called RetinaNet [12]. RetinaNet also use focal loss as loss function to minimize the loss information during training process. Most of object detection with deep learning approach use Convolutional Neural Network (CNN) used as feature detector or feature extractor in this approach [13].

A lot of deep learning CNN methods are implemented on medical field to identify cell object or bacterial counting. Deep CNN is implemented in [14] for counting bacteria colonies on microbiological plates. In malaria field, two papers implemented deep learning approaches to identify malaria. Deep CNN [15] used thick blood smear identifier to diagnose malaria. [4] implements R-CNN for identify the normal and infected erythrocytes on thin blood smear image then count the index value of malaria using smartphone camera. Faster R-CNN is implemented in [16] for detecting type of *plasmodium vivax* which infected red blood cell and leukocyte from thin blood smear image.

From [4] research, the R-CNN performance of classifying object is inadequate performance and counting *parasitemia* is time-consuming activity. This paper is motivated by those problems to implement RetinaNet object detection to identify erythrocytes object and diagnose malaria.

This paper is organized as follows: an introduction in section 1. The previous work of related topics presented in section 2. The state-of-the-art of this work described in section 3. Section 4 described the experimental result from the state-of-the-art. To conclude all section, section 5 explain the conclusion of this paper.

2. RELATED WORK

The previous work about malaria done by Zhang et al. [17] introduced robust template of infected and normal erythrocytes classification. Histogram of Oriented Gradient (HOG) used as a feature extractor from the template and Viola-Jones object detection framework is used for detecting normal, infected red blood cells, and image background. Later, Quinn et al. [15] implement deep convolutional neural network architecture for diagnosing malaria based on thick blood smear image, tuberculosis in sputum samples, and intestinal parasite eggs in stool samples. Quinn et. al research diagnose malaria by detecting Plasmodium from thick blood film images which taken from dedicated microscope camera. Poostchi et al. [18] try to exploration in detecting malaria from thin and thick blood smear image with a lot of configuration algorithms. Poostchi et al divide their research into pre-processing, segmentation, and classification parts. Each part contains with some algorithm techniques. For example, wavelet transform, gradient texture, Fractal, etc. used in pre-processing part. Then, feature extraction based on color, texture, and morphologic are applied in each image. Supervised learning such as bayesian classifier, naïve bayes tree [19], k-nearest neighbors classifier [20], linear discriminant (LD) [21], support vector machine (SVM) [22],[23], normalized cross-correlation [24], deep learning approach [25],[26], [27],[28], etc.

Recently, another deep learning methods such R-CNN applied on automated *parasitemia* counting by Sorgedrageron his paper [4]. Sorgedrager implements R-CNN with improvement in feature extraction parts by splitting every object in images into small pieces then classify them into healthy and infected erythrocytes. The research done with low resolution image that taken from smartphone camera and the experimental result of the method compared with 2 experts. Moreover, Faster R-CNN method is applied by Hung et.al [16] on detecting the types of *plasmodium vivax* on red blood cells and leukocyte objects based on thin blood smears image.

This paper implements the novel object detection techniques RetinaNet on malaria diagnosis based on thin blood smear images.

3. APPROACH

Figure 1 shows the block diagram of overall framework in this research. Standard RetinaNet state-of-the-art applied in this paper. Figure 2 which taken originally from [12]. It describes the general RetinaNet state-of-the-art. In the training process part, each data training labelled with ***LabelImg*** in every erythrocytes object for both normal and infected erythrocytes then save the label in xml format, then convert the *.xml file into *.csv file. Every data training will firstly preprocessing using image data generator function from *Keras* such as random flip, rotate, and dilatation. Then every erythrocytes object in each image will be extracted by residual model CNN of ResNet101 and ResNet50 backend in 100 epochs which shown in part a of Figure 2. Then the feature of every object will be created as feature pyramid network which shown in

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part b of Figure 2. The detail of residual model process is drawn in Figure 3 which taken from [29]. After the feature of each object extracted, the loss function will be calculated for every class of label with focal loss function in this following equation. Based on [12], α=0,25 and γ=2.

