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Environmental Harmony Through Carbon Footprint Analysis

Meghana C P[1], Chandana B A[2], Gouthami D R[3], Chaithra H P[4], Dr. Rajashekar M B[5]

UG student Department of Computer Science and Engineering, GSSS Institute of Engineering and Technology for women, Mysuru, VTU, Belagavi, India[1-4]

Associate Professor, Department of Computer Science and Engineering, GSSS Institute of Engineering and Technology for women, Mysuru, VTU, Belagavi, India[5]

Abstract: Achieving environmental harmony necessitates a comprehensive understanding of carbon footprints, which are crucial indicators of the ecological impact of human activities. This paper explores the significance of analysis of carbon footprint in fostering sustainable development and mitigating climate change. By examining various methodologies and tools for carbon footprint assessment, along with case studies demonstrating their practical application, this study elucidates the pivotal role of such analyses in guiding policy formulation and corporate sustainability initiatives. Furthermore, it discusses the incorporation of carbon footprint considerations into decision-making processes across diverse sectors, emphasizing the potential for synergistic environmental benefits and economic advancement. Through a holistic approach to carbon footprint analysis, informed by interdisciplinary research and stakeholder engagement, environmental harmony can be achieved, paving the way for a more resilient and equitable future.

Keywords: Environmental harmony, Carbon footprint analysis, Sustainable supply chain, CO2 emission, Policy formulation, Corporate sustainability.

I. INTRODUCTION

The venture “Carbon Impression Analysis” is to evaluate and minimize the natural affect related with the whole lifecycle of the item, from crude fabric extraction to fabricating, dispersion, utilize, and transfer. We utilize sensors, IoT gadgets, and progressed analytics, the venture points to give real-time data-driven bits of knowledge into the product's carbon footprint. In a world where each buy takes off an undetectable stamp on the planet, understanding the carbon impression of items is the key to capable living.

The term "carbon impression" alludes to the add up to sum of nursery gasses, basically carbon dioxide, that are radiated specifically all through the lifecycle of a product. Develop an conclusion to conclusion arrangement that can degree and communicate the carbon impression of a item in a way that is exact, effective, and straightforward for both the companies and the clients, whereas considering the complete product life span of the item from production to producer or the middle of the road specialists in the value chain or the consumer.

The carbon outflows due to mechanical generation and showcase utilization exercises are the major supporters to worldwide warming. By conducting a careful examination of the carbon impressions of distinctive items, we look for to disentangle the covered up natural costs inserted in their life cycles.

II. COMPONENTS

A. Hardware Design

The devices that can be used for Carbon Footprint Analysis are:

- MQ2 – Hydro Carbon(HC)
- MQ3 – Nitrogen Oxide(NO)
- MQ5 – Carbon Mono-oxide(CO)
- Microcontroller

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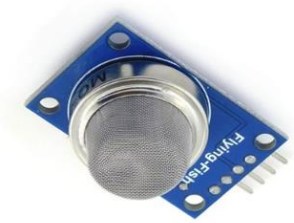
1. MQ2 – Hydro Carbon(HC):

The MQ2 gas sensor is an electronic gadget that is utilized to distinguish different sorts of gasses, counting hydrogen (H2), melted petroleum gas (LPG), methane (CH4), carbon monoxide (CO), liquor, smoke, and propane. It is broadly utilized in both private and mechanical settings to distinguish gas spills and anticipate potential hazards. Primary focal points of the MQ2 gas sensor is its tall affectability and quick reaction time, which empowers early discovery of gas spills.

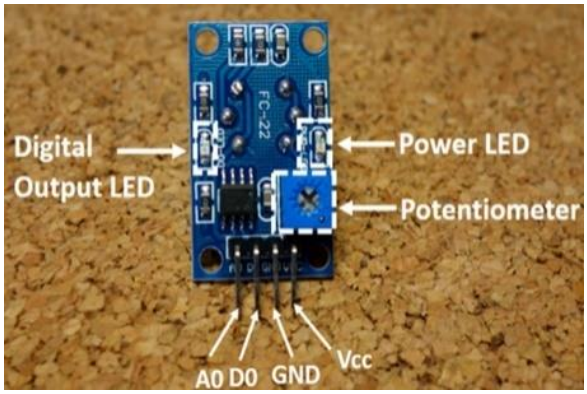
2. MQ3 – Nitrogen Oxide(NO):

