TRIBHUVAN UNIVERSITY
BIRENDRA MEMORIAL COLLEGE

A PROPOSAL REPORT ON
" MeroMath: Your Pocket Math Genius "
AN E-LEARNING MATH PROBLEM SOLVING APP

IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE BACHELOR DEGREE IN COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

SUBMITTED TO
DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
BIRENDRA MEMORIAL COLLEGE
DHARAN, NEPAL

SUBMITTED BY
GULAB MIYA (24603)
PRAJWAL RAI (24605)
YOGENDRA MAGAR (24611)

12th OCTOBER, 2023

Table of contents :

Contents

LIST OF FIGURE :

1. INTRODUCTION

1.1. BACKGROUND

“MeroMath: Your Pocket Math Genius”, an e-learning math-problem solution app, is a very dynamic and very easy-to-understand android application. It’s an app where images transform into solutions. Our app redefines the way it conquers mathematical challenges, not only by offering instant text-based solutions but also by harnessing the power of visual learning through image-to-text problem solving. This app mainly focuses for higher secondary or intermediate level education (Class 11th and 12th grade, also known as +2 Course.)

1.2. PROBLEM STATEMENT

In a world increasingly reliant on digital platforms for learning and problem-solving, there exists a pressing need for a comprehensive, user-friendly e-learning math problem solution application. This application, named "MeroMath: Your Pocket Math Genius," aims to bridge the gap between mathematical challenges and accessible solutions, particularly by utilizing its unique feature of image-to-text problem-solving.

The challenges encountered in the present system are a major drawback to the realization of efficiency and satisfaction. There isn't a proper platform which is fully based on Nepali education system.

1.3. APPLICATION

1.3.1. SCOPE

We will develop a system that will provide the following opportunities/scopes in the today’s modern technology world:

Educational Reach: "MeroMath" can cater to students of all ages, in higher secondary or intermediate level education. Educational Institutions can be adopted as a supplementary learning tool, enhancing their math curriculum. This app can serve as a valuable resource for tutoring services and test preparation courses.

Global Accessibility: "MeroMath" has the potential to reach a global audience and make quality math education accessible to anyone with a smartphone or internet access.

Continuous Learning: "MeroMath" can support lifelong learning, enabling individuals to revi sit and reinforce their math skills as needed.

Monetization Opportunities: "MeroMath" can explore revenue streams through a combination of free and premium subscription models, in-app advertisements, or partnerships with educational institutions.

1.3.2. OBJECTIVE

- Efficient Image-to-Text Conversion: Develop a fast and accurate image recognition system.
- Instant Problem Solving: Provide immediate and step-by-step math solutions.
- Adaptive Learning: Personalize the learning experience. Multilingual Support: Extend language options for global users.

2. LITERATURE REVIEW

2.1. EXISTING METHODS

“MeroMath: Your Pocket Math Genius”, an e-learning math-problem solving app, is a very dynamic and very easy-to-understand android application. The service is through a mobile application with just one click, which can make our daily life easier and faster. Presently customers spend a lot of time just typing the questions only to get answers, and also sometimes it’s hard to type mathematical symbols questions using keyboards. Moreover, the systems that exist in today’s date all are premium only. Some of the e-learning providing applications globally are:
PhotoMath: No notes or formula is available.

GauthMath: No features of giving answers by admin, if question is not answered by application.

Mathway: Not efficient to use. Above mentioned applications provide math solving solutions. But they do not measure the satisfaction level of the customer, and most importantly there is no any similar platform in Nepal which helps the students on the basis of Nepali education system.

3. METHODOLOGY

3.1. AGILE DEVELOPMENT APPROACH

Here for this project, we will be following the Agile Model for software development. We will follow this model because it is very simple and easy to use and understand. Since our project is small and requirements are properly defined and understood, this model will properly help us to complete our project.

