Bachelor of Science in Computer Science & Engineering


# Developing An Automated System to Combat Food Insecurity and Ensure Efficient Monitoring of School Feeding Programme in Bangladesh

by

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# Thesis Proposal

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# 1 Introduction

Bangladesh has one of the highest rates of malnutrition in the world. More than 9.5 million (54%) children under 5 are stunted (abnormally low height-for-age), more than 17% are wasted (abnormally low weight-for-height) and 56% are underweight (abnormally low weight-for-age). Poverty is one of the main factors of it. The Directorate of Primary Education (DPE) of the Government of Bangladesh is planning to provide a cost-free mid-day meal - khichuri and biscuits to students of pre-primary and primary schools aged 3-12 to ensure 30% of energy and 50% of the nutrients required per day aiming at enhancing attendance and reducing dropouts [1]. But on a recent ECNEC meeting (Executive Committee of the National Economic Council), the Prime Minister objected this project over a concern about its operational structure saying cooking khichuri at school could hinder students' education and advised to review and come up with newer formats [2]. She also wanted variation in students' platter. On the contrary, India has been providing different hot-cooked meals in primary and upper primary schools on all working days since 2004 under the Mid Day Meal Scheme that started in 1925 [3]. Midday meals at school are not only an encouragement for parents to send their children to school, but they also have a great impact on students' physical and mental health and education. This could be a multi-beneficial investment in human capital and local economy. In our work, we have proposed a more structured solution to School Feeding Programme in Bangladesh.

Generally, nutritionists prepare a balanced and healthy meal plan meeting the nutritional needs of children. The current meal plan for School Feeding Programme (SFP) [1] in Bangladesh has only four items - vegetable/egg khichuri for five days and biscuits + 1 fruit (when available) - which is not much diversified. People, especially children, want variation in their daily meals. In this era of Artificial Intelligence, there's much scope for improvement. An automatic menu planner can do this complex task by finding a combination of meals considering several kinds of features such as nutrients (energy, fat, protein), cost, age, etc. Thus the meal planning problem becomes a combinatorial optimization problem. In our work, we will suggest a diverse 10-day meal plan considering nutrients, cost, and

students' food preferences.

School Feeding Programme (SFP), being a nationwide initiative, needs regular auditing and monitoring. The current monitoring system has many flaws as it's done by NGOs monthly. There's much scope for disruptions like illegal supply and wastage of food. In our work, we've proposed an automated system for daily monitoring by recognizing the students' faces and the foods they will be given.

# 2 Background and Present State

World Feeding Programme (WFP) in association with the Government of Bangladesh, started working with the school feeding programme in 2001 [1]. Nutrition experts came up with a meal plan consisting of khichuri for five days and high-energy biscuits on Thursday. But an acute illness outbreak was reported in northwest Bangladesh schoolchildren, eating high-energy biscuits under the school feeding programme in 2010 [4]. This implies the significance of a balanced meal plan considering nutritional requirements, budget, preferences, etc. An automated meal plan finds solutions based on these various criteria.

Although the mathematical formulation of the Menu Planning Problem (MPP) is much easier, it is an NP-Complete problem [5]. NP-complete problems are difficult to solve in polynomial time by exact deterministic techniques. The authors of [6] developed a menu plan for Brazilian schools considering cost minimization and nutritional error minimization according to the Brazilian reference. They transformed their multi-objective into a mono-objective problem using linear scalarization and used genetic algorithm to solve it.

In [7], the authors have developed a food recommender system based on the user's taste and calorie requirement. They created a food portal website for collecting personal information such as height, weight, age, and food preferences. But a major limitation of this work was - they didn't consider the cost of foods which is a major objective in Menu Planning Problem.

The authors of [8] showed a hypervolume comparison of different multi-objective

evolutionary algorithms - NSGA-II, SPEA-2, MOEA/D and evaluated their performance after 1e8 evaluations with a repetition of 25 times for each configuration. Among them, NSGA-II outperformed the remaining two algorithms.

