Smart Lost and Back to Me: An Intelligent Lost and Found Management System

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***Abstract*—Lost items such as identity cards, ATM cards, access cards, and official documents are frequently misplaced in educational institutions, offices, and public environments. Traditional lost-and-found systems rely heavily on manual processes, which are time-consuming, inefficient, and prone to human error. This paper proposes "Back To Me: Smart Lost and Found Box", an intelligent and automated system integrating Internet of Things (IoT), Machine Learning, and web technologies to efficiently manage lost items. The proposed system consists of a smart physical box equipped with multiple slots and embedded camera modules. When a found item is deposited, the system automatically captures its image. The captured image is processed using Python based Machine Learning algorithms, specifically the YOLO (You Only Look Once) object detection model for real-time identification and classification. A web application developed using HTML and CSS enables users to register and report lost items. The system compares captured images with stored database records to verify ownership. Upon successful identification, a secure One-Time Password (OTP) is sent to the registered email ID, allowing authorized access to retrieve the item. The proposed system significantly reduces manual effort, enhances security, improves accuracy, and provides a scalable solution suitable for campuses, offices, and smart public infrastructures.**

I. INTRODUCTION

A. Background and Motivation

In recent years, the rapid expansion of educational institutions, corporate organizations, transportation hubs, and public infrastructures has significantly increased the movement of people within shared spaces. With this increased mobility, the probability of misplacing personal belongings such as identification cards, debit/credit cards, access badges, and official documents has also risen considerably. These items often contain sensitive personal information and, if misused, may lead to identity theft, financial fraud, or unauthorized access to secure facilities.

Traditional lost-and-found mechanisms largely depend on manual handling and physical verification processes. Typically, when an item is found, it is handed over to an administrative office or security personnel and stored in a common area. Records are maintained either informally or through handwritten registers. Claim verification is performed by asking the claimant to describe the item, which introduces ambiguity and security risks. Such systems are inefficient in environments with high population density, such as university campuses, railway stations, and corporate complexes.

Another major limitation of conventional systems is the absence of digital traceability. Without a centralized database, tracking the history of deposited and claimed items becomes difficult. Over time, unclaimed items accumulate, creating storage and management issues. Furthermore, manual systems are prone to human error, misplaced records, and delays in communication with potential owners.

The advancement of Artificial Intelligence (AI), Internet of Things (IoT), and computer vision technologies has opened new possibilities for automating traditionally manual processes. Intelligent object detection algorithms, particularly deep learning-based models such as YOLO (You Only Look Once), enable real-time identification and classification of objects with high accuracy and speed. These technologies have been successfully applied in surveillance, smart transportation, and industrial automation, demonstrating their reliability in real-world environments.

Motivated by these technological advancements, there is a strong opportunity to redesign the conventional lostandfound system into an intelligent, automated, and secure platform. By integrating smart hardware components with machine learning algorithms and web-based reporting systems, it becomes possible to create a seamless process for depositing, detecting, verifying, and retrieving lost items.

B. Limitations of the Traditional System

1. Manual storage and documentation in registers
2. Lack of centralized digital database
3. No secure authentication mechanism
4. Time-consuming claim verification process
5. High risk of unauthorized claims

Such systems fail to ensure accountability, scalability, and real-time monitoring.

C. Role of Smart Technologies

With advancements in Artificial Intelligence (AI), IoT, and computer vision, automated object identification and digital record management have become feasible. Deep learningbased object detection algorithms like YOLO enable realtime classification of items with high accuracy.

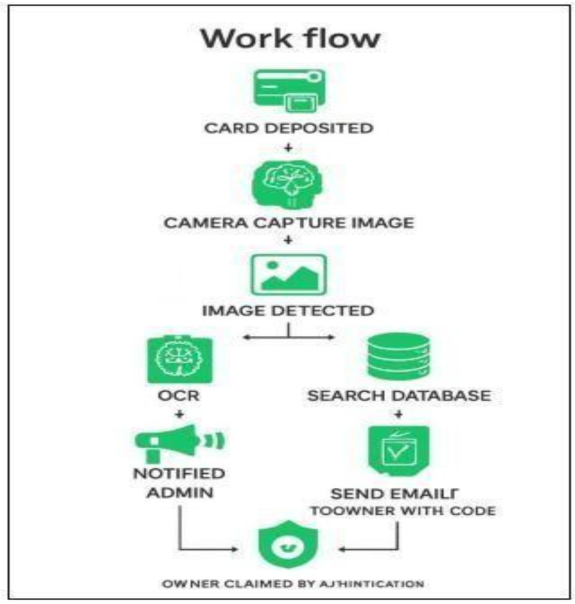
The integration of smart hardware systems with web applications provides a unified platform for reporting, identification, and retrieval of lost items.