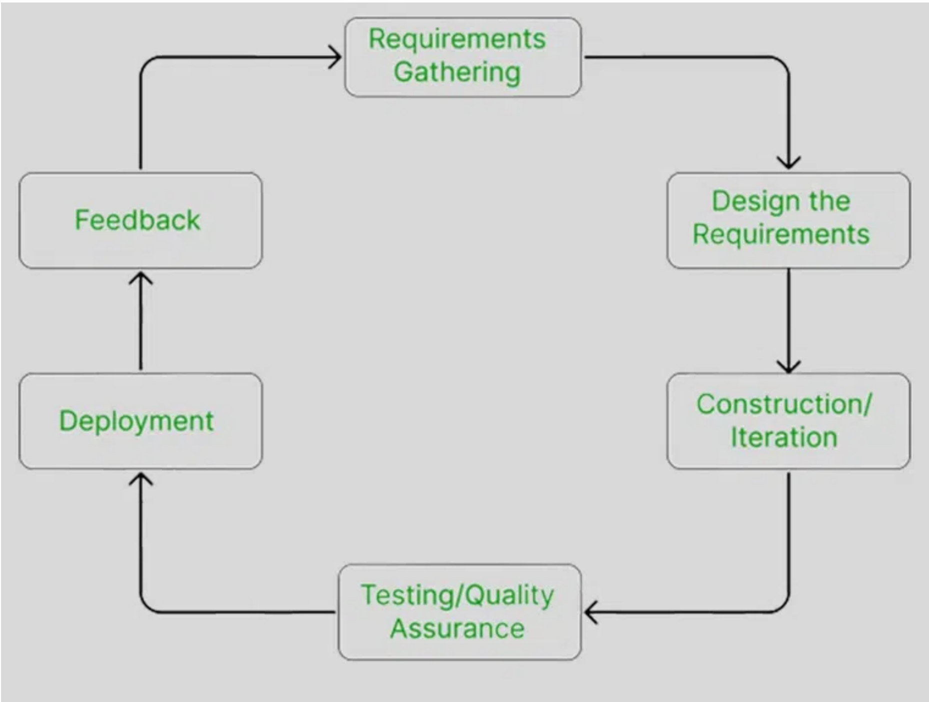

Figure 1: Agile development

3.2. BASICS STEPS

3.2.1. DATA COLLECTION

Images used in this project are obtained from National Institutes of Health, USA[6] which is a public dataset available online. This dataset is divided into 14 classes: Cardiomegaly, Emphysema, Effusion, Hernia, Infiltration, Mass, Nodule, Atelectasis, Pneumothorax, Pleural Thickening, Pneumonia, Fibrosis, Edema, Consolidation.

3.2.2 MODEL TRAINING AND FEATURE EXTRACTION

We will implement a DenseNet model for feature extraction from image dataset and train the model.

LAYERS OF DENSENET

1. Convolution layer

To extract the features from the image, various filters are applied to produce feature maps, which would be put together as the output of the convolution layer.

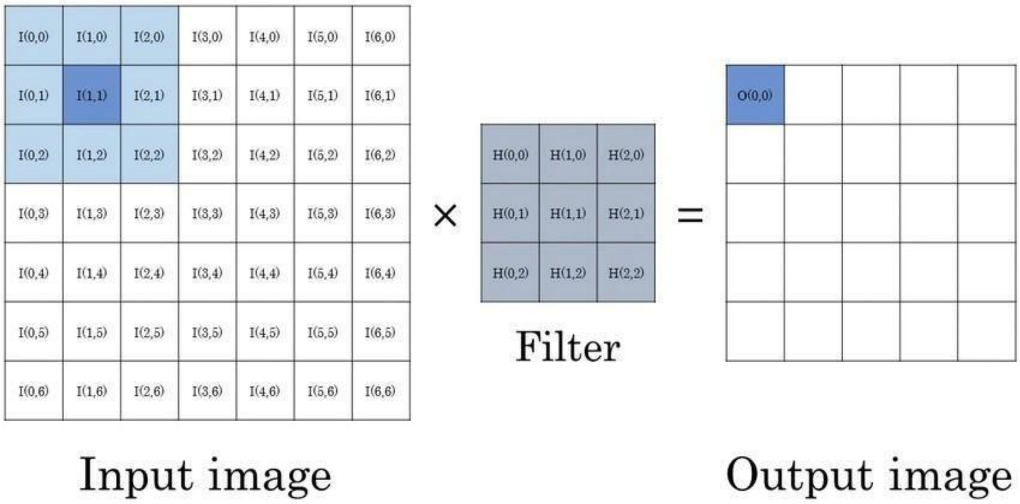

Figure 2: Convolution Layer

2. Pooling Layer

   Pooling is done in order to reduce the size of the image. This prevents the problem of overfitting. The most used method of pooling is max-pooling where the maximum value from each window is kept.