The authors of [9] used Management Information System (MIS) and Interactive Voice Response System (IVRS) to strengthen the Mid-Day Meal Program (MDMP) in Uttar Pradesh, India. They ensured the total number of students getting meals per day using IVRS that automatically called users over voice and took response as 0/1 - meals served or not served and updated to the server through MIS.

The authors of [10] developed a system to compare manual attendance from mobile application with attendance via facial recognition for mid-day meal scheme in India. They used pre-trained models of MTCNN (Multi-task Cascaded Convolutional Neural Network) for face detection. Then the aligned faces from MTCNN were passed to FaceNet for extracting the 128-bit embeddings and recognized faces using SVC classifier. Their face recognition technique was good but for monitoring the whole programme more features were needed.

In [11], the authors have developed a monitoring system for MDMP to detect students' faces through webcam using Viola Jones algorithm. After detecting, they recognized the served food using Deep convolutional Neural Network in OpenCV. Although Viola Jones Algorithm has more accuracy, it takes too much time in training. Another drawback was they have used a computer for overall monitoring, which is a challenge for village schools.

The authors of [12] developed a deep model for food recognition using Faster R-CNN model to generate RoI (Region of Interest) and used deep neural network for extracting the feature map. From the recognized results they generated a dietary assessment by analyzing the nutritional values - calorie, carbohydrate and protein, from the ingredients of the foods.

In [13] the authors have proposed a system for automating food journaling from pictures of foods taken at restaurants by inferring geo-locations and recognizing foods from the images. They extracted segments where foods are expected to be present using hierarchical segmentation. Then they trained and tested using

SMO-MKL SVM classifier. They have shown better accuracy of 63.33% with prior location as it narrows down the search space whereas without prior location accuracy falls down to 15.67%.

# 3 Specific Objectives and Possible Outcomes

The main objectives of this work are as follows:

1. To suggest a 10-day meal plan considering the daily nutritional requirements (energy, fat, protein), a government budget that can vary through community donations and students' food preferences.
2. To design and develop an android application for ensuring efficient monitoring through real-time facial and food recognition that reduces corruption and food wastage.
3. To show an overall report of remaining budget, nutritional values of the daily served foods and students' attendance improvement over the days.

# 4 Outline of Methodology

The key objectives of the proposed system can be divided into two parts:

1. Training model for detecting faces and foods.
2. Generating meal plans and other features of the android application.

## 4.1 Training Model

### 4.1.1 Face Detection

In this part the face embeddings of the students' faces will be extracted:

- Input students' images.
- Detect faces from the input images using the face_recognition class of OpenCV and extract the face embeddings.

- Save face encodings in a file for further face recognition.

### 4.1.2 Food Detection

In this part a custom model will be trained using the food images:

- Take several videos of the foods and extract images from frames.
- Split the dataset into train and test data.
- Fine-tune the custom model on train data using an android suitable pre-trained model.
- Evaluate accuracy on test data.
- Save the custom model for further food recognition

