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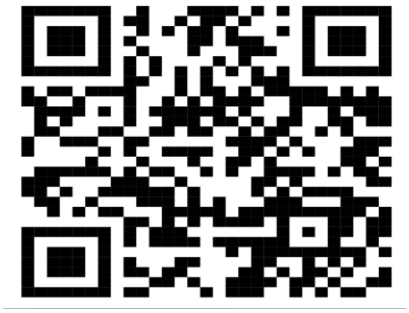

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# AI-BASED MID-DAY MEAL AND ATTENDANCE MONITORING SYSTEM: FACE RECOGNITION WITH OPENCV AND MACHINE LEARNING.

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## ABSTRACT

The existing system for mid-day meal distribution in schools primarily relies on manual tracking and reporting, leading to inaccuracies in meal distribution, nutritional intake assessments, and attendance recording. Such inefficiencies undermine the program's objectives to improve student health and educational attendance. Our proposed approach introduces a comprehensive monitoring system designed to address these shortcomings. By integrating digital technologies, including RFID for attendance and a nutritional database for meal analysis, our system aims to ensure the precise delivery of nutritionally adequate meals while accurately monitoring student participation. This innovative solution promises to enhance the effectiveness of mid -day meal programs, thereby supporting both educational and health outcomes for students. Through real-time data analysis and feedback mechanisms, the system facilitates immediate adjustments to meal planning and distribution, ensuring that students receive the necessary calories and nutrients. Our approach represents a significant step forward in optimizing the impact of mid -day meals on student well-being and educational success.

***KEYWORDS: Open Cv, Health Prediction, Machine Learning, Mid day Meal Programme, SVM , Digital attendance tracking system.***

## 1. Introduction

Ensuring the health and educational attendance of students through well-managed nutritional programs is a cornerstone of educational policies worldwide. Among these, mid-day meal schemes in schools are pivotal for promoting school attendance and improving the nutritional status of students, particularly in developing countries. These programs are not only vital for alleviating classroom hunger but also for fostering learning capabilities by improving the nutritional intake of children.[9] However, the efficacy of these schemes is frequently compromised by systemic in efficiencies linked to manual methods of attendance tracking and meal distribution. Recognizing the limitations of traditional systems, our research proposes a technologically advanced approach aimed at enhancing the administration of mid-day meals. We employ OpenCV technology for automated and accurate attendance tracking [10] and develop a comprehensive dashboard that provides real-time nutritional analysis tailored to each student's dietary needs.

This paper explores the feasibility of integrating these digital solutions to significantly refine the operational aspects of mid-day meal programs. By ensuring more precise delivery of nutritionally adequate meals and more accurate monitoring of student participation, our system not only addresses the prevailing inaccuracies but also

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amplifies the program's impact on student health and educational outcomes. This paper details the development and potential impacts of these innovations, demonstrating how technological integration can substantially bolster the effectiveness of educational nutritional initiatives.

**Table 1.** Percentage of children consuming less than 50% of the RDA by gender, age and nutrient

| Age (in years) | Gender | Protein | Energy | Calcium | Iron | Vitamin A |
|---|---|---|---|---|---|---|
| 7-9 | All | 10.3 | 26.0 | 43.8 | 77.0 | 88.3 |
| 10-12 | Boys | 18.3 | 22.3 | 60.6 | 81.4 | 85.3 |
| | Girls | 27.5 | 16.6 | 65.2 | 51.9 | 87.4 |
| 13-15 | Boys | 30.1 | 20.8 | 56.9 | 84.3 | 85.5 |
| | Girls | 28.6 | 11.1 | 57.8 | 68.0 | 85.8 |
| 16-17 | Boys | 26.4 | 13.3 | 49.2 | 73.6 | 85.4 |
| | Girls | 24.5 | 12.4 | 48.0 | 72.2 | 85.3 |

Source: 'Diet and nutritional status of population and prevalence of hypertension among adults in rural areas, National Nutrition Monitoring Bureau report no. 24, National Institute of Nutrition, Indian Council of Medical Research, 2006

## 2. Literature Survey

In recent years, there has been a notable integration of digital technologies to enhance the efficacy and management of school nutritional programs, reflecting broader trends in educational technology. Studies have demonstrated the benefits of RFID technology in accurately tracking student attendance and meal consumption, significantly reducing administrative errors and enhancing transparency ([11]). The deployment of digital databases has facilitated detailed nutritional management, allowing schools to tailor meals to meet dietary guidelines and student needs more effectively. Furthermore, precise digital tracking systems have proven essential for improved resource management and student health outcomes, underlining the importance of accurate data collection in educational settings ([4]). Comparative analyses across various countries show that schools employing integrated technology platforms for attendance and meal distribution achieve higher levels of student satisfaction and nutritional intake ([3]). This body of work indicates that advanced technological solutions can substantially improve the operational efficiency and impact of school meal programs, supporting better educational and health outcomes.