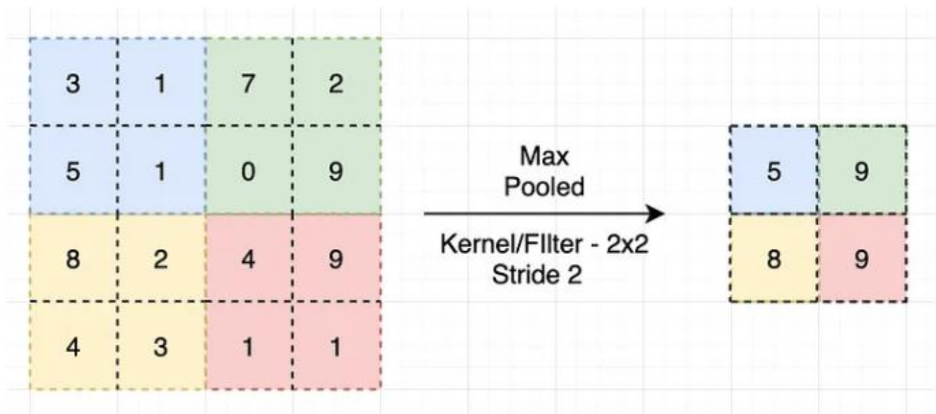

Figure 3: Pooling Layer

3. Dense Block

This block consists of two convolutions with 1x1 and 3x3 sized kernels.

4. Normalization layer

   The output of the convolution layers is linear. But they need to be non- linear, hence the output of the convolution layer is made non-linear by applying the activation function. CNN provides various activation functions like ReLU, Sigmoid, etc. all the negative values are converted to zeros in this phase.

5. Transition Block

   In the transition layer we reduce the number of channels to half of the existing channels. There is a 1x1 convolutional layer and a 2x2 average pooling layer with a stride of 2

3.2.3. IMAGE CLASSIFICATION

Whenever a new image is fed into the model, it first goes through all layers and then finally into the final classification layer. In this phase, each weight vote for each of the class and the class having high average vote will be the class of the new image provided.

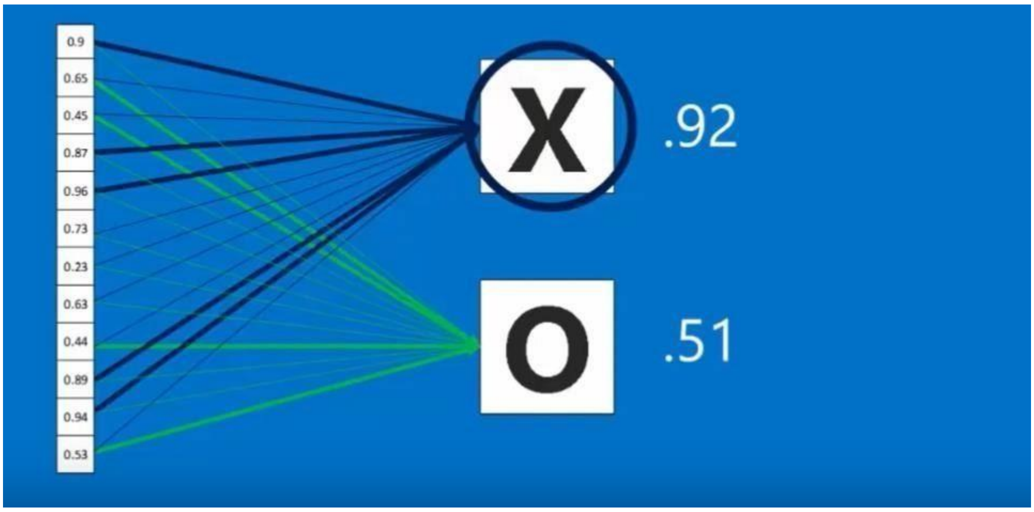

Figure 4: Sample Classification At FC layer [9]

3.3. NETWORK ARCHITECTURE

In the project we will be using DenseNet for model development. DenseNet (Dense Convolutional Network) is a network architecture that focuses on deepening deep learning networks while also making them more effective to train by employing shorter connections between layers. DenseNet is a convolutional neural network in which each layer is connected to all other layers deeper in the network, so the first layer is connected to the 2nd, 3rd, 4th, and so on. This is done to allow maximal information flow between network tiers. Each layer takes inputs from all previous levels and passes on its own feature maps to all subsequent layers to maintain the feed-forward character. It does not integrate characteristics by summation, like Resnets do, but rather by concatenating them.