D. Objective of the Proposed System

The primary objective of the proposed "Back to Me: Smart Lost and Found Box" system is to design and implement an intelligent, automated, and secure platform for managing lost items in educational institutions, corporate offices, and public environments. The system aims to replace traditional manual lost-and-found processes with a technology-driven solution that improves efficiency, transparency, and reliability. A key objective is to automate the identification of deposited items using deep learning-based object detection techniques, specifically the YOLO model, thereby reducing human intervention and minimizing errors in classification.

The primary objective of "Back to Me: Smart Lost and Found Box" is to:

- Automate the lost-and-found process
- Reduce manual effort
- Enhance security through OTP authentication
- Improve accuracy using machine learning
- Provide real-time tracking and verification



II. RELATED WORKS

A. Manual Lost and Found Systems

Traditional systems in institutions rely on administrative personnel to collect and store lost items. Studies show that manual documentation leads to inefficiencies and mismanagement over time due to lack of digitization.

B. RFID-Based Tracking Systems

Some research works proposed RFID-based item tracking solutions. While RFID improves identification, it requires prior tagging of items, making it unsuitable for randomly lost personal belongings like ID cards or debit cards.

Radio Frequency Identification (RFID)-based tracking systems have been widely used for asset monitoring and inventory management in industries, libraries, and logistics environments. In such systems, items are equipped with RFID tags that store unique identification data, which can be detected using RFID readers without requiring direct lineof-sight communication. While RFID technology offers advantages such as automated tracking, faster scanning, and improved record management, it requires prior tagging of items before loss occurs. This makes it impractical for managing randomly misplaced personal belongings such as ID cards, ATM cards, or documents that are not preequipped with RFID tags. Additionally, RFID infrastructure deployment can be costly and may require specialized hardware integration. Therefore, although RFID-based systems improve asset traceability in controlled environments, they are not well-suited for dynamic public lost-and-found scenarios where items are not pre-registered or electronically tagged.

C. Image-Based Identification Systems

Recent advancements in computer vision have enabled object recognition systems using Convolutional Neural Networks (CNNs). Object detection frameworks such as YOLO provide real-time detection with improved speed and accuracy compared to traditional region-based CNN models.

D. Web-Based Lost Reporting Platforms

Several institutions have implemented web portals where users can report lost items. However, these systems lack automated verification and still depend on manual matching by administrators.

E. Research Gap

Existing systems either rely on manual processes or require special tagging mechanisms. There is limited research on integrating smart hardware, machine learning-based object detection, and secure digital authentication into a unified lost-and-found solution. The proposed system addresses this gap.

III. PROPOSED METHODOLOGY

The proposed system integrates hardware, software, and machine learning components into a unified architecture.

A. System Architecture

The proposed Smart Lost and Found System is designed using a layered architecture that integrates hardware components, machine learning modules, and web-based services into a unified framework. At the physical layer, the system consists of a smart multi-slot storage box equipped with embedded camera modules, sensors, a microcontroller unit, and electronically controlled locking mechanisms. When a lost item is deposited into one of the slots, the sensor detects the insertion and triggers the camera to capture an image of the object automatically. The captured image is then transmitted to the processing layer for analysis.

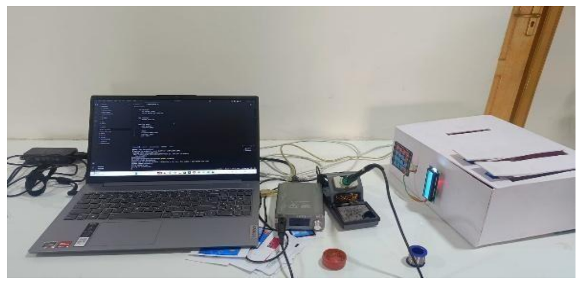
B. Hardware Module

The smart box is designed with multiple secure slots. Each slot includes:

