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# Anaaj Surakha: Detection of Corruption in Grain Scan Supply Chain

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***Abstract:*** ***The grain supply chain provides food for people reliant on the government's distribution systems; however, during the collection, storage, and delivery process issues including grain adulteration, loss of quantity, and alteration of records can be encountered due to the scale of the operation and the use of manual inspections. To meet these challenges, AnaajSuraksha is a practically developed system that detects corruption and irregularities in an early stage. The system utilizes GrainScan to take high-quality images of the grain and to weigh it using simple image processing techniques that will identify color changes, impurities, damage, or variations in the quantity of grain being measured. All of the records of the grain measurements are secured to prevent alterations and updates are made in real time to the administrators to provide transparency. By combining the systematic inspection, secure record-keeping and the efficient development of the system, AnaajSuraksha will improve food security and minimize disruption to the grain supply chain.***

***Keywords: GrainScan, AnaajSuraksha, Grain Quality, Supply Chain Monitoring, Corruption Detection.***

## I. INTRODUCTION

Food grain distribution is a vital service. Many countries continue to cultivate increasingly difficult environments for people who depend upon them for their livelihoods. Programs supported by government. These will enable grains to move through the process. Several steps are involved including harvesting, storing, transporting and disposing. Food is distributed from ration shops. Although the system has been in existence for some time, it still faces many operational challenges. The grains can be replaced with inferior quality or damaged grains. Also, the quantity can be changed or lessened before they are consumed.

All of the aforementioned concerns. This can negatively affect the quality of food obtained and result in an economic loss for the masses. This system keeps things simple. It uses a tool called GrainScan, along with digital recordkeeping, to check grain quality. You snap photos of the grains, weigh them, and store all the transaction details right away. The whole idea is to make the process clearer and more trustworthy.With this method, administrators can actually see what's going on with the grain, which helps boost quality and cuts down on corruption. A lot of problems pop up because the old way relies on ongoing checks, usually on paper, and inspectors don't always have enough oversight. Records get messy, or they're easy to change, and it's tough for anyone to figure out where things went wrong. This new approach, though, is flexible and easy to update, making it much harder for issues to slip through the cracks. Addressing these issues requires a strong necessity or demand for expert consulting. A system that can closely monitor the supply chain, collect reliable data and. Detect early indicators of manipulation. AnaajSuraksha has been created using. this aim.

## II. LITERATURE REVIEW

First, Supply chains keep food grains moving to people who need them, but let's be honest—they run into plenty of problems. Corruption, tampering, sloppy quality checks, you name it. In the past, everything pretty much hinged on manual inspections. Someone would look at the grains, maybe check their size, moisture, or pick out any obvious junk. That works sometimes, but it all depends on how careful and honest the inspector is. Mistakes happen, and sometimes people take shortcuts or cheat.

People tried to fix this with technology—things like sensors, barcodes, and some basic image analysis. These help with tracking and keeping records, but they don't really stop problems like mixing grains, cheating the scales, or messing with the data. A lot of these systems still make you enter data by hand, and security's pretty weak, so it's easy for things to go wrong.Lately, there's been some buzz about using machine learning and automatic image checks to spot bad quality. Sounds good, but most of this is still stuck in the lab. You don't see it much in actual ration shops. That's where AnaajSuraksha steps in. It pulls together image-based quality checks, weight verification, and secure digital storage—all in one place. The result? A system that's actually practical and reliable for keeping the grain supply chain honest and efficient..

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## III. MODELING AND ANALYSIS

*A. Proposed Monitoring and Corruption Detection Framework*

Grain supply chains involve procurement, storage, transportation, and distribution. Corruption, including adulteration and false reporting, may occur at any stage. Therefore, a clear process model is required to identify vulnerable points and define appropriate monitoring mechanisms.

1) *Identification of Corruption Points:* The major corruption-prone stages in the grain supply chain are identified as follows:
   - Procurement: Mixing low-quality grains or adding im- purities.
   - Storage: Replacing good-quality grains with old or dam- aged stock.
   - Transportation: Reducing quantity during loading or unloading.
   - Distribution: Incorrect record entries or diversion of stock.

These stages were analyzed to determine the type of data that must be captured for effective monitoring and fraud detection.