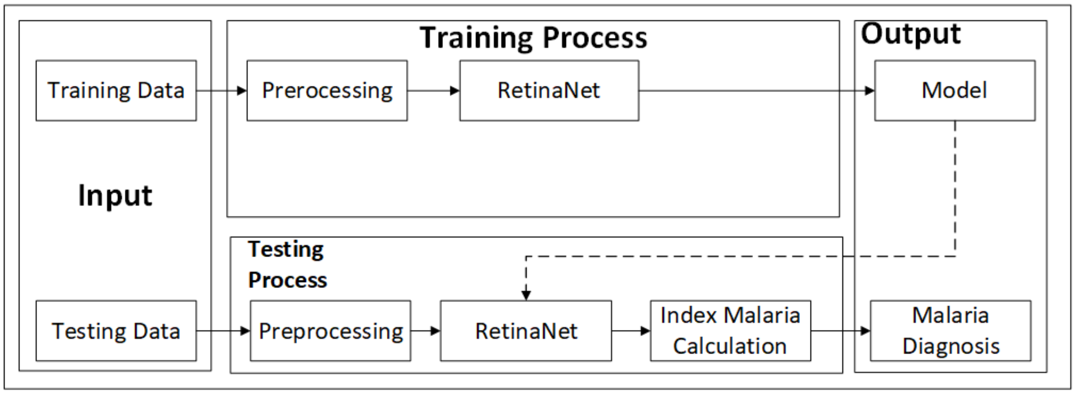

Figure 1 Block Diagram of the Research

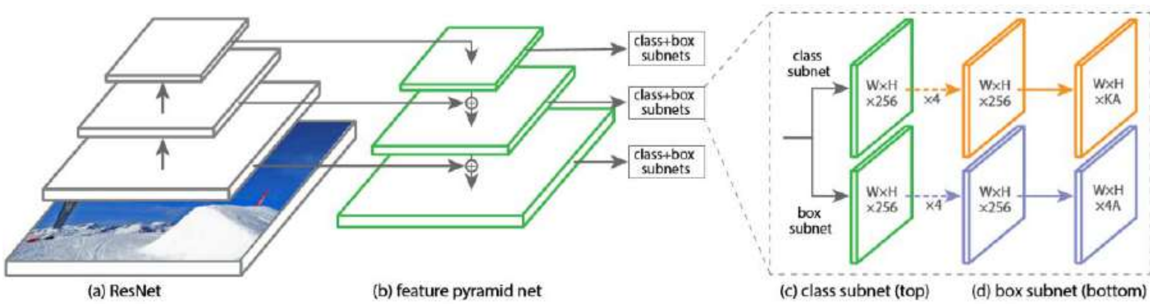

Figure 2 State-of-the-art RetinaNet

$$FL(p_t) = -\alpha(1-p_t)^{\gamma}\log(p_t) \ldots\ldots (1)$$

In the testing part of the system, firstly pre-processing is done with each testing image by extract the ImageNet mean [30]. Every RGB matrix image will be extracted then convert the matrix into BGR type and reduced by caffe mode filter with this following equation.

$$B\,[\ldots,0] -= 103{,}939$$
$$G\,[\ldots,1] -= 116{,}779 \ldots\ldots\ldots\ldots\ (2)$$
$$R\,[\ldots,2] -= 123{,}68$$

Futhermore, the extracted feature of image done in each pre-processing result image by FPN with ResNet101 and ResNet50 backend. The output from feature extraction are P_3 – P_7 pyramid of FPN. Parallel process such labelling in classification subnet and creating fixed bounding box in box-regression subnet applied on the result of feature extraction. Classification subnet contain simple fully connected network (FCN) which applies four 3x3 convolution on pyramid feature result from feature extraction with C channels followed by ReLU activation. Then,3x3 convolution with K A filters applied on the previous result. As default of RetinaNet architecture the value of C=256 and A=9. In box regression subnet, simple FCN as FCN in classification subnet applied on each pyramid level for the purpose of regressing the offset from each

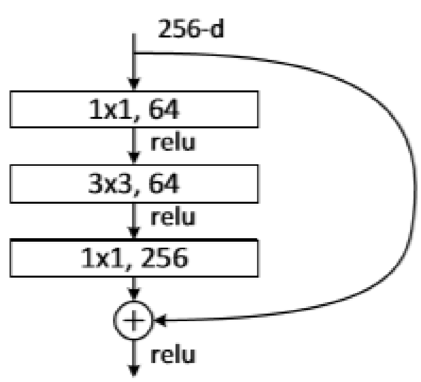

Figure 3 Residual Model

anchor box to a nearby ground-truth object. To improve the prediction speed, predicted box is applied on 1000 top-scoring box in each FPN level and to get final prediction of the bounding box, all prediction in each FPN level combined with non-maximum suppression with 0,5 threshold.

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Finally, to calculate the malaria index value equation (3) applied in this paper.

$$index\ malaria = \frac{x}{y} x100\% \ .... (3)$$

The value of $\boldsymbol{x}$ in equation (3) is the number of infected erythrocytes, and $\boldsymbol{y}$ is the number of normal and infected erythrocytes from detected erythrocytes object in testing image. If the index value more than 0%, then the diagnosis of patient is malaria.

4. RESULTS

In this section, this paper compares the performance of RetinaNet state-of-the-art with ResNet101 and ResNet50 backend. This method is implemented in two machines. First machine which used for training the data has Xeon processor, 64 GB RAM, Nvidia Tesla V100, and 100 GB SSD specification form floydhub.com server. The second machine that used for testing the model has i7 4720HQ, 12 GB RAM, Nvidia Geforce 940M, and 256 GB SSD specification. The experiment uses Tensorflow and Keras for implementing RetinaNet model.