The MQ3 Gas Sensor module is fabulous for recognizing gas spills (in domestic and industry). It is able of identifying CO, CH4, NO, Benzine, Hexane, LPG, and Liquor. Estimations may be made as before long as attainable due to their tall affectability and speedy response rate. The potentiometer can be utilized to alter the sensor's affectability. This low-cost semiconductor gas sensor module is exceptionally straightforward to work and has both analog and computerized yield. This Gas Sensor module can be utilized in breathalysers since it is touchy to liquor. Benzine is so also as it were feebly touchy to MQ3 Sensor.



3. MQ5 – Carbon Mono-oxide(CO)

The Gas Sensor module, specifically MQ5, is designed for gas leakage detection in both home and industrial settings. It has the capability to detect H2, LPG, CH4, CO and alcohol because it has high sensitivity and fast response time. Additionally, the module features an adjustable sensitivity through a potentiometer. Gas sensors, also known as gas detectors, capable of detection and identify various kinds of gases, typically used for detecting toxic or explosive gases and measuring gas concentration.



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4. Microcontroller

A Microcontroller (MCU) is a little computer on a single coordinates circuit that is outlined to control particular assignments inside electronic frameworks. It combines the capacities of a central preparing unit (CPU), memory, and input/output interfacing, all on a single chip. Microcontrollers are broadly utilized in implanted frameworks, such as domestic machines, car frameworks, restorative administrations, and mechanical control frameworks. They are moreover utilized in customer gadgets items, such as gaming frameworks, computerized cameras, and sound players.

B. Software Design

Embedded C is a programming language specifically crafted for developing firmware within embedded systems, which combine hardware and software to perform specific functions. This language is well-suited for programming microcontrollers and microprocessors and is more resource-efficient than high-level languages like assembly. Various compilers like Keil Compiler, SPJ Compiler, and Embedded GNU C Compiler are mentioned for compiling Embedded C programs. The text mentions that operating systems (OS) like Windows XP or higher manage hardware and software resources, providing services essential for application programs. Microsoft SQL Server 2005 is highlighted as the database server used for managing data. Visual Studio 2010 and Eclipse are noted as necessary IDEs for software development. These IDEs support various programming languages, debugging, GUI building, and more. IIS is referred described as an extensible web server supporting multiple protocols, integral to the Windows NT family since Windows NT 4.0. A central tool in software development, Visual Studio supports languages like C, C++, C#, and F#. It features a code editor with IntelliSense, a debugger, form designer, web designer, class designer, and database schema designer. Visual Studio also supports plug-ins that extend its functionality.

III. LITERARURE SURVEY

Machine Learning Based Carbon Footprint Management the Frozen Vegetable Processing Industry - 2021
The paper introduces a methodology, combining statistical and machine learning techniques, to address production management challenges in frozen vegetable production. By initially assessing production through correlation and clustering processes into five groups, it identifies optimal, near-optimal, and suboptimal processes, including those affected by human error. Supervised machine learning validates the clustering, with k-means emerging as the preferred method. The methodology is tested on onion production, demonstrating significant improvements in energy efficiency. Similar benefits are observed in cauliflower and broccoli production. By aligning processes with optimal centroids, energy utilization per ton of final product can be reduced.

Predicting C02 Emission Footprint Using AI Through Machine Learning - 2022
Tackling carbon emissions and their effects in relation to climate change is of utmost importance in the modern era. Leveraging AI and ML, this study focuses on developing a model to forecast global CO2 emissions, especially considering COVID-19 pandemic's effects. By examining reduced emissions during the pandemic, significant insights were gained. Four methods were employed, with the post-COVID model exhibiting an impressive 9% MAPE, forecasting emissions for 2022-2027. Comparison with existing benchmarks validates the precision of the predictions. While acknowledging the requirement for further consideration of external factors and optimization methods, the study highlights the efficacy of AI-based ML in forecasting emissions. Additionally, it underscores the potential of lockdown measures in reducing emissions, suggesting policy interventions to mitigate CO2 footprints.