2) *GrainScan Imaging and Visual Inspection:* The pro- posed system incorporates a GrainScan imaging module to capture grain samples at different stages of the supply chain. The system extracts basic features such as color, texture, purity level, and grain size. This enables detection of visible anomalies including stones, dust, insects, or mixed grains. The extracted features are compared with standard grain characteristics to identify deviations. The feature extraction process is intentionally kept simple to ensure usability in field environments such as warehouses and ration shops.
3) *Weight Verification Model:* A weight comparison model is integrated to validate measured grain weight against ex- pected values. Significant deviations indicate possible quantity tampering, leakage, or unauthorized diversion. Weight verification complements the GrainScan visual in- spection module. Since adulteration often coincides with weight discrepancies, combining image-based analysis with weight tracking improves the detection of linked corrupt practices.
4) *Anomaly Detection Mechanism:* The system analyzes both image features and weight values to identify inconsisten- cies. If grain color or texture deviates from normal standards, the batch is flagged for further inspection. Similarly, if the recorded weight is lower than expected, the system marks it as a potential quantity mismatch. This integrated approach enables early-stage corruption detection with minimal human intervention.
5) *Secure Transaction Record Management:* Each trans- action record—including grain image, weight data, batch ID, timestamp, operator ID, and location—is securely stored in a centralized database. The system performs consistency checks to identify missing records, duplicate entries, repeated edits, or unusual quantity drops.

By linking every entry to a specific operator and location, the system minimizes the risk of false reporting and data manipulation. Secure recordkeeping, combined with image analysis and weight verification, establishes a robust and transparent monitoring structure.

Overall, the integrated framework demonstrates that cost- effective imaging tools, automated weight verification, and se- cure database management can significantly reduce corruption and manipulation within grain supply chains.

## IV. SYSTEM DESIGN AND ARCHITECTURE OVERVIEW

The proposed system manages grain quality monitoring, recording, and decision-making analytically through a well- defined architecture. Grain samples at different stages (pro- curement, storage, transport, distribution, etc.) are collected and processed through the GrainScan imaging module. Weight data and images are combined for anomaly detection, and all information is securely stored in a central database. Figure ?? illustrates the overall system architecture.

*A. Hardware Components:*

The hardware used in the system includes
- High-resolution Camera: Captures grain color, size, and texture.
- Digital Scale: Records batch weight at each stage.
- Processing Unit: Microcontroller or computer for pro- cessing images and weight data.
- Connectivity Modules: Wi-Fi or Ethernet for uploading data to the central database.

*B. Software Modules:*

The software system consists of the following modules:
- GrainScan Image Processing: Extracts color, texture, size, and impurity features from grain images.
- Weight Verification Module: Compares measured weight with expected batch weight.

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- Anomaly Detection: Identifies deviations in color, tex- ture, and weight, and flags suspicious batches.
- Database Management: Securely stores all images, weights, timestamps, operator IDs, and locations.

### C. *Data Transfer and Communication:*

At each stage of the supply chain, operators capture grain images and enter batch weight. The system associates each entry with the operator ID and location. Local analysis of images and weight is performed before uploading the data to the central database. Any discrepancies trigger alerts, helping to detect adulteration, quantity mismatches, or other forms of corruption early in the supply chain.

### D. *System Architecture Overview:*

The system is designed to monitor grain quality and detect irregularities throughout the supply chain. Grain samples are collected at different stages—procurement, storage, transport, and distribution—and are processed using the GrainScan imaging module. Weight measurements are combined with image data to identify anomalies. All collected information is stored securely in a central database

## V. EXPERIMENTAL RESULTS AND PERFORMANCE EVALUATION

### A. *Dataset and Setup:*

We tested the system using grain samples collected from procurementcenters, warehouses,transportunits,and distributionpoints.ImagesweretakenusingtheGrainScanmodule,and batch weights were measured using the digital scale. Operator IDs and locations were recorded for traceability. Experiments were carried out both in controlled laboratory settings and in real field environments to ensure reliability.

### B. *GrainQualityAssessment:*

Images were analyzed to extract features such as color, tex- ture, size, and impurities. Batches that deviated from standard grain characteristics were flagged. Figure ?? shows examples of normal and irregular grain samples.
Thesystemwasabletodetect:

- Color changes caused by spoilage or mixing with lower- quality grains.
- Texture differences indicating moisture or damaged ker- nels.
- Foreignmaterialssuchasstones,dust,orothergrains.

### C. *Weight Verification:*

Batchweightswerecomparedagainstexpectedvalues.Any significant deviation triggered a flag for review. Table ?? summarizes the results. Combining weight verification with imageanalysis improveddetection accuracyand reducedfalse negatives.

### D. *AnomalyDetectionResults:*

By analyzing both image and weight data, the system flaggedunusualbatchesforinspection.Thisapproachreduced the need for constant human supervision while ensuring that potential quality or quantity issues were caught early.