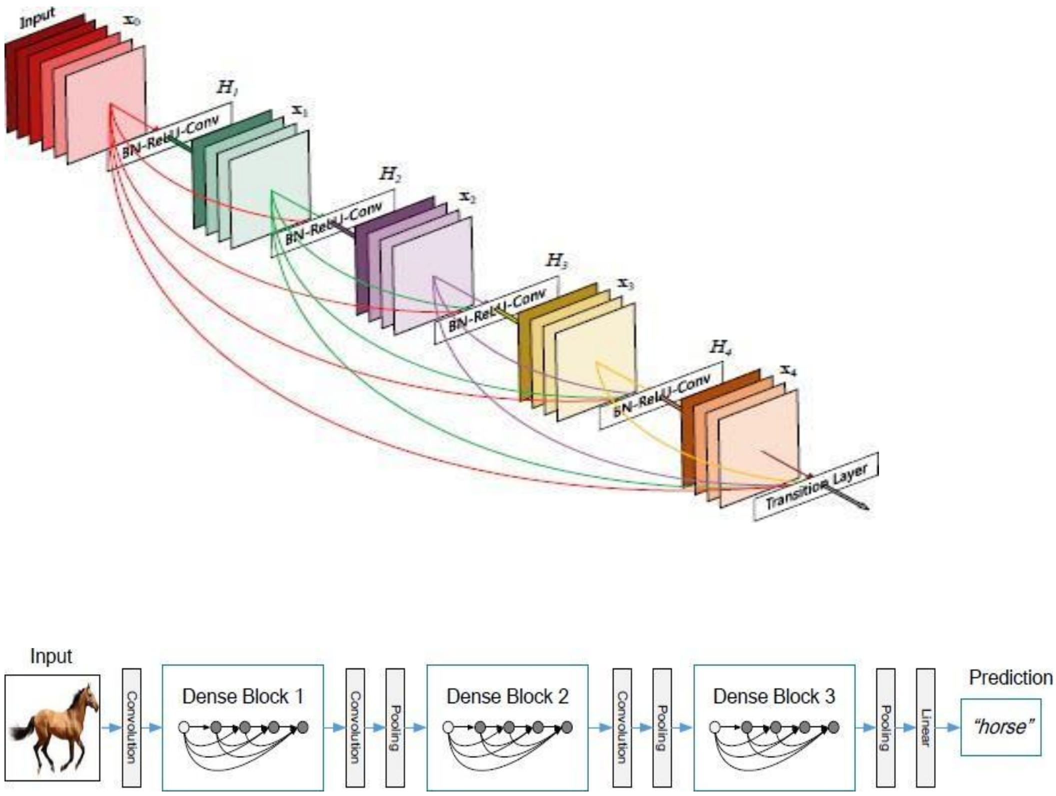

Figure 5 : Various blocks and layers in DenseNet[10]

Layers	Output Size	DenseNet-121	DenseNet-169	DenseNet-201	DenseNet-264
Convolution	112 × 112	7 × 7 conv, stride 2			
Pooling	56 × 56	3 × 3 max pool, stride 2			
Dense Block (1)	56 × 56	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 6$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 6$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 6$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 6$
Transition Layer (1)	56 × 56	1 × 1 conv			
	28 × 28	2 × 2 average pool, stride 2			
Dense Block (2)	28 × 28	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 12$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 12$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 12$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 12$
Transition Layer (2)	28 × 28	1 × 1 conv			
	14 × 14	2 × 2 average pool, stride 2			
Dense Block (3)	14 × 14	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 24$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 32$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 48$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 64$
Transition Layer (3)	14 × 14	1 × 1 conv			
	7 × 7	2 × 2 average pool, stride 2			
Dense Block (4)	7 × 7	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 16$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 32$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 32$	$\begin{bmatrix} 1\times1 \text{ conv} \\ 3\times3 \text{ conv} \end{bmatrix} \times 48$
Classification Layer	1 × 1	7 × 7 global average pool			
		1000D fully-connected, softmax			