- Camera module for image capture
- Microcontroller for system control
- Electronic locking mechanism When an

item is deposited:

1. The sensor detects insertion.
2. The camera captures the image.
3. The image is transferred to the processing unit.



C. Image Processing and Object Detection

The Image Processing and Object Detection module forms the core intelligence of the proposed Smart Lost and Found System. When a lost item is deposited into the smart box, the embedded camera captures a high-resolution image of the object under controlled lighting conditions. The captured image is first subjected to preprocessing techniques to enhance detection accuracy. These preprocessing steps include resizing the image to a fixed resolution, noise reduction, brightness normalization, and color space adjustment. Such operations ensure consistency in input data and improve the robustness of the detection model against environmental variations such as lighting changes and object orientation.

After preprocessing, the image is fed into a deep learningbased object detection framework implemented in Python. The system employs the YOLO (You Only Look Once) model, which performs object localization and classification in a single forward pass through the neural network. Unlike traditional region-based detection algorithms that require multiple processing stages, YOLO divides the image into a grid structure and predicts bounding boxes, confidence scores, and class probabilities simultaneously. This unified approach significantly reduces computational time while maintaining high detection accuracy, making it suitable for real-time applications.

D. Web Application Module

The Web Application Module serves as the user interaction layer of the proposed Smart Lost and Found System, providing a digital platform for reporting, tracking, and managing lost items. The web interface is developed using HTML for structural design and CSS for styling and responsiveness, ensuring a simple, user-friendly, and accessible layout across devices. Through this interface, users can register their details and submit information about lost items, including name, type of item, identification number, description, and registered email ID. These inputs are validated and securely stored in a centralized database, forming the basis for automated matching with detected objects from the smart box.

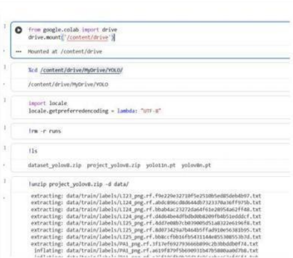
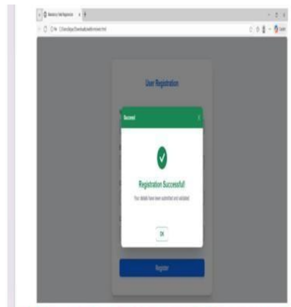


fig1:Trained cards in roboflow   fig2:YOLO algorithm in googlecolab

The web application also includes an administrative dashboard that allows authorized personnel to monitor deposited items, verify unmatched cases, and manage system records. When the image processing module identifies a potential match between a deposited item and a registered report, the system automatically triggers an email notification containing a One-Time Password (OTP) to the rightful owner. The user can then enter the OTP through the web interface to authenticate their identity and unlock the corresponding storage slot. The application ensures secure data handling, structured record management, and real-time communication between users and the system. By digitizing the reporting and verification process, the Web Application Module enhances transparency, reduces manual effort, and significantly improves the overall efficiency of the lostandfound workflow.



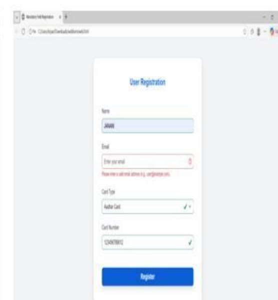
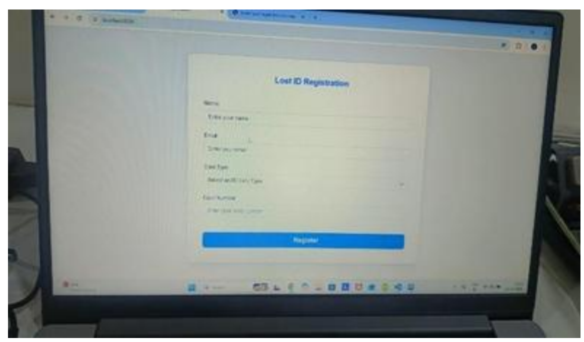


Fig3:Registration page after valid registration   Fig4:Registration page due to invalid registratior



E. Matching and Verification

The matching process includes:

1. Object category matching (e.g., ATM card)
2. Metadata comparison (card number, name)
3. Database verification

The Matching and Verification module is responsible for identifying the rightful owner of a deposited item and ensuring secure retrieval. Once the image processing unit classifies the object using the YOLO model, the detected category and associated features are forwarded to the database comparison engine. The system first performs category-level filtering, where the detected item type (e.g., ID card, ATM card, access badge) is matched with corresponding entries submitted through the web application. This initial filtering reduces the search space and improves matching efficiency.