4.1 Dataset

This research uses dataset image from [16] and Dr Yani Triyani repositories. This dataset contains 25 images for testing and 2 images for training from [16],75 images for testing and 4 images for training from Dr. Yani Triyani. The amount of training data is 255 objects which divided into 2 classes label, Normal and Infected erythrocytes. Each image has varied size. Testing dataset are divided into 2 parts testing. First part of testing is done with 75 images which contain infected and normal erythrocytes in each image. Second part of testing is done with 25 images which contain normal erythrocytes to test the system in testing normal erythrocytes. Some examples of training data are shown in Figure 4 and Figure 5. The detail example of Normal erythrocyte is shown in Figure 6 and infected erythrocytes is shown in Figure 7.

4.2 Evaluation Criterion

To evaluate the method performance in both ResNet50 and ResNet101 backend in RetinaNet model, this paper uses precision, recall, and accuracy to get quantitative value of evaluation. Precision, recall, and accuracy evaluation is one of image field evaluation either machine learning, deep learning, or information retrieval [31][32][33]. Precision is defined as how relevant the algorithm or a method predict the object, recall is defined as how the algorithm can retrieve the object, while accuracy is defined as the correctness of classification object [32].

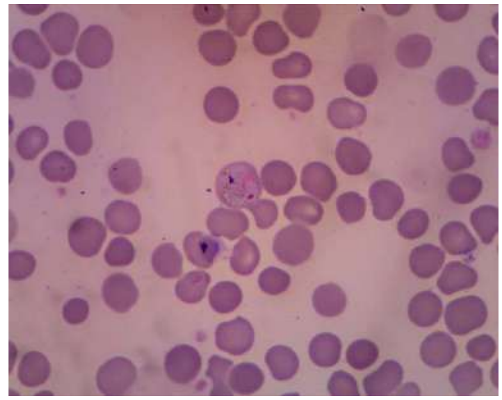

Figure 4 Example of Training Data from Dr Yani Triyani Repositories

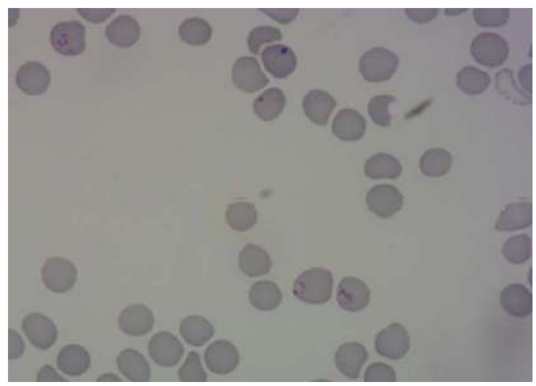

Figure 5 Example of Training Data from Hung et.al Research

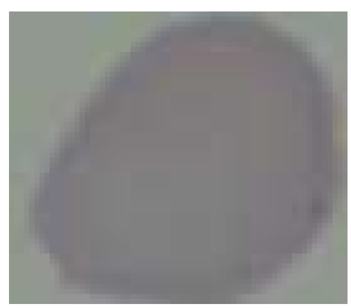

Figure 6 Normal Erythrocytes

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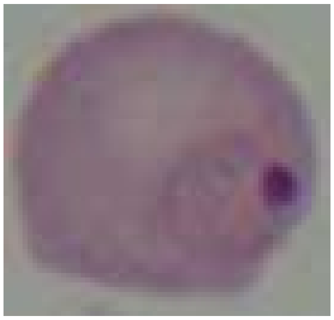

Figure 7 Infected Erythrocytes

4.3 Training

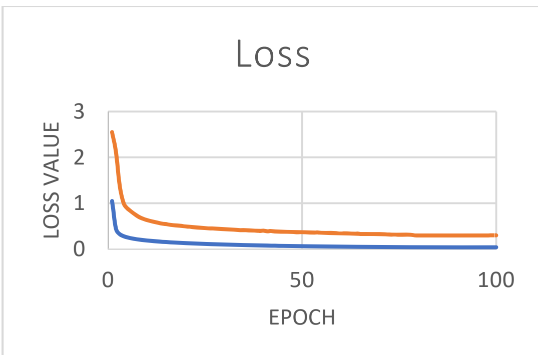

Figure 8 Loss Graph Value

The model used in this paper is based on custom training with 255 objects data training without using pre-trained model. The model is built with 100 epoch and 16 batch size training setting for both ResNet50 and ResNet101 backend. From 100 epoch training, RetinaNet model with ResNet101 backend shows 0,0398 classification loss and 0,2986 regression loss while ResNet50 backend shows 0,0461 classification loss and 0,316 regression loss. Figure 8 illustrates the graph of resulted loss value during training. The training of RetinaNet with ResNet101 backend done in 28 hours while RetinaNet with ResNet50 backend done in 23 hours.

