Green Vault: Solar-Powered, AI-Driven, and IoT-Enabled Smart Storage for Sustainable Agriculture

SRM INSTITUTE OF SCIENCE & TECHNOLOGY (Deemed to be University u/s 3 of UGC Act, 1956)

SDG 7(Affordable & Clean Energy)   SDG 9(Industry, Innovation & Infrastructure)   Responsible Consumption & Production

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iEMbotics
Turning Silicon Dreams into Reality

Abstract

Food spoilage in agricultural storage leads to significant waste and economic losses, amplified by inadequate monitoring of conditions. Inadequate monitoring increases food spoilage, requiring an urgent need for advanced preservation solutions. To address this, we developed a solar-powered, AI-integrated smart fridge named **Green Vault**, that uses IoT sensors to monitor parameters like temperature, humidity, and gas levels. The AI module trained with the YOLOv8 model detects spoiled goods. This system enhances storage efficiency and reduces reliance on electrical grids.

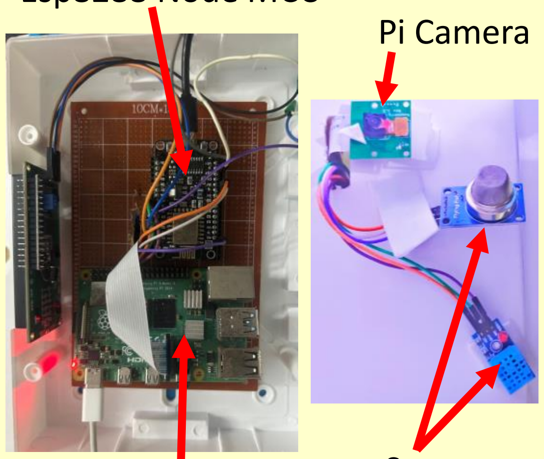
Methodology

Green Vault employs MQ-135 Gas Sensor to detect ethylene & methane levels from rotten food, & the DHT11 sensor to monitor temperature and humidity. The collected data is sent to Firebase, a real-time cloud database, & updated in the mobile app that allows remote temperature control. If the temperature is adjusted below 20°C, an additional cooling unit activates to enhance cooling. For spoilage detection, a YOLOv8 model trained on rotten & healthy food images runs on a Raspberry Pi, with a Pi Camera capturing images for analysis. The system is powered by a solar panel, boosted by an XL6009 converter & fed to TP4056 module for charging, reducing grid dependency.

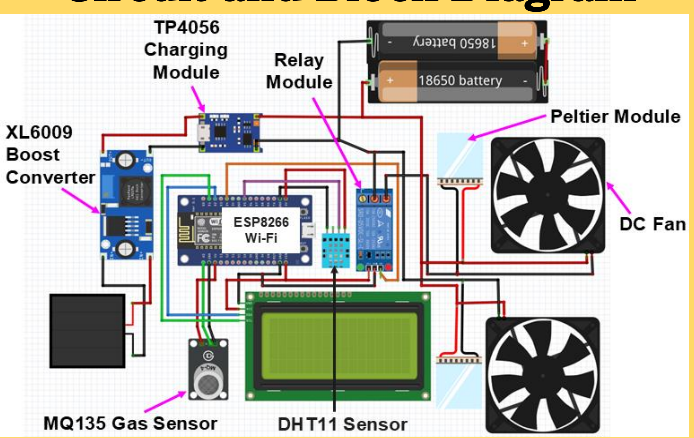
Experimental Setup

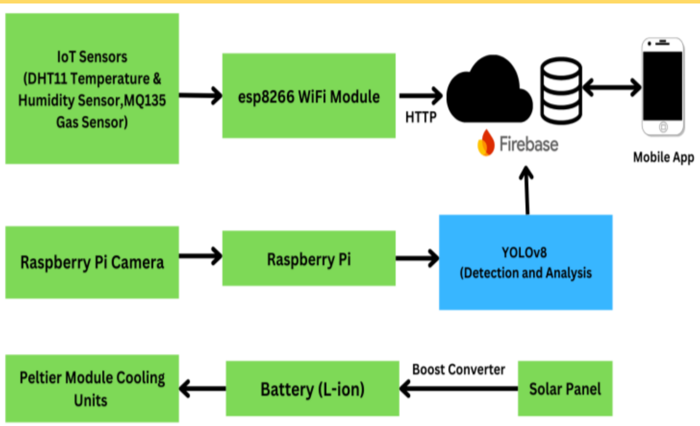
Material used : -
Biodegradable Thermoplastic Polyurethane (TPU) is an advanced material that is much more environmentally friendly .