Following category filtering, the system performs metadata level comparison using the information provided by users during lost-item registration. Attributes such as item number, partial identification details, and descriptive fields are compared with stored records to determine potential matches. If a high-confidence match is identified based on predefined similarity thresholds, the system automatically generates a secure One-Time Password (OTP) and sends it to the registered email address of the suspected owner.

F. Security Mechanism

Security is ensured through:

- OTP-based authentication
- Secure database storage
- Controlled slot access
- Administrative monitoring

IV. EXPERIMENTS AND RESULTS

A. Experimental Setup

The experimental setup of the proposed Smart Lost and Found System was designed to evaluate its performance under controlled yet realistic operational conditions. A prototype of the smart box was developed with multiple storage compartments, an embedded camera module, a microcontroller unit, and an electronic locking mechanism. The system was deployed in a simulated campus environment to replicate real-world lost-and-found scenarios. A dataset consisting of commonly misplaced items such as ID cards, ATM cards, access badges, and laminated certificates was collected under varying lighting conditions and orientations to ensure model robustness.

For the object detection component, the system was implemented in Python using the YOLO deep learning framework. The dataset was divided into training and testing subsets to evaluate generalization capability. The model was trained over multiple epochs with optimized hyperparameters, including batch size, learning rate, and image resolution, to achieve high detection accuracy while maintaining real-time performance. Images were resized to a standard resolution before being processed by the model.

B. Performance Metrics

1. Detection Accuracy

The YOLO-based model achieved high detection accuracy under standard lighting conditions. Accuracy improved with increased dataset size and training iterations.

2. Response Time Average processing time per image:

- Image capture: ~1–2 seconds
- Detection and classification: ~2–3 seconds
- Database matching and OTP generation: ~2 seconds Total average response time: ~5–7 seconds

3. System Reliability

The system demonstrated stable performance across multiple test cycles. False positive rates were minimal after model optimization.

C. Comparative Analysis

Feature	Traditional System	Proposed System
Record Keeping	Manual	Digital Database
Identification	Physical Verification	AI-Based Detection
Security	Low	OTP Authentication
Response Time	Slow	Fast
Scalability	Limited	High

The integration of machine learning and web technologies significantly improved efficiency compared to conventional methods.

V. CONCLUSION AND FUTURE WORK

A. Conclusion

The Smart Lost and Found System presents an innovative and secure solution for managing lost items in institutional and public environments. By integrating IoT hardware, computer vision, and web technologies, the system automates the entire lost-and-found process. The use of YOLO ensures real-time object detection with high accuracy. The web application and OTP-based authentication enhance security and user convenience. Experimental results confirm that the proposed system significantly reduces manual effort, improves verification accuracy, and increases operational efficiency.

The system is reliable, scalable, and suitable for real-world deployment in campuses, offices, airports, railway stations, and shopping malls. B. Future Work Although the proposed Smart Lost and Found System demonstrates high accuracy, security, and operational efficiency, there remains significant scope for further enhancement and large-scale deployment. One major direction for future work involves integrating Optical Character Recognition (OCR) technology to automatically extract textual information such as name, ID number, or card number directly from detected items. By combining OCR with the existing object detection module, the system can achieve more precise ownership verification and reduce dependency on manually entered metadata. Additionally, incorporating advanced authentication mechanisms such as facial recognition alongside OTP-based verification can provide multi-factor security, ensuring that items are returned strictly to their rightful owners. Another important enhancement includes the development of dedicated mobile applications for Android and iOS platforms to improve accessibility and real-time user interaction. Cloud-based deployment can further enable centralized data management, multi-location synchronization, and scalable infrastructure suitable for large environments such as airports, railway stations, and smart campuses. The object detection accuracy can also be improved by training the YOLO model with a larger and more diverse dataset under varied environmental conditions. Furthermore, integration of SMS alerts and push notifications can enhance communication speed beyond email-based alerts. These advancements will transform the system into a fully autonomous, scalable, and intelligent lost item management platform aligned with smart city and digital transformation initiatives.

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