4.4 Experimental Result

To give rich information about implementation of RetinaNet object detection in malaria cases, this paper compares RetinaNet with ResNet101 and ResNet50 backend in detecting malaria from thin blood smear images. The comparison based on 100x testing which divided into 3 categories testing. In the first testing, 50 images which contain infected and normal erythrocytes object in each image from [14]. The second testing used 50 images which contain both infected and normal erythrocytes from Dr Yani Triyani repositories, and the third testing is a particular testing to test the system in detecting normal erythrocytes with 25 images from Dr Yani Triyani repositories. From the first and second testing, both model of system can calculate the malaria index value and decide the malaria diagnosis based on index value which obtained from normal and infected erythrocytes object in each image.

In Table 1 and Table 2 shows the 10 example results of first and second testing compare with the doctor result which determined as ground truth value. In both tables, the result of the testing with ResNet101 and ResNet50 backend of RetinaNet model show various difference of detected objects and index value comparing to the doctor result. Both models show the difference results either. The diversity result of the model can be affected by difference layer of the the backend, then every model extracts the different features of every object in each image, from that different feature the system decides the different predict object. In Figure 9 and Figure 10 illustrates the one of identification result in first parts testing with ResNet101 and ResNet50 on RetinaNet model. Additionally, in Figure 11 and Figure 12 describes the one of identification result in second parts testing with ResNet101 and ResNet50 on RetinaNet model

Table 1 10 Samples of Detection Result from Hung et.al Testing Images

Images	Normal			Infected			Index Value			Diagnosis
	A	B	D	A	B	D	A	B	D	
4	18	19	24	3	5	1	15%	21%	4%	Infected Malaria
5	16	17	58	3	2	3	16%	11%	5%	Infected Malaria
6	13	13	54	5	5	6	28%	28%	10%	Infected Malaria
7	16	10	40	4	8	4	20%	44%	9%	Infected Malaria
8	9	18	58	2	2	2	18%	10%	3%	Infected Malaria
9	7	20	41	5	4	3	42%	17%	7%	Infected Malaria
12	38	38	49	1	1	2	3%	3%	4%	Infected Malaria
13	15	20	35	6	1	1	29%	5%	3%	Infected Malaria
14	22	18	33	3	5	1	12%	22%	3%	Infected Malaria
15	31	29	34	1	3	1	3%	9%	3%	Infected Malaria

Journal of Theoretical and Applied Information Technology
15th March 2020. Vol.98. No 05

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

5 sample results of the third testing are shown in Table 3. Within 25 image testing, both models successfully detect normal erythrocytes object, but in some images, there are miss-prediction object done by both models. Figure13 shows the example of the third testing result with miss-prediction.

Red box on Figure 9 – Figure 13 show the normal erythrocytes and orange box show the infected erythrocytes. Then, label A in Table 1-3 means the result of RetinaNet model with ResNet101 backend, Label B means the result of RetinaNet model with ResNet50 backend and D means the result of doctor identification.

Table 2 10 Samples of Detection Result from Dr Yani Triyani Testing Images

Images	Normal			Infected			Index Value			Diagnosis
	A	B	D	A	B	D	A	B	D	
74	50	51	50	3	2	1	6%	4%	1,96%	Infected Malaria
75	55	56	58	1	2	1	2%	3%	1,69%	Infected Malaria
76	49	40	52	2	4	1	4%	9%	1,89%	Infected Malaria
77	46	44	50	5	5	2	10%	10%	3,85%	Infected Malaria
78	51	49	50	10	3	11	16%	6%	18,03%	Infected Malaria
79	49	58	62	3	3	1	6%	5%	1,59%	Infected Malaria
80	38	50	68	8	3	3	17%	6%	4,23%	Infected Malaria
81	37	51	61	10	2	2	21%	4%	3,17%	Infected Malaria
82	39	43	43	15	12	14	28%	22%	24,56%	Infected Malaria
83	26	17	33	12	19	14	32%	53%	29,79%	InfectedMalaria