### E. *Discussion:*

Theexperimentsshowthatthesystemcanreliablydetect corruption and quality issues. Integrating image analy-sis, weight monitoring, and secure recordkeeping provides a practical method for monitoring grain throughout the supply chain.Thesystemperformedeffectivelyinbothlaboratoryand field conditions, demonstrating its applicability in real-world scenarios.

TABLE I
Grain Quality and Detection Results

| SampleID | GrainType | Image Observation(GrainScan) | WeightStatus | SystemDetectionResult |
|---|---|---|---|---|
| S1 | Wheat | Clearcolour,uniformtex-ture, no impurities | Correctweight | NormalBatch |

| | | | | |
|---|---|---|---|---|
| S2 | Rice | Slightcolourvariation,smalldustparticlesdetected | Correctweight | MinorQualityIssue |
| S3 | Wheat | Visiblestonesandforeignparticles | Correctweight | AdulteratedBatch |
| S4 | Rice | Good quality grains, no vis-ible defects | Underweightby1.2kg | QuantityMismatch |

*F. Results and Discussion:*

The table shows the comparison of different grain samples tested using the AnaajSuraksha system. GrainScan helped identify visual issues such as colour changes, impurities, and damaged grains, while the weight verification system detected shortages.

By combining these two checks, the system can accurately classify grain batches into categories such as normal quality, minor quality issue, adulterated batch, or quantity mismatch. This comparison shows how the system helps in identifying both quality problems and possible weight fraud, ensuring better monitoring and transparency in grain distribution.

## VI. SYSTEM ARCHITECTURE

The Smart Ration System is designed to work through three main parts: Admin, Dealer, and Consumer, all connected to make the ration distribution process easier and more reliable. The Admin module is responsible for managing and control- ling the entire system. It verifies and approves new dealers and customers, assigns ration quotas, and generates bills for transactions. This helps make sure that only authorized users can access the system and that each dealer receives the correct quantity of stock.

The Dealer module focuses on the distribution side of the system. Dealers update customer details, manage their own profiles, and distribute ration items to customers based on the quotas provided by the admin. This module works as a bridge between the administration and the consumers, helping the ration reach the right people.

The Consumer module allows customers to interact with the system directly. Consumers can check available ration items, add items they need, complete the purchase process, and log out securely after finishing their tasks.

Overall, the system architecture ensures a smooth and orga- nized flow of information from the admin to the dealer and finally to the consumer. This helps make ration distribution more transparent, efficient, and less likely to have errors or misuse.

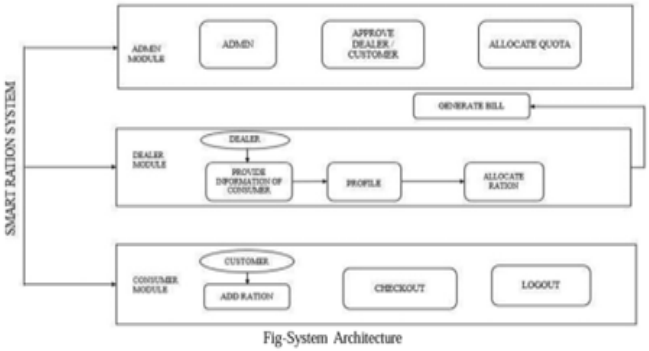


Fig-System Architecture

Fig. 1. System Architecture of AnaajSuraksha

## VII. FUTURE SCOPE

The AnaajSuraksha system can be further enhanced to improve transparency, traceability, and overall efficiency in the grain distribution process. In the future, the system can be integrated with a centralized government monitoring portal, enabling higher authorities to supervise grain movement across regions in real time.

The inclusion of RFID technology during transportation can help track grain bags from warehouses to ration shops, thereby reducing diversion and unauthorized handling. Biometric ver- ification of beneficiaries can also be incorporated to ensure that food grains are distributed only to eligible individuals.

Storage conditions can be further improved by integrating temperature and humidity sensors within warehouses to pre- vent spoilage and preserve grain quality. Additionally, a mobile application for citizens can be developed to allow users tocheck distribution details, track stock availability, and report irregularities directly to authorities.

In the long term, secure digital record-keeping mechanisms such as blockchain-based transaction management can be implemented to prevent tampering and ensure permanent, traceable records. These advancements would strengthen ac- countability, enhance public trust, and create a more resilient and transparent grain supply chain system.

