Mid-Day Meal Analytics Using Machine Learning

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Abstract

More often than not, corruption and Government schemes tend to go hand-in-hand with the benefits not reaching the true beneficiaries. The Mid-Day Meal scheme is no different. The continuous monitoring and auditing of the scheme poses a challenging task, especially in a country as large and diverse as India. This has led to innumerable cases of rampant corruption activities which pose a huge challenge for the Government to tackle. This study analyzes the Mid-Day Meal scheme in terms of its target audience, social metrics and scalability factor along with how the integration of modern-day technologies like Artificial Intelligence (AI), specifically Machine Learning (ML) and Object recognition to the existing model of scheme, could help counter the above-mentioned challenges. This study proposes a solution which involves auditing of classroom students with the help of ML and AI integrated cameras in schools where the students are captured while food is served to them and then analysed by the camera software for authenticity of students and meal. The implementation of this research backed model on pan India scale could be a precursor to restoration of fair and square social welfare schemes and exemplify how technology could aid the government to curb corruption activities and create a better society for its people. This study also explores the various feasibility and implementation factors associated with the proposed solution.

Keywords

Mid-Day Meal, Corruption, Machine Learning, Smart Camera, Auditing, Monitoring.

1.INTRODUCTION

The Mid-Day Meal (MDM) scheme serves over 120 Million school children in over 1.2 Million schools across the country and is largest of its kind scheme. This scheme over the years has led to significant improvements in the overall standing of India in terms of health and education, as indicated by indices released by the various National and International agencies, annually[1].

There are several reports validating the same. Among the most prominent ones is the Annual Status of Education Report (ASER) of 2012. It reported that 83.4% schools served Mid-Day Meal on a day of surprise visit and almost same percentage of schools (81.3%) were having proper infrastructure, that is, kitchen sheds for cooking mid-day meal[2]. A vastly improved availability of mid-day meals had contributed to the increase in enrolment. These reports indicate an overall surge in the school enrolment of children, better health and education standards.

However, with the revolution at the brink of happening, several reports and studies have pointed out to the lack of proper management at the ground level and how some bureaucrats and other ground-level management staff have gotten involved in corruption activities and malpractices. Be it serving of Chapati (an Indian bread) with salt instead of nutritional 'Sabzi' and 'Dal', or serving of milk diluted in 100 times of water. In some rare cases, the meals were not being served at all. The school management staff would report the meals were served but only to be later caught in sting operations by media that the food material was instead being sold in open market. Those were rare cases because they were caught on camera by the media and senior government agencies[3]. Thousands of similar cases go unnoticed due to the lack of proper monitoring and surveillance.

Over the years, various countries across the world, especially the west have adopted the advancements in technical field and integrated them with their economic development projects. These advancements are basically used to obtain better metrics and indices at a relatively lesser cost and manpower. This has led to better results in terms of both cost and scalability [4].

But the synergic effect is reached when such technological advancements are combined with social welfare schemes, Mid-Day Meal scheme in this case. Today's digital and smart camera market has become so sophisticated and affordable that its integration with several social welfare schemes of the government is now possible and feasible.

The paper makes the following original contributions:

i. Discusses the problems associated with MDM scheme, especially corruption.
ii. Proposes a smart Machine Learning (ML) camera-based monitoring solution to counter the issues.

2.LITERATURE REVIEW

A. Introduction and History of Mid-Day Meal

The Mid-day Meal Scheme is a school meal scheme of the Government of India and is designed to improve the nutritional standing of school-age children across the country. Post-Independence, there was an exponential rise in the malnourished children between the ages of 3-14 years. This was more prevalent in the lower strata of the society where people couldn't afford nutritional meals. The parents of daily- wage earning families would rather put their children to work than to go and study in schools. This led to a huge dropout rate in the primary and middle schools, especially amongst girl students.