Table 3 Sample of Normal Detection Results

Images	A	B	D
1	85	87	83
2	89	94	81
3	77	78	74
4	103	110	97
5	82	78	88

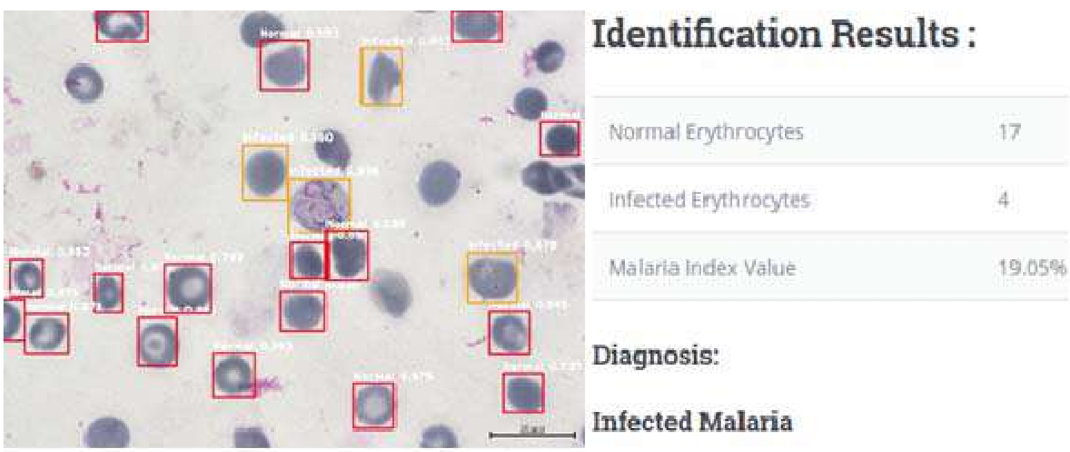

Figure 9 RetinaNet with ResNet101 Backend Identification Result on Hung et.al Testing Image

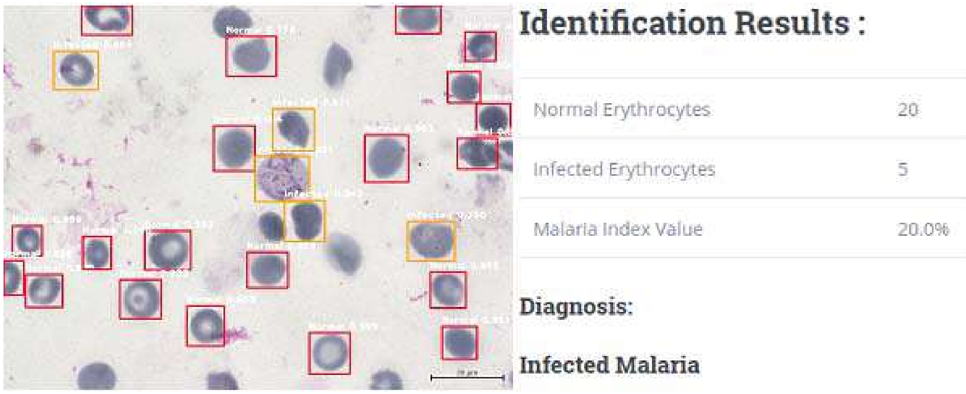

Figure 10 RetinaNet with ResNet50 Backend Identification Result on Hung et.al Testing Image

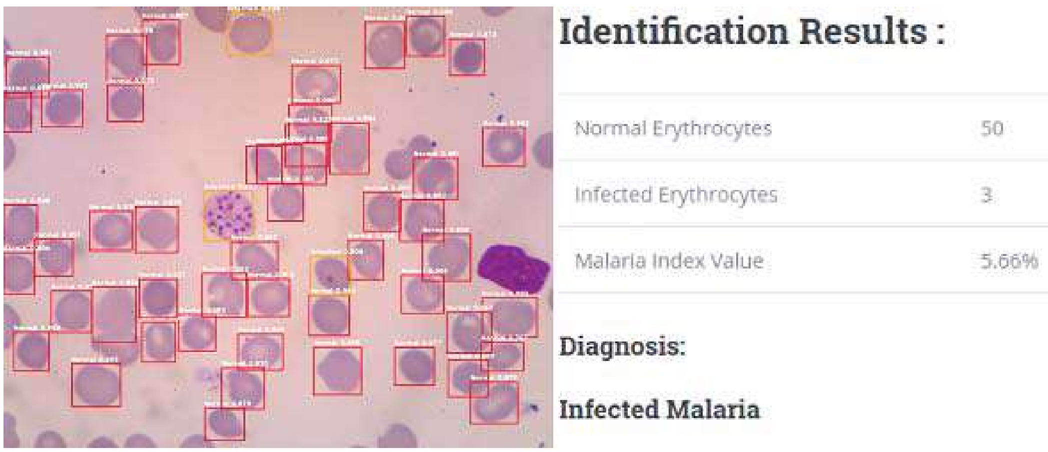

Figure 11 RetinaNet with ResNet101 Backend Identification Result on Dr YaniTriyani Repositories Testing Image