How to estimate carbon footprint when training deep learning models? A guide and review – 2023
This paper examines seven tools for measuring energy intake during the training of deep learning models, specifically focusing on regular CNNs for image processing. It delves into each tool's intricacies, elucidating concepts that may be unfamiliar to AI practitioners. Highlighted are the pros and cons of online tools, emphasizing that the choice depends on architecture and whether one aims to measure the entire node or specific processes. The study reveals that while software tools have a minimal impact, this can become significant in larger experiments. Notably, energy consumption remains constant throughout epochs, suggesting that measuring on a few epochs and extrapolating may suffice. It emphasizes the consequence of scaling infrastructure to match needs, avoiding unnecessary node reservations. However, it notes that current tools only measure dynamic energy consumption, underscoring the need for further research to incorporate static consumption and environmental impacts.

A systematic review of machine learning approaches in carbon capture applications – 2023
The integration of Industry 4.0 and Industry 5.0 to address environmental concerns, particularly in reducing carbon emissions, has gained significant attention. Leveraging smart technologies like machine learning (Industry 4.0) and

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collaborative development through R&D teams (Industry 5.0), offers promising solutions to combat climate-related challenges. Utilizing bibliometric methods, information from the Scopus database were analyzed, comprising approximately 314 articles spanning from 1999 to June 2022. The analysis explored criteria such as co-authorship country, citations, keywords, and emerging topics. Findings revealed China, the United States, and Iran as key contributors for CO2 capture in machine learning research. Noteworthy topics include CO2 adsorption, and carbon capture, which have garnered heightened interest from 2020 to 2022. However, there exists a notable gap in research focusing on predicting CO2 adsorption capacity using various machine learning methods. Hence, this bibliometric analysis functions as a valuable tool to identify research gaps, technological advancements, and emerging areas of interest within the field.

CaML: Carbon Footprinting of Household Products with Zero-Shot Semantic Text Similarity – 2023
In this paper, they introduced a semantic text similarity algorithm to estimate carbon emissions of household products using EIO-LCA methods. By matching products to corresponding industry sectors with published carbon emission factors, this algorithm demonstrated superior performance compared to manual mapping and direct supervision methods. Initial results, including annotations by both experts and non-experts, show promising outcomes, reducing reliance on manual annotations compared to previous methods. To address ambiguity in product descriptions, we propose incorporating product images into a multi-modal model for more accurate embeddings. Additionally, leveraging the hierarchy of NAICS codes can enhance classification accuracy by encoding it as a unit of the loss function. While our focus was on mapping products to NAICS codes for EIO-LCA completion, we acknowledge similar manual bottlenecks in process-based LCAs. This study paves the way for incorporating additional environmental impact dimensions in future Life Cycle Assessments(LCAs). The ultimate aim is to empower consumers for comprehending and mitigating their carbon footprints by providing accurate footprint estimates for products. Achieving this requires scalable and accurate prediction algorithms, where machine learning plays a crucial role. Future efforts will involve assessing the variabilities linked with contemporary forecasting and integrating them into decision-making processes. Moreover, while we have made strides in estimating overall carbon footprints, further work is needed to compare products and identify those with lower emissions. Automation or augmentation tools to assist in such decisions represent an important direction for future research.

IV. SYSTEM MODELLING AND DESIGNING

Frameworks plan is the handle of characterizing the engineering, components, modules, interfacing, and information for a framework to fulfill indicated necessities. Frameworks plan might be seen as the utilization of frameworks hypothesis to item improvement. There are few covers with the disciplines of frameworks investigation, frameworks engineering and frameworks building. The building plan of a framework emphasizes upon the plan of the frameworks engineering which depicts the structure, conduct, and more sees of that framework. Framework plan is the handle of characterizing the components of a framework like design, modules and components, the diverse interfacing of those components and the information that goes through that framework. It is implied to fulfill particular needs and prerequisites of a commerce or organization through the designing of a coherent and well-running framework.

