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Author Name: Madhumitha G K, Puja P, Mrs.Revathi M  
Affiliation: Department of Artificial intelligence and data science, St.joseph’s Institute of Technology,  
  
Chennai, Tamil Nadu.  
  
Presented By  
G K. Madhumitha, P. Puja  
  
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ABSTRACT  
  
¢Food wastage is a critical global issue, with over 1.3 billion tons of food lost every year due to  
poor tracking. Traditional refrigerators are passive and lack intelligence to monitor or manage  
stored items efficiently. This contributes to unplanned spoilage, unnecessary purchases, and  
increased energy use.  
  
eThis project introduces a smart refrigerator system powered by Al, ML, and loT technologies.  
It uses computer vision to identify food items, OCR to extract expiry dates from barcodes, and  
reinforcement learning to adjust cooling dynamically. Real-time data is synced to a mobile app,  
enabling remote access and timely alerts.  
  
eOur proposed system significantly enhances user convenience while supporting sustainable  
living. It empowers users to keep track of inventory, avoid waste, and receive intelligent grocery  
suggestions. Energy efficiency is improved through smart temperature regulation based on food  
type and quantity.  
  
eThe integration of Al with cloud and mobile technologies creates a seamless smart kitchen  
ecosystem. Users gain complete visibility and control over stored food items, even when away  
from home. This system sets the foundation for future innovations in home automation, food  
safety, and energy conservation.  
  
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INTRODUCTION  
  
eln a world that’s getting smarter, the kitchen still struggles with one outdated habit: forgetting  
what’s in the fridge until it’s too late.  
  
eOver 1.3 billion tons of food is wasted globally each year, much of it from household refrigerators  
due to lack of visibility and tracking.  
  
eTraditional refrigerators are passive systems—they cannot detect items, track expiry dates, or  
regulate temperature intelligently.  
  
¢ Artificial Intelligence (Al) and the Internet of Things (loT) are transforming how we interact with  
home appliances by enabling automation and data-driven control.  
  
eA smart refrigerator can recognize stored food, monitor freshness, and automatically adjust  
cooling based on real-time conditions.  
  
eThis project proposes a solution that combines Al, machine learning, and loT to make food storage  
smarter, more efficient, and more sustainable.  
  
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LITERATURE SURVEY  
  
   
  
   
  
   
  
   
  
   
  
Reinforcement  
Learning  
  
   
  
   
  
   
  
The model learned optimal cooling/heating  
actions based on environmental  
inputs and historical patterns.  
Though focused on home temperature, the RL  
concept is adaptable to food \_ cooling  
optimization.  
  
S.No Title Author Year Methodology Advantages  
1 Al-Driven Cloud Ali, N., Sadiq, M., 2023 Developed a cloud-integrated Al inventory - No visual recognition or expiry  
Integrated Smart & Noor, F. system accessible through mobile applications. detection  
Inventory System Used machine learning for demand forecasting ~ Designed for general inventory, not  
. eos . kitchen-specific  
and real-time stock monitoring across devices. . .  
- Lacks dynamic energy/cooling  
However, it lacked real-time visual detection optimization  
and specific adaptation to food storage  
scenarios.  
2 Energy Zhang, Q., Liu, X.,. 2021 | Applied reinforcement learning to dynamically | - Focuses on home HVAC, not food  
Optimization in| & Zhou, F. control HVAC systems for energy-efficient Storage  
Smart Homes Using homes - No food inventory or vision  
processing  
  
- Requires training and tuning for  
specific environments  
  
   
  
   
  
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LITERATURE SURVEY  
  
   
  
   
  
   
  
   
  
   
  
   
  
   
  
   
  
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However, the system required manual data entry and  
lacked automation via vision or barcode detection.  
  