Realizing the relationship between education and health, the government of India launched the National Programme of Nutritional Support to Primary Education or the Mid-Day Meal (MDM) Scheme in 1995. The MDM scheme was launched with an objective of improving nutritional status of children and reducing classroom hunger. Apart from this it also included promoting school participation (in terms of enrolment, attendance and retention), fostering social inequality, enhancing caste and gender equality with special attention to children belonging to unprivileged groups.

B. Introduction of Smart Camera

The rise and emergence of the digital camera market can be easily marked to have begun in the late 1990s and stretched to the first decade of the new century. The various reasons that led to this growth were technological advancements in manufacturing of chips, improvements in embedded system design, the development of CMOS (Complementary Metal Oxide Semiconductor) image sensors and so on. But in all of these subtle developments, the development of CMOS image sensors (CIS) - which are cheaper to manufacture boosted this growth. Together with digital cameras and camera phones, accessibility and demand for smart cameras also increased. The market for this category of smart devices skyrocketed in 2012, and was projected to spread its arms at a yearly average of 12% by 2017, which it did[5]. So, the global CIS market rose from $6.6 billion in 2012 to $11 billion by 2017. For these reasons and because of the potential of CIS sensors to make smart cameras smaller, cheaper and more widespread, and integration of chipsets and processing power within cameras, the doors for the development of smart cameras have opened around the world.

C. An Overview of Machine Learning

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being directly programmed. Machine Learning primarily focuses on learning through experience approach, where data is used to train a program to act in a certain way. The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

Machine Learning can be classified into:

i. *Supervised machine learning algorithms:* Here, a trained data set containing labelled examples is used to analyse input and predict future outcomes. The input may also become a part of the existing data set in order to improve the efficiency.
ii. *Unsupervised machine learning algorithms*: Unsupervised learning is a type of machine learning that looks for previously undetected patterns in a data set with no pre-existing labels and with a minimum of human supervision. Cluster Analysis is used to detect, segment and group data sets with shared attributes.
iii. *Semi-supervised machine learning algorithms:* These algorithms fall somewhere in between the above two types of algorithms. These use a

large part of labelled data and a small part of unlabelled data and thus enable the system to improve its learning accuracy.

iv. *Reinforced machine learning algorithms:* These algorithms take suitable action to maximize reward in a particular situation. It is employed by various softwares and machines to find the best possible behaviour or path they should take in a specific situation, that is, they follow greedy approach.

D. Amalgamation of Smart Camera and Mid-Day Meal

The simple combination of a government scheme and technology for its implementation and monitoring could really change the degraded and tarnished face of the bureaucratic system of this country. It is also evident when technology comes into play, there is very little scope of tempering of data, if the data is well encrypted and secured. Furthermore, the more a particular process or event is automated and tech-driven, the more transparent it becomes. The following figure gives a brief idea about how this can be achieved.

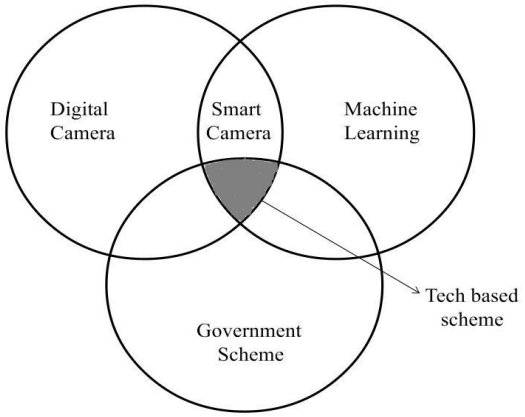

Fig. 1: Amalgamation of Technology and Government schemes

3.OBJECTIVE

The aim of this study is to propose a technology-based solution to monitor and audit the MDM scheme at the ground level, to propose a system that would send reports of schools to the concerned authority when needed and bring about transparency at the ground.