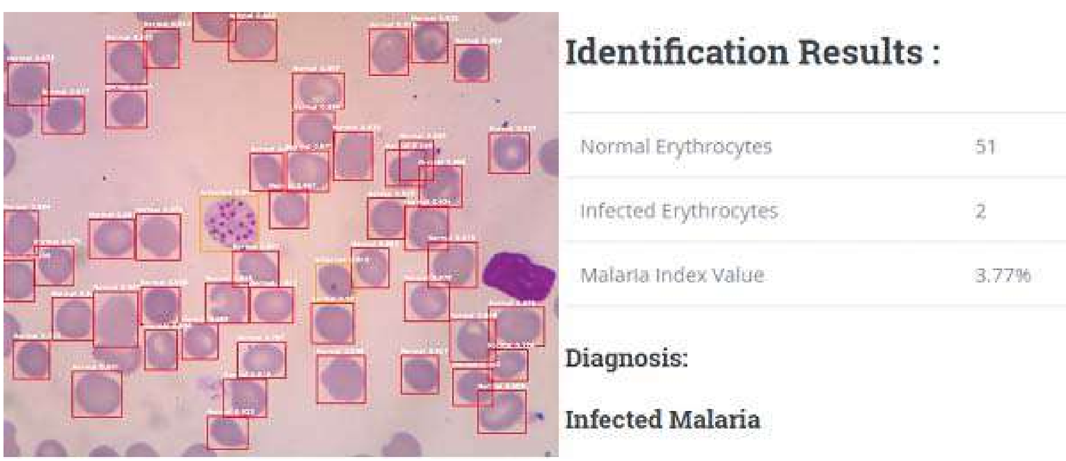

Figure 12 RetinaNet with ResNet50 Backend Identification Result on Dr YaniTriyani Repositories Testing Image

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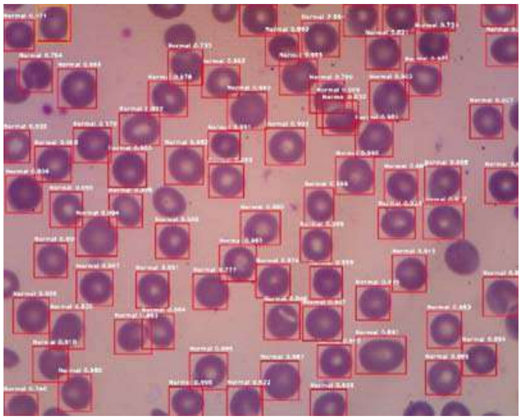

Figure 13 Missprediction Label Example

To give measurable RetinaNet performance in detecting erythrocytes object, Table 4 shows average result of precision, recall, and accuracy value within erythrocytes detection by RetinaNet model with ReNet101 and ResNet50 backend. A model with ResNet101 backend gives a better result in precision with 0,94 value than [4] in detecting erythrocytes object. Recall and accuracy values of both models shows inadequate performance. RetinaNet with ResNet101 backend gives 0,74 recall and 0,73 accuracy and ResNet50 backend in RetinaNet model gives 0,78 recall and 0,71 accuracy. This can be due to small amount of training data while creating the model. Then, every model predicts the various erythrocytes object not optimally. Small amount of training data caused by financial issue for renting the floydhub.com server. To give easy reading, Figure 14 illustrates the chart of precision, recall, and accuracy in erythrocytes detection.

On the other hand, this paper also evaluates the model in classifying normal and infected erythrocytes within precision, recall, and accuracy value. Table 5 informs the average result of giving normal label in erythrocytes object during testing and Figure 15 illustrates the chart of classifying normal erythrocytes performance. Both backend in RetinaNet models show satisfied performance in labelling normal erythrocytes. RetinaNet with ResNet101 backend shows 1,0 precision, 0,98 recall and 0,98 accuracy while RetinaNet with ResNet50 shows 0,99 precision, 1,0 recall, and 1,0 accuracy. In evaluating of infected labelling within erythrocytes object, Table 6 shows the average precision, recall, and accuracy in labelling infected erythrocytes. Both back-ends in RetinaNet model give inadequate precision result and better result in recall and accuracy side. RetinaNet with ResNet101 backend gives 0,67 precision, 1,0 recall, and 0,99 accuracy. Moreover, RetinaNet with ResNet50 backend gives 0,64 precision and 1,0 of recall and accuracy. In Figure16, shows the graph of average precision, recall, and accuracy of RetinaNet model with both backend.