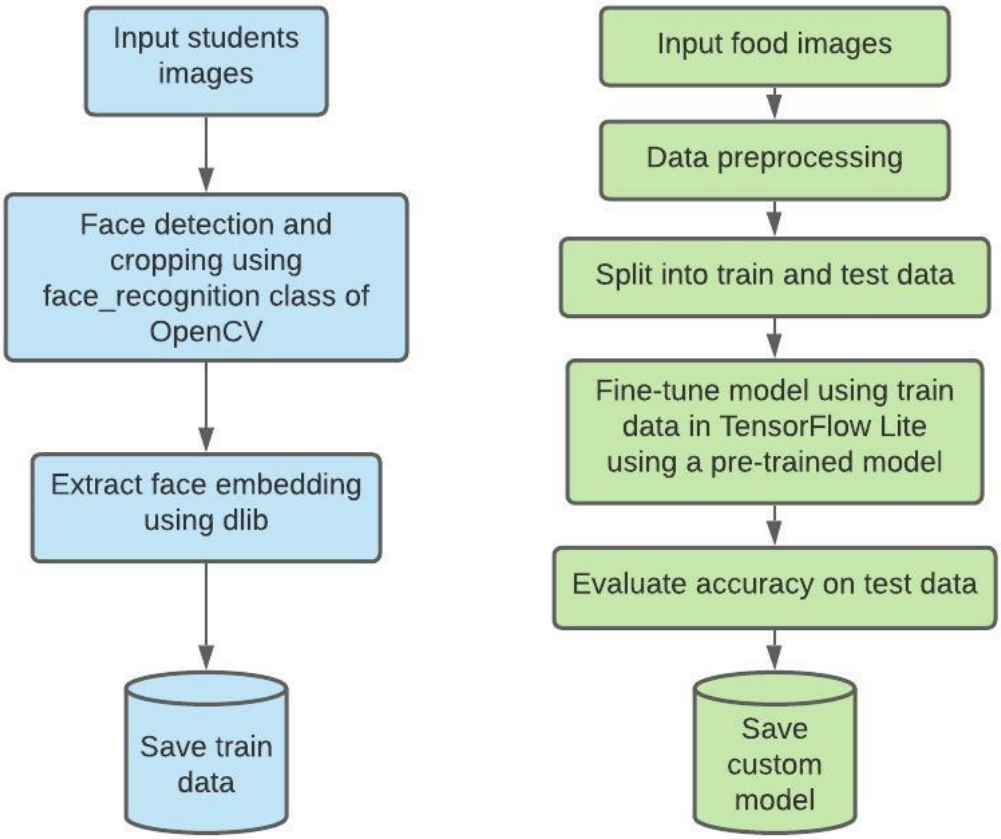



Figure 4.1: Process flow diagram of the model training

## 4.2 Application Interface

An android application will be developed for monitoring the programme efficiently. This application will have several features:

1. Teacher login system.
2. Generate meal plan.
3. Take attendance at the start of the day.
4. Take attendance after serving food to students.
5. Show report
6. Take donations from the community

### 4.2.1 Teacher log in system

Any teacher from the school can login to the system.

### 4.2.2 Generate meal plan

- Take food images, nutritional values, and prices from the food dataset. The dataset will be prepared with foods that fit in the nutritional range [14].
- Calculate the budget for 10 days that can vary according to community donation.
- Generate a 10-day meal plan using Non-Dominated Sorting Genetic Algorithm - II (NSGA-II). It will generate several meal plans maximizing foods that students prefer and minimizing the total cost within budget. Teachers can choose a meal plan from these. This will ensure variation in meals served every day.

### 4.2.3 Morning Attendance

Taking attendance at the start of the day will ensure the preparation of an exact number of meals needed per day and reduce food wastage. Steps for taking attendance using android camera:

- Start camera for taking real-time attendance.
- Detect faces from the video stream using the face_recognition class of OpenCV and extract the face embeddings.
- Recognize face comparing with the pre-trained face embeddings using the Haar Cascade Classifier.
- If a face is recognized, increase the count.
- Repeat the process until finished.

#### 4.2.4 Attendance after serving foods

The teacher will have to start camera for monitoring the served food.

##### 4.2.4.1 Face recognition

- Detect faces from real-time video stream using face_recognition class of OpenCV and extract the face embeddings.
- Recognize faces comparing with the pre-trained face embeddings using the Haar Cascade Classifier.
- Repeat the process until finished.

##### 4.2.4.2 Food recognition

- Detect foods from real-time the video stream using the object_recognition class of OpenCV
- Recognize foods using the pre-trained model.

In the end check if all of the present students got food or not, and take feedback on a scale from 1 to 5.

#### 4.2.5 Show Report

This part will show

- Remaining budget after each day.
- Students' attendance improvement over the days.

- nutritional information of the daily-served foods.

### 4.2.6 Take donation

Although schools receive an incentive from the government, they can collect donations from the community for improving meal quality.