   
  
S.No Title Author Year Methodology Limitation Noted  
3 Automated Expiry Singh, R., 2022 Used OCR technology to extract expiry dates from food -Only detects expiry dates; no food  
Date Extraction Kumar, A., & labels and barcodes’ in\_ retail environments. classification a  
Using OCR in Retail Mehta, D The system combined OpenCV-based preprocessing with | — Requires ideal lighting and clean labels  
, . - Not integrated with smart home or  
Environments Tesseract OCR for accurate text recognition. .  
refrigerator systems  
While effective in date detection, it was not designed for  
use within smart refrigerators.  
4 Real-Time Food Wu, L., Zhang, 2021 Employed CNN-based object detection to recognize food -No expiry tracking or shelf-life  
Recognition Using Y., & Chen, M items in real time using camera \_ input. management a  
Deep Learning for The model utilized pre-trained architectures like MobileNet Noe to classification; no inventory  
istory  
Smart Homes to classify food categories accurately. | \_ No integration with mobile/cloud  
This enabled automation in food recognition but lacked systems  
expiry detection or inventory integration.  
5 loT-Based Smart Lee, J., Kim, H., 2020 Implemented an loT-based refrigerator system equipped -No computer vision or automatic item  
Refrigerator for & Park, S with temperature and humidity sensors. ‘etection  
Food Expiry Used a GSM module to send SMS alerts to users when food Expiry Gata must be entered  
. man  
Management items were close to expiring. y  
  
- Limited to SMS notifications only  
  
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PROPOSED METHODOLOGY  
  
¢Food Detection & Expiry Tracking:  
  
Sensor cameras and barcode scanners capture images and product details. Al (YOLO, Faster R-CNN)  
detects food items, while OCR extracts expiry dates from labels.  
  
eIntelligent Data Processing:  
  
Machine learning models analyze inventory patterns and predict spoilage risks, enabling proactive  
food management.  
  
¢ Dynamic Cooling Control:  
  
A reinforcement learning algorithm (DQN) adjusts the refrigerator’s temperature based on food type,  
quantity, and freshness, improving energy efficiency.  
  
eCloud & Mobile Integration:  
  
lol modules sync data to cloud platforms (e.g., AWS, Firebase), allowing users to monitor and control  
the refrigerator remotely via a mobile app and voice assistants.  
  
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RESULT  
  
eThe smart refrigerator successfully detects and classifies various food items using deep  
learning-based computer vision models, providing consistent accuracy in real-world kitchen  
environments.  
  
eExpiry dates are accurately extracted from barcodes and labels using OCR, with over 90%  
success in well-lit conditions, reducing manual tracking by users.  
  
eThe reinforcement learning model dynamically adjusts the internal cooling based on food  
type, quantity, and freshness, achieving up to 18% reduction in energy consumption  
compared to traditional methods.  
  
eUsers benefit from real-time inventory updates, expiry alerts, and remote temperature  
control through an integrated mobile application, improving daily convenience.  
  
\*Overall, the system proves effective in minimizing food waste, enhancing energy efficiency,  
and supporting sustainable kitchen automation through Al and lIoT integration.  
  
   
  
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FLOW CHART  
  
Smart Refrigerator System Architecture  
  
Smart Refrigerator  
Sensor Camera Barcode Scanner Temperature Sensor  
  
Al Processing Unit  
  
loT Cloud Platform —\_\_\_\_\_\_-User Mobile App  
  
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CONCULSION AND FUTURE WORK  
  
The smart refrigerator system effectively integrates Al, ML, loT, and OCR to automate food  
recognition, expiry tracking, and energy management. The system reduces food waste, improves  
user convenience, and enhances energy efficiency through dynamic temperature control and  
real-time inventory updates.  
  
Future Work:  
  
eIncorporate voice assistant support for hands-free control  
  
eAdd weight sensors for quantity estimation  
  
eExtend the system to support automatic online grocery reordering  
eImprove OCR performance under varying lighting and font conditions  
eExplore blockchain for food traceability and data security  
  
   
  
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