Table 4 Evaluation Result of Erythrocytes Detection

Evaluation	ResNet101			ResNet50		
	Precision	Recall	Accuracy	Precision	Recall	Accuracy
1	0,92	0,53	0,56	0,84	0,64	0,56
2	0,94	0,85	0,80	0,92	0,81	0,75
3	0,96	0,85	0,82	0,95	0,88	0,83
Average	0,94	0,74	0,73	0,90	0,78	0,71

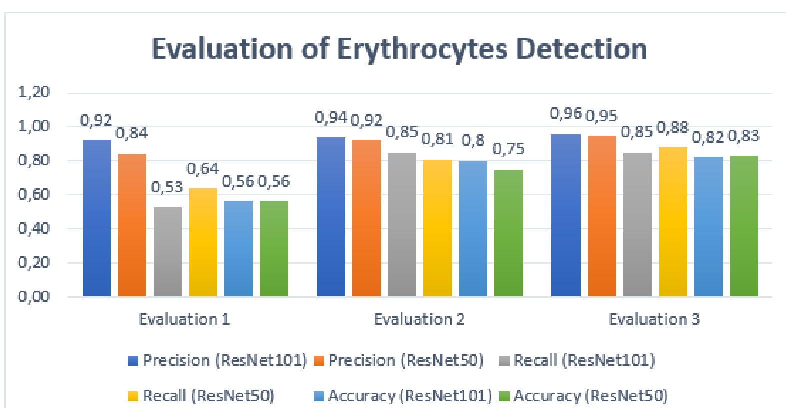

Figure 14 Graph of Evaluation Erythrocytes Detection

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Table 5 Evaluation Result of Labelling Normal Erythrocytes

Evaluation	ResNet101			ResNet50		
	Precision	Recall	Accuracy	Precision	Recall	Accuracy
1	1,00	0,96	0,96	0,99	1,00	1,00
2	1,00	1,00	1,00	0,99	1,00	1,00
3	0,99	0,99	0,99	0,99	0,99	0,99
Average	1,00	0,98	0,98	0,99	1,00	1,00

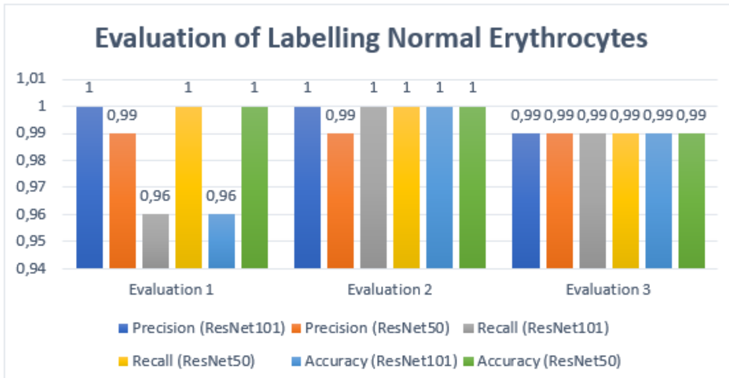

Figure 15 Graph of Evaluation Labelling Normal Erythrocytes

Table 6 Evaluation Result of Labelling Infected Erythrocytes

Evaluation	ResNet101			ResNet50		
	Precision	Recall	Accuracy	Precision	Recall	Accuracy
1	0,71	0,99	0,98	0,66	1,00	1,00
2	0,62	1,00	1,00	0,62	1,00	1,00
Average	0,67	1,00	0,99	0,64	1,00	1,00

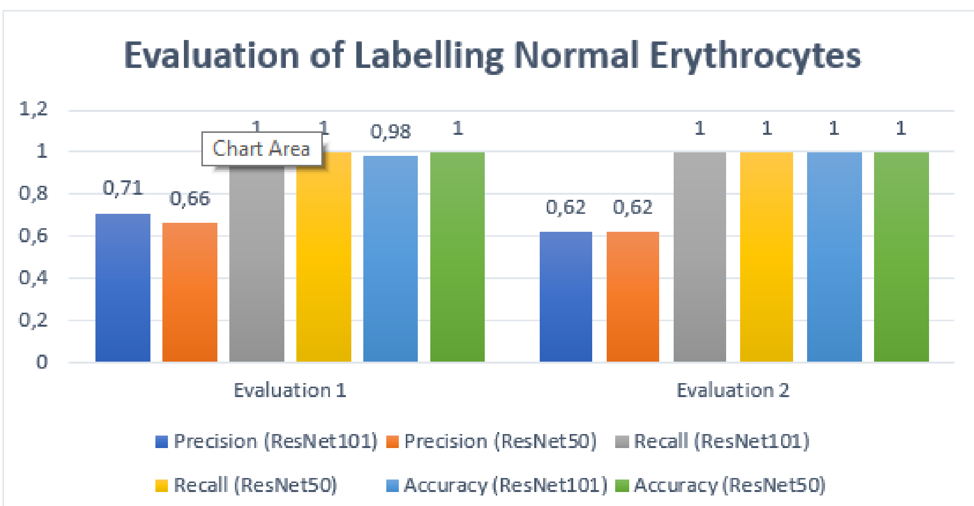

Figure 16 Graph of Evaluation Labelling Infected Erythrocytes

5. CONCLUSIONS

In this paper, RetinaNet object detection approach is applied for diagnosing malaria based on thin blood smear image with ResNet101 and ResNet50 backend. Based on third evaluation with 100 images, RetinaNet with both ResNet101 and ResNet50 backend show the adequate performance in detecting erythrocytes object and labelling normal erythrocytes. But in labelling infected erythrocytes this model performs inadequate with low score of precision value. This can be due to small amount and

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

variation of infected erythrocytes data training. However, both back-ends of RetinaNet model can successfully diagnose malaria. Thus, for improving the the performance of RetinaNet model in identifying malaria object from erythrocytes, enlarging the amount of training data must be tried.