## VIII. CONCLUSION

TheAnaajSuraksha presents a simple yet reliable solution to reduce corruption in the grain supply chain. The system combines GrainScan-based image inspection with weight verifica- tion to detect issues such as adulteration, damaged grains, and quantity mismatches at an early stage. Instead of depending only on manual inspection, this approach adds an extra layer of verification that improves transparency. All transaction details, including grain images and weight records, are securely stored in the database, which minimizes the risk of record manipulation. During testing, the system showed consistent performance and was easy to operate, even for users with basic technical knowledge. The results indicate that integrating basic image analysis, structured recordkeeping, and automated verification can significantly improve monitoring in real supply chain environment.Overall,AnaajSurakshaenhances accountability, reduces human error, and supports fair and efficient grain distribution..

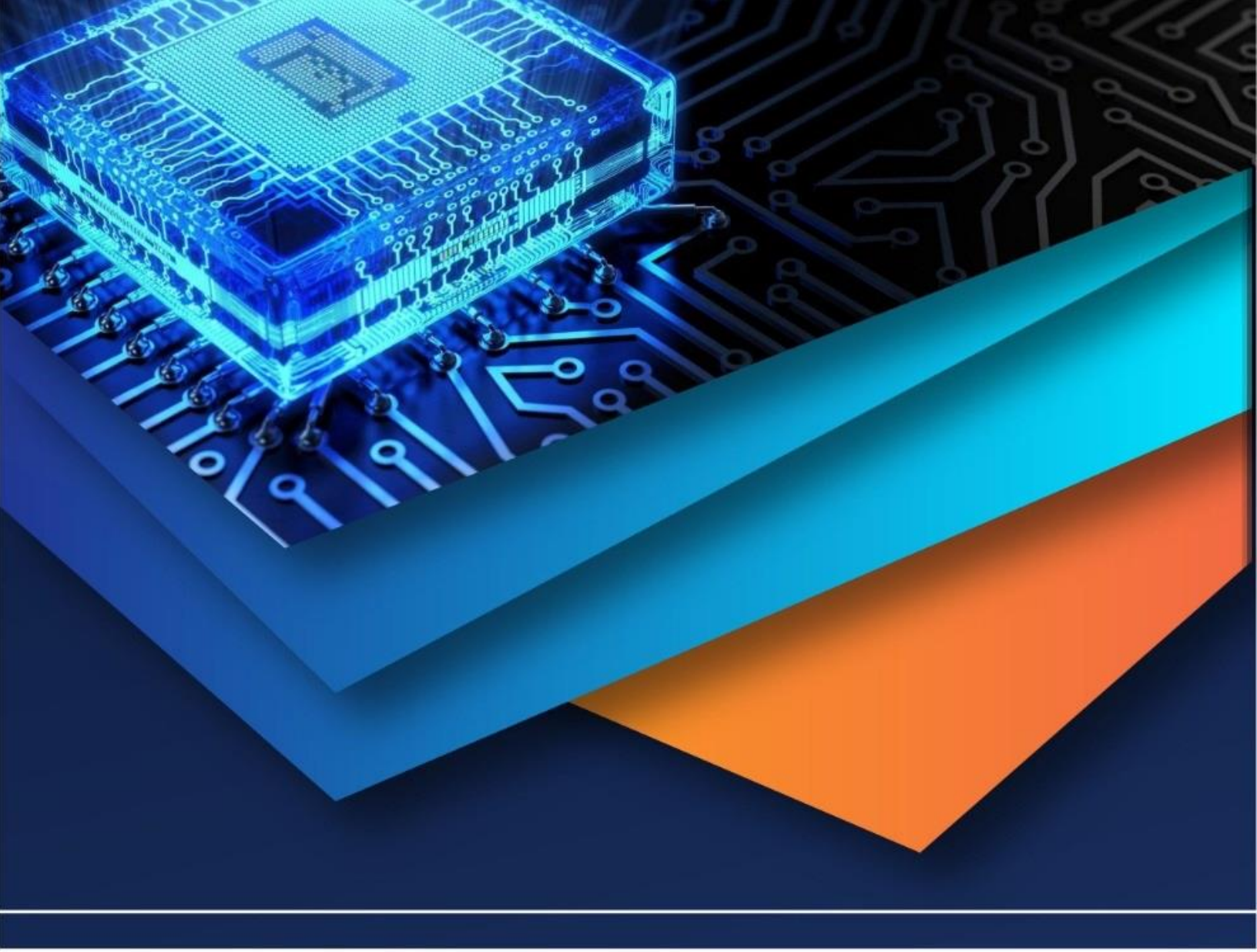
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