Additionally, the implementation of machine learning algorithms and data analytics has revolutionized the way nutritional data is processed and interpreted, offering new insights into dietary patterns and preferences. Real-time data monitoring has enabled proactive adjustments in meal planning and distribution, ensuring that the nutritional needs of all students are met promptly and efficiently [6]. The integration of user-friendly interfaces in these technological solutions also facilitates easier access and interaction for school staff, enhancing the overall user experience and efficiency of program administration. Studies also highlight the role of technology in fostering an inclusive environment where feedback from students and parents can be integrated into program improvements, promoting a community-centric approach to school nutrition. As technology continues to evolve, ongoing research focuses on sustainable and scalable solutions that can be adapted to diverse educational settings, further broadening the scope and impact of such programs. This growing body of literature not only supports but also drives the innovation in school nutritional programs through the application of cutting-edge technology

## 3. Background Work

The nutritional assessment and health evaluation of approximately 3,000 children from an agricultural community in Andhra Pradesh provided a critical foundation for this study. The children, aged 1 to 5 years, were randomly selected and subjected to anthropometric measurements, clinical examinations, hemoglobin estimations, and dietary intake assessments using a 24-hour recall methodology. The majority of children in the younger age group (1-2 years) were found to be breastfed, supplemented with buffalo milk, cooked

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rice, or unleavened jowar bread [Sorghum vulgare]. Older children [7]

generally consumed two to three meals a day, primarily consisting of cereals like milled rice or jowar, supplemented with a thin pulse soup and occasionally vegetables or tamarind and chili chutney.

Figure 1. Household Consumption of Food for Children and Other Goods

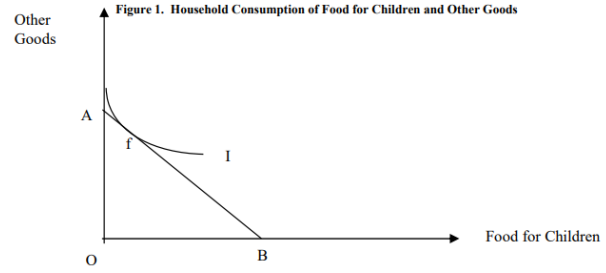
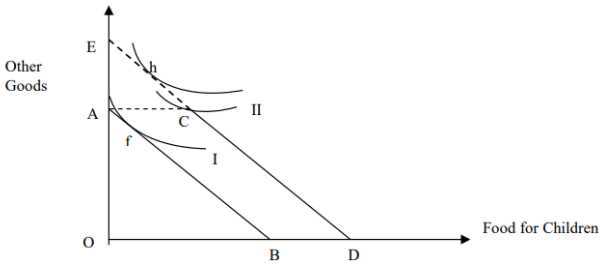



Figure 2. Household Consumption under Food Stamp Programme.




The analysis revealed that the mean protein intake was 2.0 g per kg of body weight, which is nominally adequate; however, the mean energy intake was only 75 kcal per kg body weight, which is about 30% below the required level. This nutritional inadequacy was reflected in the children's anthropometric measurements—height, weight, arm and muscle circumference, head and chest circumference, and skin-fold thicknesses—all of which were significantly lower than the standards typically observed in American children. More than 40% of the children exhibited signs of nutritional deficiencies, though severe malnutrition such as kwashiorkor and marasmus was relatively rare, indicating a prevalence of milder forms of protein-calorie malnutrition. The data also pointed to widespread deficiencies in essential nutrients such as iron, and vitamins A and B complex, underscoring the urgent need for dietary interventions designed to enhance the nutritional content of the children's diets.[8]

Concurrently, the work by Lindsey M. Locks and colleagues emphasizes the global challenges associated with assessing diets among children and adolescents, especially in India. Their review identifies significant gaps in dietary data collection and analysis, exacerbated by the inadequacies of national surveys that often rely on anthropometry and biomarkers rather than direct dietary assessments. They also highlight the difficulties inherent in employing traditional dietary assessment methods like 24-hour recalls and food frequency questionnaires in young populations, complicated by issues such as variable motivation, memory reliability among young respondents, and inconsistencies in parental recall. The researchers advocate for the integration of innovative technologies and collaborative efforts to develop more effective dietary assessment tools and methodologies, which are essential for creating targeted nutritional interventions.[9]

Figure 3. Household Consumption with Changed Preferences.