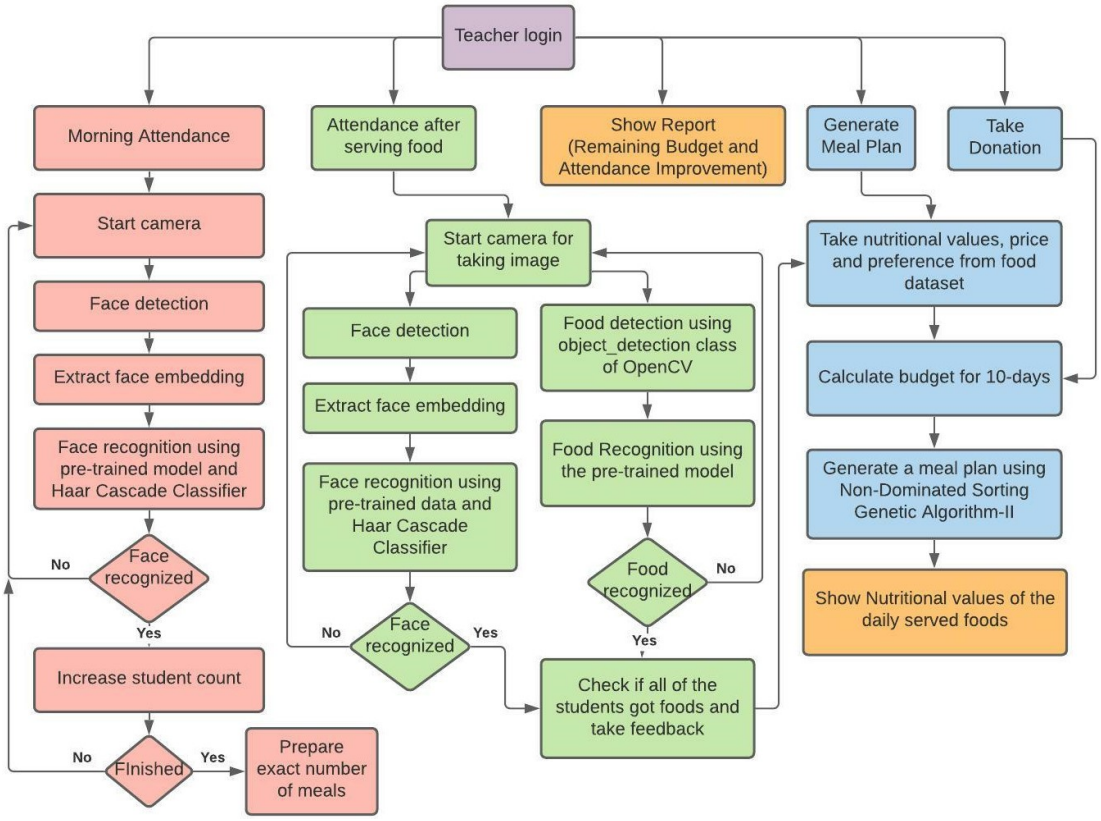



Figure 4.2: Process flow diagram of the application interface

# 5 Required Resources

A computer with a good GPU and webcam is needed for implementation.

## 5.1 Required Tools

- Personal Computer with any Operating System
- Android Smartphone
- A good webcam
- Jupyter Notebook

- Android Studio

# 6 Cost Estimation

Cost estimation of this project is given below:

a. Cost of Data Collection :

| | |
|---|---|
| • Internet Cost | Tk 2400 |
| Total | Tk. 2400 |

b. Cost of Materials :

| | |
|---|---|
| • Personal Computer | Tk 51000 |
| • Android Smartphone | Tk 16500 |
| • Webcam | Tk 3800 |
| Total | Tk. 71300 |