Figure 6: Several DenseNet architectures [10]

3.4. MODEL DEPLOYMENT

We will compare the performance of our system with existing ones on following criteria:

a. AUC (Area Under the Curve)

b. ROC curve (Receiver Operating Characteristics)

4. EXPECTED OUTPUT

The main aim of this proposal is to design and develop a framework and a software tool for solving a math problem fast and easy way. The stages involved in the proposed methodology includes feature extraction and classification into 14 classes using DenseNet.

5. TIME SCHEDULE

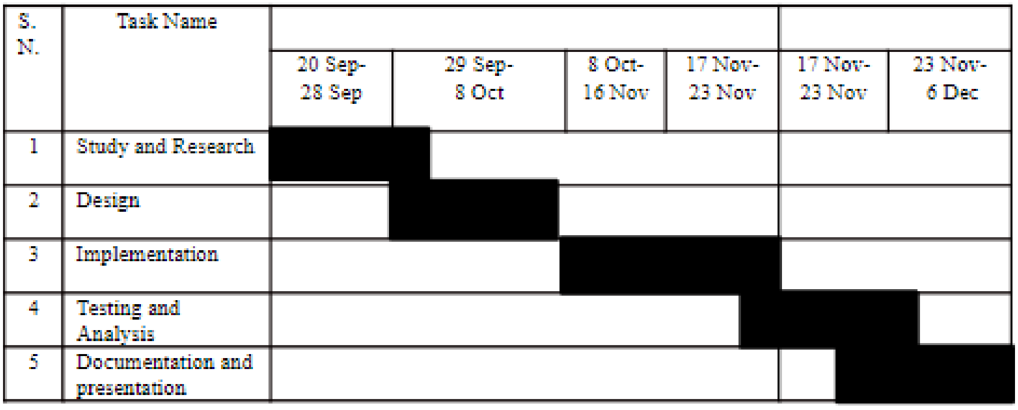

Figure 7: GANTT CHART

6. REFERENCES

- [1]Pranav Rajpurkar, J. I. (2017). CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays. 7.
- [2]Irvin, J., Rajpurkar, P., Ko, M., & Yu, Y. (2019, January 21). CheXpert: A Large Chest Radiograph Dataset with Uncertainty Labels and Expert Comparison, 9.
- [3]Eid, M. M., & Elawady, Y. H. (2021, January). Efficient Pneumonia Detection for Chest Radiography Using ResNet-Based SVM. European Journal of Electrical Engineering and Computer Science, 5(1), 8.
- [4]Irvin, J., Rajpurkar, P., Ko, M., & Yu, Y. (2019, January 21). CheXpert: A Large Chest Radiograph Dataset with Uncertainty Labels and Expert Comparison, 9.
- [5]Jayathilaka, C. (2020, July 30). Waterfall Methodology. Waterfall Methodology | by Chathmini Jayathilaka. Medium. Retrieved May 22, 2022, from https://medium.com/@chathmini96/waterfall-vs-agile-methodology-28001a9ca487
- [6]https://nihcc.app.box.com/v/ChestXray-NIHCC
- [7]https://www.researchgate.net/figure/Imageconvolution-with-an-input-image-of-size-7- 7-and-a-filter-kernel-of-size-3-%203_fig1_318849314
- [8]https://www.geeksforgeeks.org/cnn-introduction-topooling-layer/
- [9]How Convolutional Neural Networks work. (2016, August 18). YouTube. Retrieved May 22, 2022, from https://www.youtube.com/watch?v=FmpDIaiMIeA
- [10]Gao Huang, Z. L. (2018). Densely Connected Convolutional Networks.9.
- Sarkar, A. (2020, July 11). Creating DenseNet 121 with TensorFlow. Retrieved from Towards Data Science: https://towardsdatascience.com/creating-densenet-121-with- tensorflow-edbc08a956d8