Internal Circuit



Circuit and Block Diagram





Power Calculation

Battery Capacity : –

Voltage per battery = 3.8 V
Current per battery = 3.0 Amps
For 2 batteries in series, voltage adds up, current remains the same and in a parallel combination , the output branch will have the current add up.
Voltage series = voltage per battery X 2 = **7.6 V**
Current parallel = current per battery X 2 = **6 Amps**
Total power calculation (Power = Voltage * Current)
total_power = voltage series * current parallel = 7.6 X 6 = **45.6 Watts**

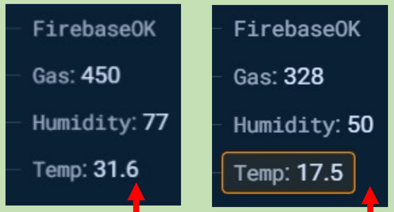
Solar Charging: -

Solar panel output: **5 V** & **0.5 Amps**
After the boost converter: **10 V** & **2.5 Amps**
Total power after boost converter : -
P_{boost} = 10 X 2.5 = **25 Watts**
Time taken to Charge the Batteries:-

$$\text{Time} = \frac{\textit{Battery capacity}}{\textit{power delivered}} = \frac{45.6}{25} \approx 2 \text{ hrs}$$

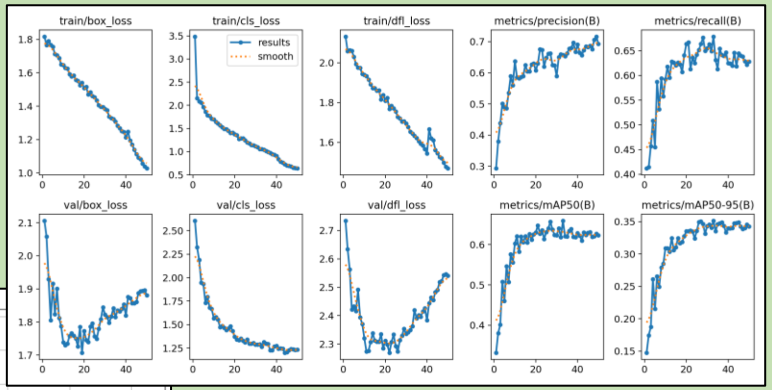
User Interface

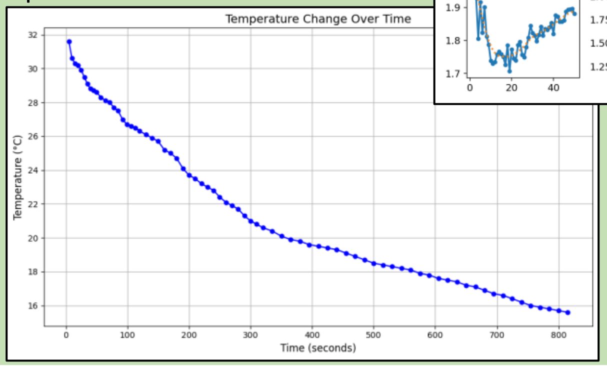
Results

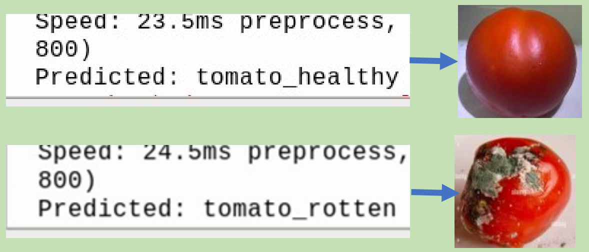


Data getting uploaded

New Data Updated







References

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2. Afsharpour, Pariya, Toktam Zoughi, Mahmood Deypir, and Mohamad Javad Zoqi. "Robust deep learning method for fruit decay detection and plant identification: enhancing food security and quality control." Frontiers in Plant Science 15 (2024): 1366395.
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