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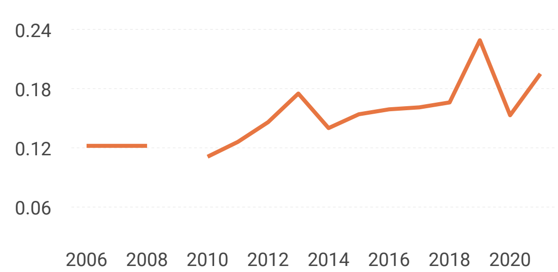

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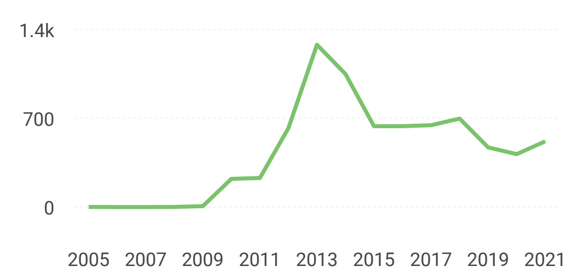

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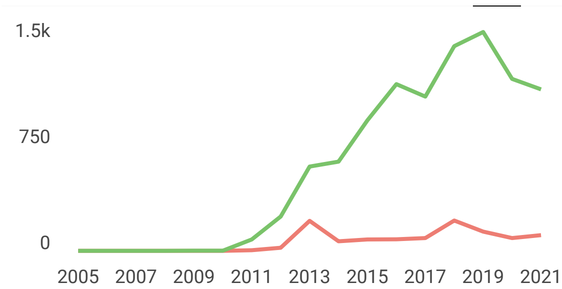

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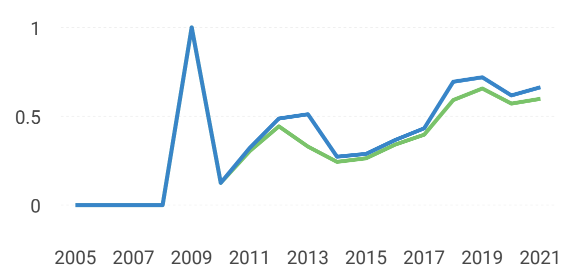

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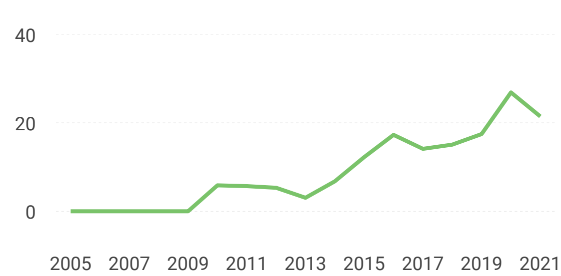

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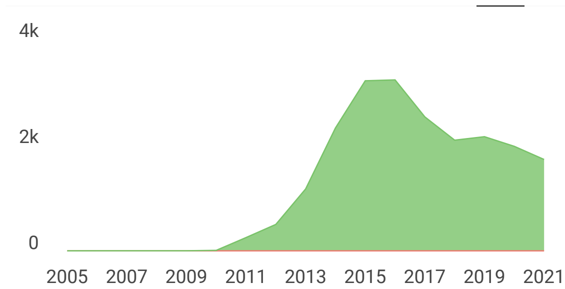

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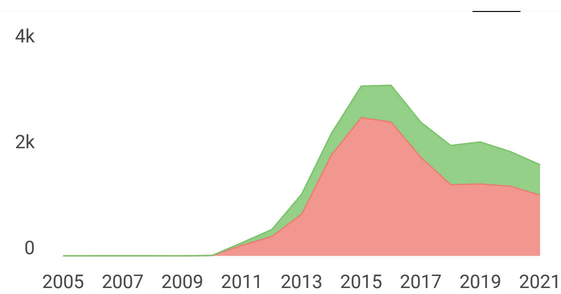

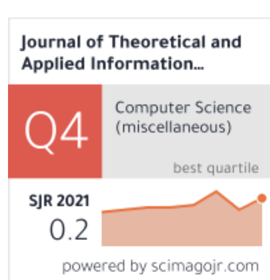

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