National University of Science & Technology

Chemical Contamination & Food Safety in Pakistan

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1 Introduction

The NutriScan project aims to address the health risks associated with contaminated fruits and vegetables. Through technology, it empowers communities to detect produce contamination effectively. This innovative solution integrates machine learning, IoT systems, and image processing to create a tool capable of identifying chemical adulteration in agricultural products.

2 Proposed Solution

The solution combines:

Research: Machine learning methods like DurbeenNet and KNN, IoT systems, and image processing techniques.

Survey: Understanding user needs and awareness levels regarding contamination.

Technology: A prototype enabling contamination detection through image uploads, safety information, and community engagement.

3 Methodology and Tools

To achieve the proposed solution, the following methodology was employed:

- **Research Phase:** Studied existing methods, such as the DurbeenNet model and IoT-based detection systems, to identify chemical adulteration in produce.
- **Data Acquisition:** Captured high-resolution images and gathered chemical residue readings using IoT sensors.
- **Data Preprocessing:** Enhanced image quality and processed sensor readings for analysis.
- **Model Training:** Leveraged labeled datasets for training models to identify toxic vs. non-toxic produce.
- **Classification and Feedback:** Combined IoT and image data to provide real-time contamination feedback.

4 Initial Vision

The project initially aimed to:

1. Identify the most accurate and efficient methods for detecting contamination.
2. Create a simple and user-friendly contamination detection system accessible to farmers and consumers.
3. Reducing reliance on costly laboratory testing by offering an affordable, real-time detection tool.
4. Empowering users to independently assess the safety of their produce.

5 Design Decisions

Several key design decisions shaped the project:

- **DurbeenNet Model:** Chosen for its high accuracy (96.7%) in detecting formaldehyde-treated fruits.
- **IoT Integration:** To ensure real-time monitoring and contamination analysis.
- **User Interface:** Focused on simplicity for widespread adoption.

6 Areas for Improvement

- **Sensor Accuracy:** Enhancing real-time chemical monitoring capabilities.
- **Model Personalization:** Tailoring machine learning models to regional contamination trends.
- **User Engagement:** Introducing interactive features like daily tips and shopping assistants for safe produce.

7 Unresolved Issues

Certain problems persist:

- **Accessibility Challenges:** Limited accessibility of IoT devices in rural areas.
- **Model Inefficiencies:** Accuracy discrepancies in certain contamination cases.
- **Dataset Updates:** Ensuring datasets are regularly updated to maintain accuracy.

8 Conclusion

NutriScan represents a significant step forward in addressing the health risks posed by contaminated produce. The project has successfully combined advanced technologies with practical applications, laying the groundwork for improved food safety and consumer awareness. While challenges persist, the progress made so far highlights the potential for further innovation and impact in this critical area.

9 References

- **DurbeenNet Model**: Deep learning model for detecting formaldehyde-treated fruits with 96.71% accuracy (Source: PMC Article).
- **IoT-Based Systems**: Sensors with ML algorithms to measure formalin levels (Source: TroIndia Study).
- **KNN Algorithm**: Classifies fruit images based on contamination patterns with 90% accuracy (Source: KSSEM Research).
- **GNNs**: Models chemical effects on fruits using small-molecule interactions (Source: Nature Research).
- **YOLOv3 + CNNs**: Real-time detection of adulterated produce via color and texture patterns (Source: IRJMETS Study).

10 Future Prospects

Given the opportunity, the project could evolve to:

- Launching a mobile app with advanced detection tools and personalized recommendations.
- Expanding IoT lab research for next-gen contamination detection technologies.
- Increasing community engagement through AI-driven contamination trend analysis and safety resources.

This report serves as a guide for future advancements and implementation strategies, showcasing the project's successes, addressing its challenges, and exploring potential opportunities for growth.