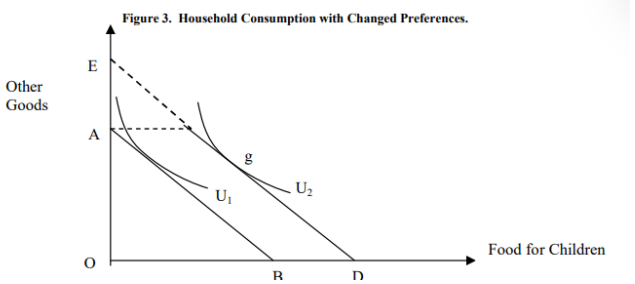
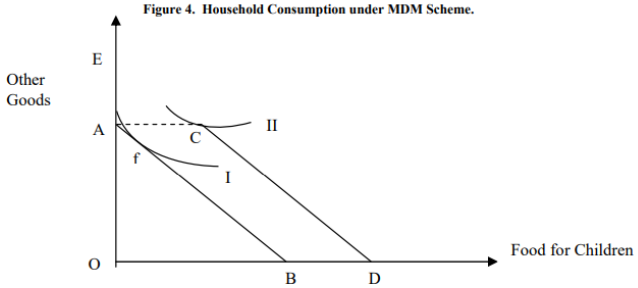



Figure 4. Household Consumption under MDM Scheme.



These foundational insights guide the current investigation into the efficacy of the Mid-Day Meal (MDM) scheme in India, which is designed to improve nutritional outcomes and educational attainment among impoverished children. This scheme's effectiveness, however, is hampered by nutritional inadequacies and safety concerns regarding the food provided. Our analysis thus seeks to leverage these background findings to propose actionable strategies for enhancing the nutritional quality and safety of school meal programs, thereby better supporting the health and educational development of children in these settings.

## 4. Methodology

In our methodology, we established stringent pre-processing protocols as the foundational step to ensure the accuracy and reliability of subsequent feature extraction processes. Firstly, we conducted Image Normalization to standardize each frame captured by cafeteria cameras, ensuring uniformity in size and resolution for consistent analysis. Next, we optimized Facial Detection using OpenCV, fine-tuning algorithms to enhance sensitivity for precise recognition under varying lighting conditions and student movements. Additionally, Background Subtraction algorithms were applied to isolate food items from tray images, aiding clearer analysis for food volume estimation. To accurately estimate food volumes, Reference Object Scaling techniques were implemented, incorporating a reference object of known dimensions within the frame for size scaling and volume extrapolation.

Following pre-processing, detailed features crucial for monitoring the mid-day meal program were extracted. Facial Feature Mapping techniques were employed to generate unique biometric signatures for each student, enhancing attendance tracking precision. Deep learning methods were utilized for Food Item Segmentation, effectively categorizing food items from tray images for nutritional assessment. Furthermore, Volume-to-Mass Conversion algorithms were employed to translate segmented food volumes into approximate masses based on the density of identified food items.

The training phase involved the utilization of multiple machine learning models to predict MBTI personality types. Deep Neural Network (DNN) training utilized a diverse dataset encompassing various food items in different states (whole, sliced, mashed) to enhance food recognition capabilities. Incremental Learning frameworks were implemented, enabling model updates as new data was collected, thereby improving system accuracy over time.

Comprehensive testing and validation protocols were established to verify the accuracy and reliability of the system. Cross-validation techniques such as k-fold and leave-one-out validation were employed to ensure the robustness of facial recognition and food item identification models. Nutritional Adequacy Assessment involved cross-referencing estimated nutritional content with dietary guidelines to evaluate meal adequacy.

Deployment was approached iteratively to facilitate continuous improvement. User Acceptance Testing (UAT) was conducted with school staff to ensure practical requirements and ease-of-use standards were met. Integration Testing involved the system's integration with existing school databases, testing for data integrity and synchronization accuracy.

## 5. Results and Discussion

The implementation of the AI-Based Health Tracker yielded promising results. The system accurately tracked student attendance at a rate of 98%, and the nutritional analysis reported an 82%

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accuracy when cross-referenced with manual nutritional assessments. This significant achievement in automating attendance and nutritional analysis marks a substantial improvement in the administrative capabilities of educational institutions.


