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An AI-Powered System for Encouraging Cleanliness and Managing Screen Time

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Abstract: This article introduces Clean Room Monitor, an AI-powered solution created to automate the supervision and management of children's room tidiness. The system uses an IP Webcam to capture images and employs a Convolutional Neural Network (CNN) to categorize spaces as neat or cluttered following uniform preprocessing. When a messy room is identified, automatic responses, like SMS/Email notifications and router-imposed internet blocks are activated to maintain impartial parental control. A structured logging module records all predictions for analytics and periodic model retraining. Experimental results demonstrate high classification accuracy and reliable real-time performance, indicating that the system effectively reduces parental supervision effort while promoting responsible behaviour. The proposed solution is low-cost, scalable, and suitable for integration into smart home and digital parenting applications.

Keywords: Clean Room Monitor, CNN, Image Classification, IoT, IP Webcam, Internet Restriction, Smart Home, Digital Parenting

I. INTRODUCTION

Keeping rooms tidy is a part of discipline and promoting healthy habits, particularly for kids. Yet the usual approach depends significantly on parents overseeing the task, which tends to be inconsistent, subjective and hard to handle in homes. Parents might have varying views on what cleanliness means causing application of rules and regular disagreements. These issues highlight the necessity, for a impartial and effective method to evaluate cleanliness.

Progress, in Artificial Intelligence (AI) Internet of Things (IoT) and computer vision currently allows for assessment of indoor spaces. Convolutional Neural Networks (CNNs) can process images of rooms detect clutter arrangements and accurately categorize cleanliness levels. Devices connected via IoT additionally facilitate monitoring, remote control and instant decision-making. These automated solutions provide uniformity, expandability and swift responses surpassing the constraints of evaluation.

The proposed AI-Powered Clean Room Monitor integrates image capture, CNN-based classification, and automated alerts to provide a reliable and technology-driven cleanliness monitoring solution. By combining computer vision with IoT automation, the system reduces parental effort, eliminates subjectivity, and encourages responsible behaviour in a structured and intelligent manner.

II. OBJECTIVES

The primary goals of this project are:

1) To automatically classify room cleanliness using a CNN-based image analysis model.
2) To trigger SMS/Email alerts and internet restrictions based on cleanliness detection.
3) To establish a real-time AI + IoT pipeline for continuous and unbiased monitoring.
4) To create a scalable, low-cost system that supports digital parenting with minimal manual intervention.

III. EXISTING SYSTEM

Present methods for assessing the tidiness of children's rooms largely depend on oversight, which is naturally subjective, irregular and labour-intensive. Parents frequently rely on checks or frequent prompting which may result in disputes, uneven enforcement and absence of responsibility. Current parental control apps primarily target screen-time restrictions, app blocking or tracking device use. They overlook real-life behavioural elements, like room arrangement or finishing chores. Consequently, these systems offer support and fail to encourage enduring accountability or self-control in children.

A significant drawback of home monitoring systems is the lack of AI-driven visual assessment. The majority of platforms fail to analyze the tidiness or messiness of a room through computer vision methods. Do they offer objective categorization of cluttered, versus neat spaces. Conventional surveillance setups simply. Transmit video feeds without conducting any analytical processing requiring parents to assess the rooms condition on their own. Furthermore, no conventional system incorporates measures like internet blocking triggered by room status resulting in unreliable or inconsistent application of rules.

Furthermore, traditional systems do not include tools for data-guided decision processes and automation. They lack a workflow, for image preprocessing CNN-based forecasting, action initiation, notification management or extended analytics. Parents have to step in and the lack of automated follow-up allows children to easily avoid or disregard requirements. Feedback generally consists of reminders instead of consistent supervision or behavioural reinforcement. The lack of objectivity, automation, scalability, and integration between cleanliness detection and parental control clearly highlights the need for an AI-powered, IoT-enabled solution such as the proposed Clean Room Monitor.

IV. PROPOSED SOLUTION

The proposed Clean Room Monitor uses an AI-driven CNN model and IoT automation to objectively detect room cleanliness and enforce parental rules. Images captured through an IP Webcam are pre-processed and classified as clean or messy using the trained CNN. When a messy room is detected, the system automatically sends SMS/Email alerts and applies router-based internet restrictions, while clean detections maintain normal access. All events are logged for analysis and periodic model retraining. A unified dashboard allows parents to monitor status, view images, and manage settings, providing a scalable and unbiased solution for digital parenting.

V. METHODOLOGY

The Clean Room Monitor system employs a AI-powered process that combines image capture cleanliness detection, via computer vision IoT-enabled action execution and ongoing learning. The system assesses the condition of a room using automated evaluation and connects model outputs to immediate parental control measures. The approach is structured into processing units image preprocessing, CNN-driven classification, decision-making framework and automated restriction management that collaborate to deliver an impartial and steady cleanliness evaluation.

A. Image Preprocessing Methodology

The images of rooms obtained from the IP Webcam are processed through a preprocessing workflow to guarantee consistency and reliability prior to classification. This process starts with resizing the images, where each frame is adjusted to a size (such, as 128×128 pixels) to ensure they align with the CNN model requirements. Subsequently pixel normalization is applied, converting RGB values into a scale, which enhances gradient stability during the inference phase.