4.METHODOLOGY

The proposed methodology makes use of both qualitative and quantitative perspectives, and includes a broad array of different approaches like literature reviews, public perception and expert guidance and content validation. The solution focuses on parameters such as

i. Simplicity
ii. Implementation prospects
iii. Feasibility
iv. Innovation aspect

5.DISCUSSION

The solution consists of installation of the proposed ML based smart cameras in schools where monitoring and auditing have to be done. The cameras should be installed in the serving area of the school where the students are served their quota of meal. The camera should be fixed at a standard height and distance in order to capture the faces and served plates of students. It is expected that as the students are served the meal, they form a queue and leave one by one after receiving their quota of the day. As this happens, the smart camera captures them in a video and saves snapshots of individual serves. These snapshots stored in the internal storage of the smart camera, are then analyzed by the camera software, which identifies distinct faces and analyses served plates to verify if the food was served as per the menu. This data is then stored in the internal database of the camera.

The data storage in the camera's internal storage is divided into two categories, namely, video and snapshots. If on a given day, the meal is served as per the set benchmarks and criteria, the recorded video is automatically deleted at the end of the day to optimize the internal storage. However, the snapshots(images) of individual serves are kept in the storage for a longer duration of time, say, 6 months. The fig.2 shows the working of the proposed software system, right through the camera capturing and analyzing the data, to data storage in database and accessing of reports at the frontend.

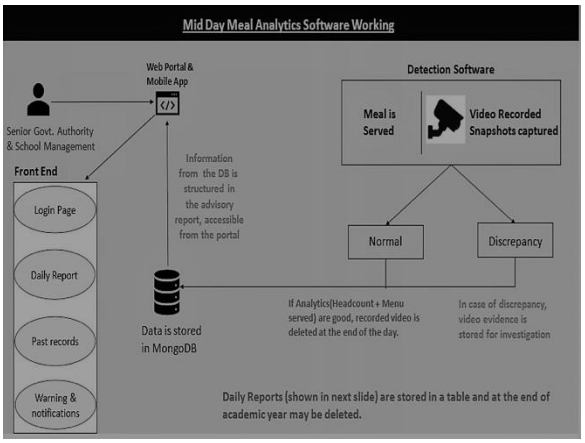

Fig. 2: Working of Proposed Solution

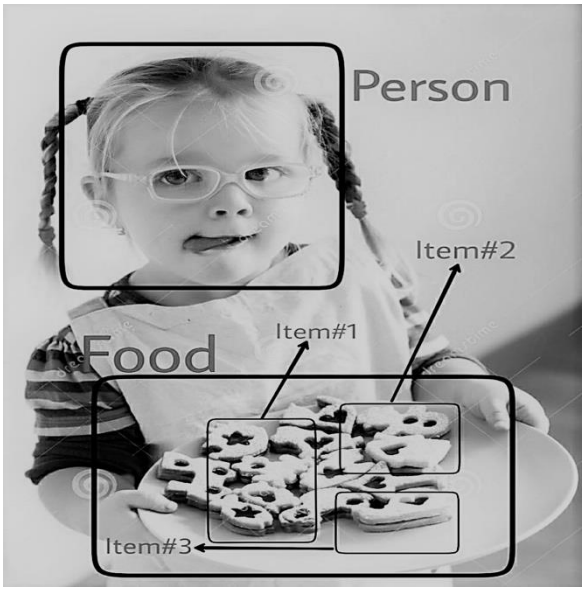

Fig. 3: Standard Camera-Student alignment

In case of discrepancy, the video is saved in the storage for further investigation. If on a given day, the set benchmarks are not met, a warning is triggered by the software. Upon continuous failures by the school management, the concerned authorities, one at the state level and one at the national level, are sent the report of that school. The involvement of authorities at dual level promotes a more transparent system. Then the authorities could take an appropriate action in compliance with the law against the school management. This helps to curb corruption activities at the ground level.