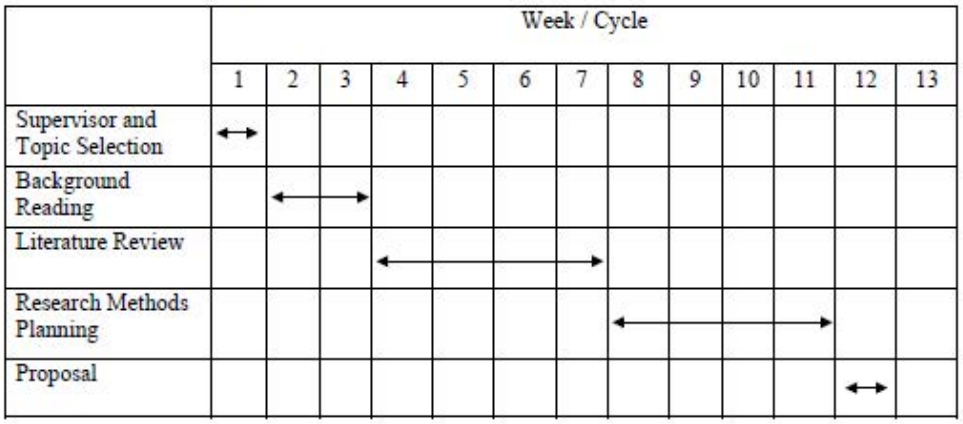
c. Drafting & Binding :

| | |
|---|---|
| • Paper | Tk 1000 |
| • Drafting | Tk 2000 |
| • Printing | Tk 1000 |
| • Binding | Tk 500 |
| Total | Tk. 4500 |
| Miscellaneous | Tk. 1000 |
| Grand Total | Tk. 79200 |

## 6.1 Time Management

Gantt Chart for the entire timeline from the beginning of the thesis to the end is added here.

1. CSE-400 (A – Proposal)




2. CSE-400 (B – Final Defense)

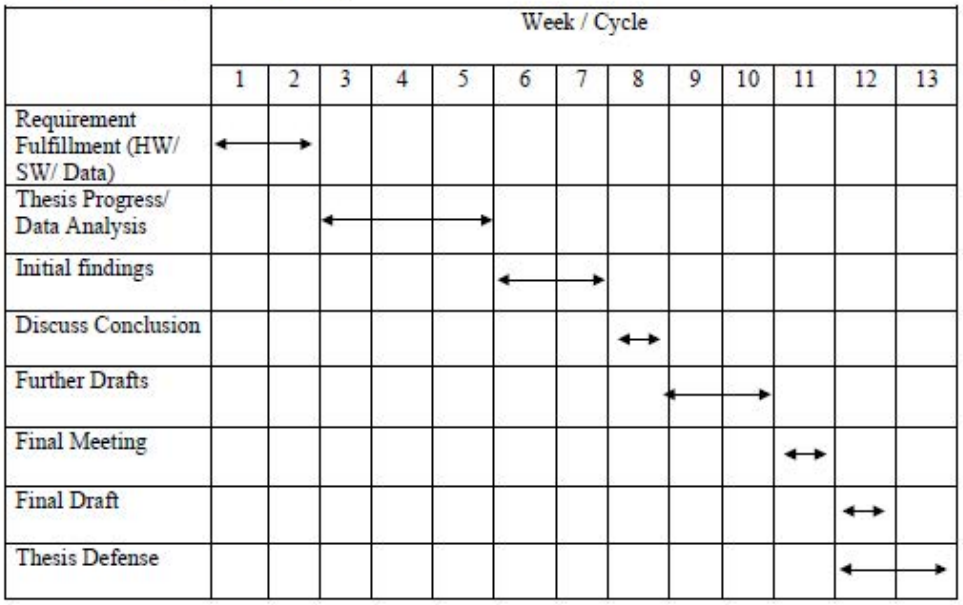



Figure 6.3: Gantt chart of time management.

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**CSE Undergraduate Studies (CUGS) Committee Reference :**

**Meeting No :** **Resolution No :** **Date :**

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**Signature of the Student**

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