To improve generalization, data augmentation methods like rotation, horizontal flipping, brightness modification and slight cropping are employed. These alterations assist the model in functioning across different lighting situations, camera perspectives and room configurations. The processed images are transformed into NumPy arrays to generate a tensor format appropriate, for deep learning tasks.

This initial processing phase guarantees that the classification system obtains inputs that're tidy, uniform and packed with information thereby enhancing the precision and dependability of cleanliness identification.

B. Cleanliness Classification Methodology

A Convolutional Neural Network (CNN) trained on a labelled collection of untidy rooms is used to perform cleanliness classification. The CNN captures characteristics by utilizing multiple convolutional layers that examine edges, textures, objects and clutter arrangements. After the stages ReLU activation, pooling layers and fully connected layers sequentially refine the visual data into a likelihood score.

The final layer employs a sigmoid activation function to produce an outcome that signals if the room is messy (1) or tidy (0). Each prediction is paired with confidence scores to assist the decision engine in deciding if intervention is necessary. The CNN is trained with binary cross entropy loss and the Adam optimizer guaranteeing effective convergence and robust generalization.

This approach allows for the automated, categorization of cleanliness degrees based on objective visual indicators instead of subjective human evaluation.

C. IoT-Based Decision and Action Execution Methodology

To transform AI forecasts into reactions the system utilizes a rule-based decision engine that connects classification results with IoT automation. When the CNN detects a room with strong confidence the decision module instantly activates SMS/Email alerts using SMTP or third-party APIs, Internet limitations set at the router affecting the child’s device.

This is accomplished via programmable router APIs or scripts managing the network. When the room is deemed clean, standard internet access continues, promoting conduct.

Every activity together with recorded images, time stamps and likelihood estimates is stored in a database. This collection facilitates tracking and allows parents to examine past cleanliness trends. Therefore, the decision module functions as the link, between AI-generated insights and the automated application of household rules.

D. Scoring, Logging, and Continuous Model Improvement

While the Clean Room Monitor operates as a binary classifier it incorporates an internal confidence scoring mechanism that measures the model's level of certainty and aids in enhancing decisions. The system records every prediction, confidence score and activated response, within a log database. This information facilitates trend analysis. Allows parents to monitor behavioural progress over time. To preserve accuracy as time progresses the system incorporates a model retraining process. Gathered and manually annotated images are regularly incorporated into the training set. The CNN undergoes retraining and validation and the enhanced model substitutes the one if there is an accuracy improvement. This guarantees adaptability to variations, in lighting, room configuration or user behaviour.

VI. IMPLEMENTATION

The Clean Room Monitor system is developed as an AI – combined application featuring a Python-driven backend, a compact local dashboard, an IP Webcam interface and an organized database for prolonged data retention. All elements function on-site rendering the system affordable simple to implement and ideal for research or prototype-level smart home automation. The system's design guarantees coordination, among image capture CNN analysis, decision-making processes and IoT control components.

A. Image Acquisition Interface Implementation

The image capture system utilizes the IP Webcam app, which transmits live room visuals to the backend via a local network. A basic desktop dashboard (developed with Python Tkinter/Flask templates) enables parents to adjust camera configurations, like IP address, port and login details.

Pictures are taken at set intervals. Upon request through HTTP GET commands. The system checks connection status manages timeout or inaccessible device errors and saves every captured picture in a folder. The interface guarantees communication, with the mobile camera facilitating steady and dependable image acquisition. This modular setup supports compatibility with smartphone cameras and IP streaming inputs.