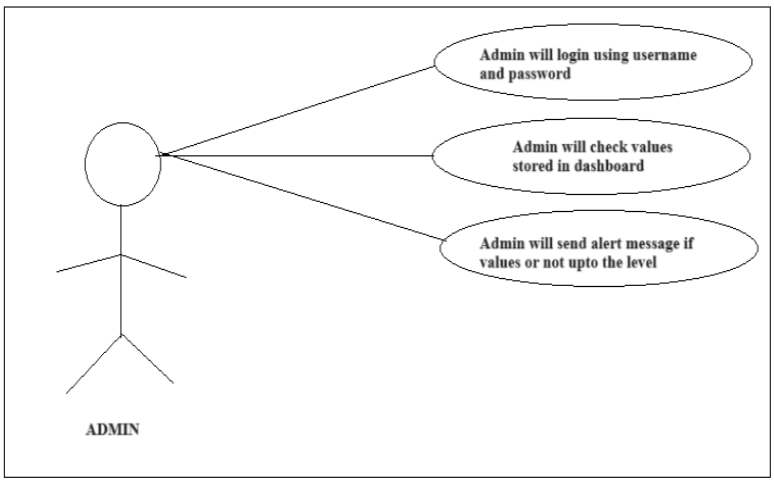

Fig. 1 Use Case Diagram

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1. Dataflow Diagram

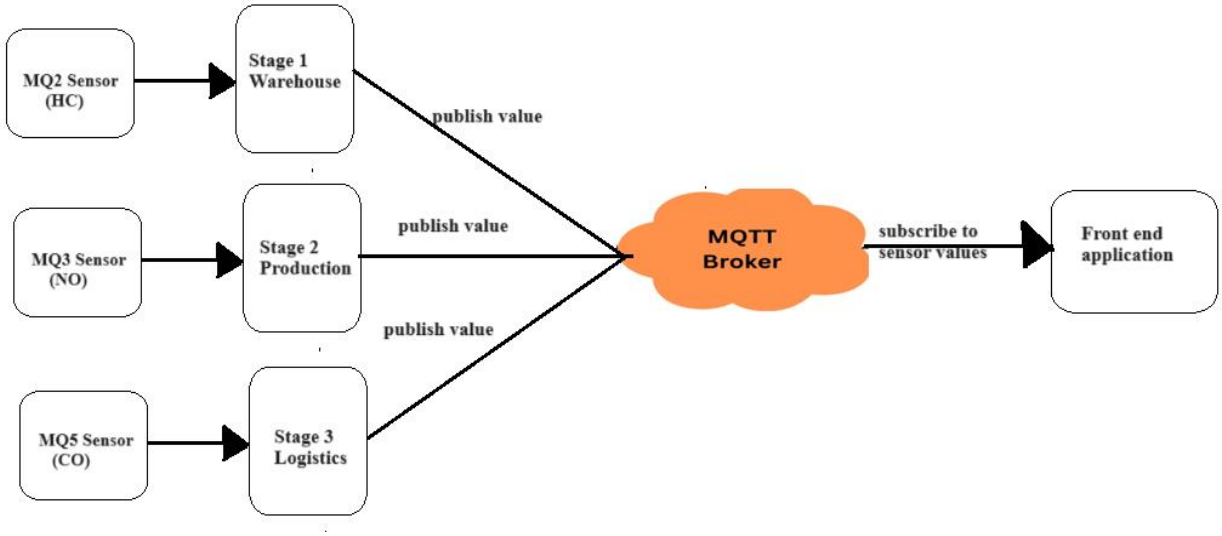

Fig. 2 Dataflow Diagram

2. Working

In this Carbon footprint Analysis, we use 3 stages Warehouse, Production and Logistics. and also, we use three sensors MQ2(HC), MQ3(NO), MQ5(CO). This three are connected with microcontroller, and three sensors packed with each stage and the values we get from every stage would be pushed to cloud using MQTT protocol and finally display in the monitor or front end application.