The fig.3 shows how exactly the camera will process a snapshot. The camera checks for different faces of students and their served plates which ensures two things. One, that not one student is made to rotate about their position again and again with one plate to fool the camera. Two, different faces with their plates with full meal ensure that adequate quantity of meal was cooked on the given day. These two measures cut the possible malpractice tactics which may be employed by unethical minds.

As far as the cost factor is concerned, there are various renowned business brands that offer different types of smart cameras under different price brackets. The cost of one camera may vary anywhere between Indian Rupees 5,000-20,000, depending on the brand and specifications[6]. Further, the government can get these at a discounted rate and tax exempted through a profitable and suitable tender. There are a number of different ways to design camera coverage for a particular room, office, school or building. Several designs are primarily built with the cost of installation in mind, instead of looking at the system as an investment in protecting assets or people. A good surveillance system should be focused on protecting people and assets.

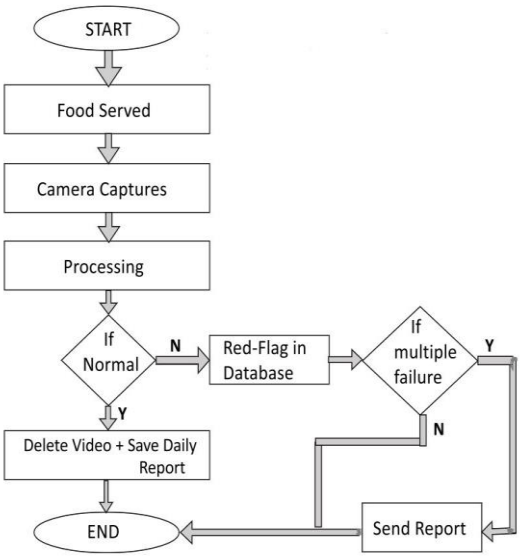

Fig. 4: Flowchart of Working Solution

Prerequisites include a one-time student database creation by the school authority, which will consist of school details and identification photo of every student to ensure that the meal is served only to the enrolled students. Owing to smart camera's inbuilt storage and processing capabilities, no external system is needed to facilitate camera's functioning.

Furthermore, as the data is analyzed and stored in the camera itself, the proposed solution doesn't require a 24x7 internet connection. An internet connection is needed only to aware the concerned authorities and to send analytic reports.

A typical technology stack would consist of

i. Front End: REACT for mobile application and HTML& CSS for web application
ii. Back End: Python3 standard libraries, flask, Keras(Tensorflow)
iii. Database: MongoDB and Firebase Database

6.CONCLUSION AND FUTURE WORK

The idea of adapting digital monitoring systems to make social welfare schemes cheaper, well audited and monitored, and eradication of malpractices is a compelling one in modern society. Making the process transparent, normalizes it in the eyes of the citizens, removes a certain ground-reality barrier between the beneficiaries and the government and puts a certain amount of pressure on the bureaucracy as well. It also opens the doors for a more direct form of delivery where things do not just happen on paper, but happen in reality as well.

In this paper, we introduced a Machine Learning based monitoring system that integrates common technologies to safeguard the world's largest meal distribution scheme. The working, the design, and technology stack of the proposed solution have been outlined. This model may further be extended to take student attendance and conduct other secondary activities which will save time and resources.

Tough the proposed solution explicitly addresses the core problem, there are a few things left to work on. Firstly, in order to determine dilution-level adulteration, certain liquid density sensors will have to be integrated into the camera's hardware. A Liquid Density Sensor (LDS) can directly measure fluid viscosity, concentration and temperature. These are already available in the market, and can easily be integrated with the camera as per the compatibility of hardware and software. Secondly, to ensure smooth functioning of the camera in frequent power disruption areas, a battery backup may be integrated into the camera's hardware as well. This battery will be hidden inside the body of the camera to avoid any sort of tampering with it. A battery which is compact in size and offers a long period of backup is recommended.

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