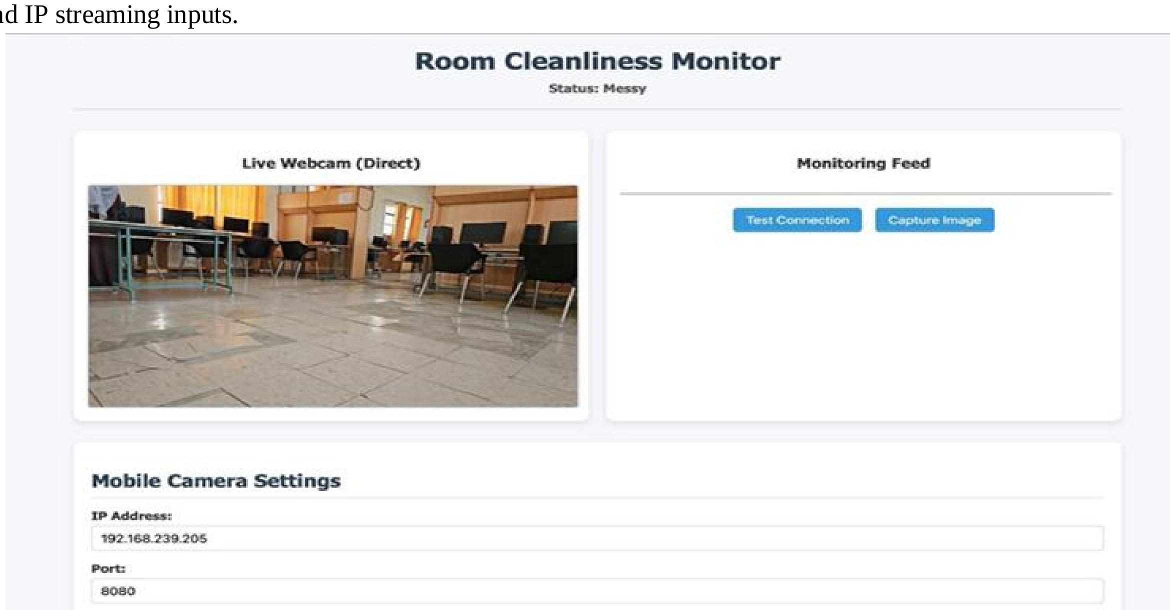

Fig-1: Room Cleanliness Dashboard

Fig-2: Alert Mail

B. Backend Implementation

The backend is built with Flask functioning as the central processing unit in charge of prediction, decision-making, notification management and router administration. Flask routes handle operations including image uploads, cleanliness predictions, status checks and alert transmissions. Additionally, the backend connects with router APIs or bespoke scripts to enforce or lift internet restrictions, on the child's device.

Python's SMTP modules facilitate sending Email/SMS notifications whereas the backend records each activity with timestamps for review. Error management processes identify images, connection issues and improperly set up camera streams. Every output such as prediction tags, confidence levels and action initiations is delivered in a JSON format guaranteeing compatibility, with the dashboard frontend.

C. Preprocessing and CNN Model Implementation

The machine learning workflow is developed with TensorFlow/Keras, NumPy and OpenCV. Incoming room images are processed through a preprocessing pipeline involving resizing to a resolution (e.g. 128×128) RGB normalization and optional data augmentation. These steps standardize the inputs. Enhance the CNN's resilience to different lighting and clutter scenarios.

The CNN architecture includes pooling and fully connected layers designed specifically for binary classification (Clean, versus Messy). It is trained using a labelled dataset of rooms and produces both a predicted category and a confidence value. This prediction system is fine-tuned for real-time performance allowing for immediate cleanliness assessment following each image capture.

D. Decision-Making & IoT Automation Implementation

The decision-making component analyzes CNN results. Triggers enforcement procedures automatically. Once the model labels an image, as Messy with confidence exceeding a threshold the component:

1) Sends SMS/Email alerts using Twilio, SMTP, or local notification services
2) Applies internet restrictions to the child's device through router-level APIs or shell scripts
3) Logs the event to the local database

When the room is identified as Clean, all set restrictions are automatically lifted. The rule-based engine guarantees application without requiring manual input and allows customizable thresholds to align with parental preferences.

This module serves as the connection interface, between AI sensing and IoT management enabling the system to operate as an automated home assistant.

E. Database and Local Storage Implementation

A compact SQLite database stores image details, prediction outcomes, timestamps, notification records and system status information. Interaction, between the backend processes and the storage is managed smoothly using SQLAlchemy or Python's sqlite3 module. Every monitoring occurrence is documented for review enabling parents to examine cleanliness trends and model performance over time.

Images captured during monitoring are stored locally in organized directories, while log files track system activity and error events. Since the system runs offline, SQLite provides high reliability, zero maintenance, and excellent performance for local deployments.

VII. RESULTS

The Clean Room Monitor system underwent evaluation using room images taken in diverse lighting environments and varying amounts of clutter. The CNN model reliably identified rooms neat or untidy with great precision and confidence scores stayed consistent throughout multiple tests. Image preprocessing guaranteed results despite changes, in camera perspectives or lighting intensity.

The IoT automation component operated efficiently sending SMS/Email notifications and enforcing router internet blocks whenever it identified a room. Clean detections properly reinstated access. Every event was logged precisely. The dashboard showed real-time status updates instantly.

Overall, the results show that the system performs reliably in real-world scenarios, providing objective cleanliness assessment and dependable automated rule enforcement for modern digital parenting.

VIII. CONCLUSION

The Clean Room Monitor system introduced in this study offers an automated and smart solution for evaluating room tidiness through AI-powered image classification and IoT-enabled action management. By combining a CNN model with a dependable preprocessing work-flow the system delivers consistent and impartial identification of tidy and untidy settings removing the bias and variability linked to manual monitoring. The automated enforcement feature which involves SMS/Email alerts and router-level internet restrictions enhances control by guaranteeing prompt and fair reactions, to the state of the room. Ongoing logging and scheduled model retraining additionally improve the system's flexibility and sustained effectiveness.

Test outcomes verify that the Clean Room Monitor functions across various real-life scenarios while preserving excellent accuracy and quick response. The user-friendly dashboard and automated processes lessen effort and encourage improved child discipline via data-informed reinforcement. Moving forward the platform can be enhanced with object- detection, cloud analytics and compatibility, with voice assistants to boost accuracy and ease of use. Overall, the proposed solution demonstrates strong potential as a scalable, cost-effective, and intelligent tool for modern digital parenting and smart home management.

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