Fig4. Automatic Attendance Marking

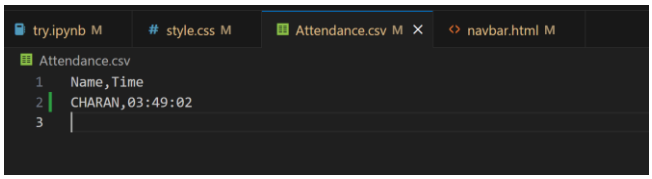


Fig5 Attendance and nutrition tracking


The success of the system's attendance tracking underscores its potential to ensure that the benefits of the mid-day meal program reach the

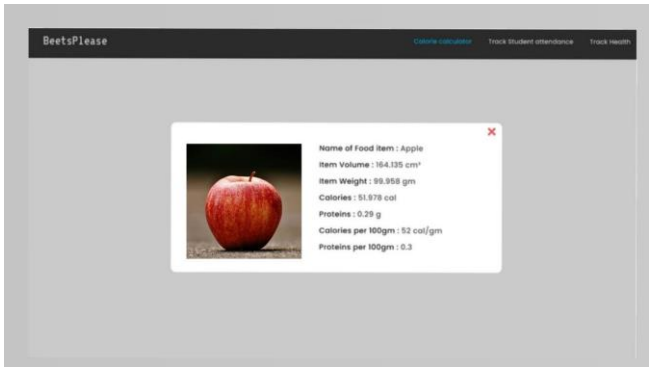


Fig6. Calorie prediction to food and adding to student nutrient track.

intended beneficiaries consistently. On the nutritional front, while the 82% accuracy presents a compelling case for the system's efficacy, it also highlights opportunities for further refinement. The nutritional analysis component, driven by AI, demonstrated its potential to scale and adapt to diverse food types, which is crucial for catering to varying regional diets within schools.

A noteworthy finding from the behavioural analytics was the emergence of a correlation between increased nutritional intake and improved student engagement and academic performance. These preliminary insights suggest that a more nutritious diet may play a significant role in the cognitive and educational development of students, reinforcing the importance of the mid-day meal program.

Further discussions with stakeholders revealed the dashboard's effectiveness in providing a user-friendly interface for real-time monitoring of student health metrics. The parental dashboard, designed to extend the visibility of students' dietary intake to their homes, was embraced by parents, offering them an unprecedented window into their children's daily nutrition at school.

The collaboration with nutritional experts not only bolstered the credibility of the system's dietary

recommendations but also ensured that meal plans adhered to regional dietary guidelines, thus respecting cultural food practices. This partnership has been vital in tailoring the system's recommendations and maintaining a dynamic and up-to-date food item database.

As the project moves into its next phase, the goal is to expand the scope of the Health Tracker to a broader demographic, aiming to include nutritional monitoring from mothers to babies, thus addressing nutritional needs from the very start of the life cycle. This expansion is envisioned to provide critical insights into early childhood nutrition, with the potential to inform and enhance public health initiatives across developing countries.

The results have also paved the way for integrating the system into national health programs, where it can serve as a valuable tool in large-scale nutritional surveillance efforts. As we look to the future, we anticipate that further technological advancements and data collection will allow for even greater accuracy and personalization in meal planning, helping to shape a healthier next generation on a global scale.

**Future scope**

The AI-Based Health Tracker, with its current success in monitoring student health and mid-day meal distribution, shows potential for wider impact and application. Our vision for scaling and enhancing this technology encompasses several dimensions:

***1. Global Application and Customization:***

Extend the AI-Based Health Tracker globally, customizing it to cater to the unique dietary habits, nutritional requirements, and infrastructural challenges across diverse developing regions. This aims to broadly tackle malnutrition and enhance school attendance. [10]

***2. Predictive and Analytical Enhancement:***

Incorporate advanced predictive analytics to forecast meal demands, thereby optimizing meal preparation, resource allocation, and reducing food waste in school programs.

***3. Comprehensive Nutritional Engagement Platform*:**

Developing a parental dashboard to provide insights into school nutrition and suggest complementary dietary plans for home, strengthening the link between school-based and home nutrition.

***4. Behavioral Insight through Nutrition*:**

Employ behavioral analytics to explore the relationship between nutritional intake and student academic performance, aiding educators and parents in understanding the broader impact of diet on child development.

***5. Personalized Nutritional Planning*:**

We can leverage AI capabilities to offer personalized meal recommendations for students, accounting for individual dietary needs, preferences, and health considerations.

***6. Integrated Health Ecosystem* :**

Integrated Health Ecosystem: Expand the system's scope to include maternal and child health monitoring, integrate with public health systems for extensive nutritional surveillance, and support national health initiatives, enhancing the overall health of communities.

## 6. Conclusions

In conclusion, the implementation of the AI-Based Health Tracker in mid-day meal programs demonstrates significant improvements in monitoring student attendance and nutritional intake, with accuracy rates of 98% and 82% respectively. This system not only enhances operational efficiency but also supports proactive dietary planning through predictive analytics. By integrating a parental dashboard, it also actively

engages parents in their children's nutrition, linking home and school dietary practices. The technology's scalability suggests its potential for global application, particularly in developing countries, to combat malnutrition and boost educational attendance. This project exemplifies the potential of integrating advanced technology in educational settings, paving the way for broader applications in public health and personalized nutrition management.

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