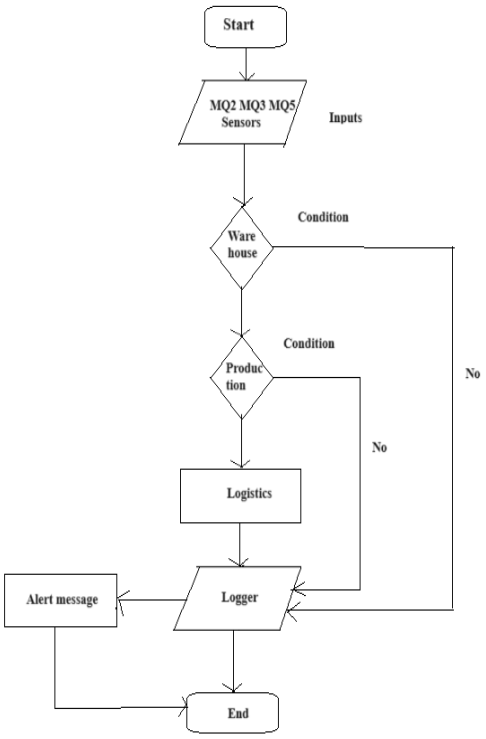

Fig. 3 Design of Carbon Footprint Analysis

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V. IMPLEMENTATION

The footprint of carbon signifies the collective carbon dioxide emissions generated by an activity or amassed throughout a product's lifecycle. This encompasses actions of individuals, communities, authorities, businesses, entities, operations, industry sectors, and so forth. Products encompass both tangible goods and intangible services.

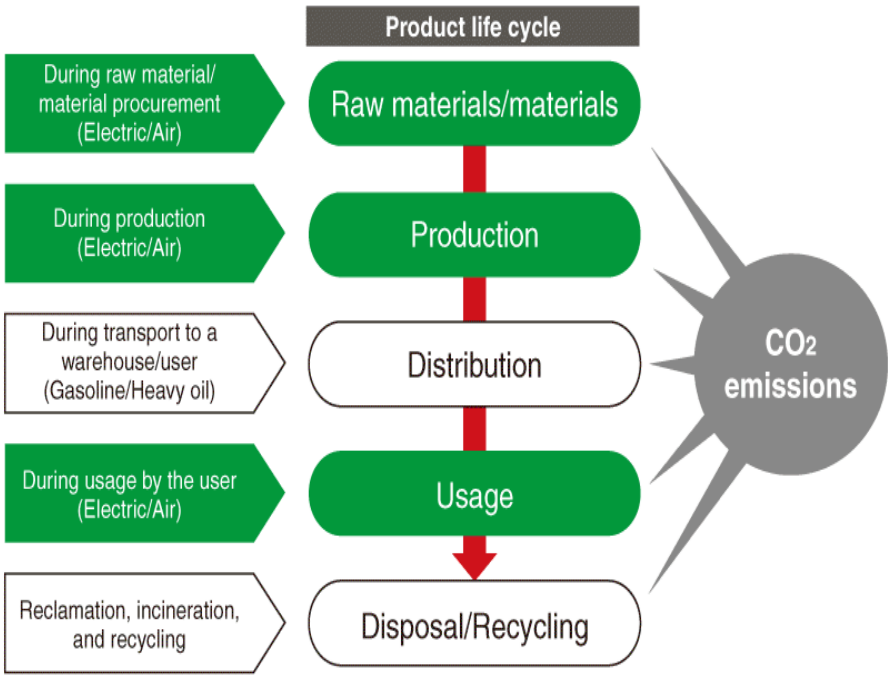

Fig. 4 Methodology

LCA serves as a method to assess the environmental ramifications, such as air pollution, and energy depletion, linked with a product across its whole lifecycle. In contrast, the footprint of carbon exclusively measures the quantity of emission of greenhouse gas, CO2, without considering other environmental impacts.

APPLICATIONS

- Policy Making and Regulation.
- Corporate Sustainability.
- Manufactures employ carbon footprint evaluation for the environmental impact of their products from production to disposure.
- By providing information on the footprint of carbon of different products and services, consumers can be encouraged to make more ecologically sustainable choices.
- The energy industry uses carbon footprint evaluation to assess and optimize the balance between different energy sources, such as comparing the footprints of sustainable energy sources against fossil fuels.
- Transportation and Logistics aids in diminishing the aggregate emissions linked with transporting goods and individuals.

VI. CONCLUSION

The objective of this project was to generate a system that monitors and regulates flammable gases and carbon monoxide levels in remote areas using MQTT Protocol. It employs a combination of MQ2, MQ3, and MQ5 sensors to detect methane, smoke with carbon monoxide, and other gases, respectively. Data collected by these sensors is transmitted to a cloud-based web server, enabling remote access. The primary purpose is to swiftly identify gas presence, alerting users to potential leaks or fire risks. Additionally, users can remotely manipulate a valve via relay to manage gas flow. Utilizing an ESP8266 microcontroller, the system enhances safety by averting explosions and gas contamination, offering real-time monitoring and control from any location worldwide.

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