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Automated Attendance Monitoring System for Cattle through CCTV.

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ABSTRACT
In a period of rapid technological advancement, the traditional methods of taking attendance of cattle after coming from grazing yard is done by normal counting as this have become inefficient and outdated. To overcome this issue, an Automatic Attendance Monitoring System (AAMS) using Closed-Circuit Television (CCTV) technology has been introduced as a solution. These abstracts highlight its key features and benefits. The Automated Attendance Monitoring System through CCTV uses the power of computer vision and machine learning (ML) for attendance monitoring. Using CCTV cameras in big dairy farms cows & buffalos are monitored. This can be also been implemented in grazing yards systems to analyse unique identification of data. That data will be cross-analysed using the database to record the attendance by colour, breed, and most importantly RFID tag. This system analyses accuracy the in-out time of cattle's using this recognition system. In training data, with multiple images of individual cow or buffalo from all angles & features are captured. Up to 30000-50000 images will be generated with supporting to that closed circuit images of all RFID implanted at ears of cattle. If the image captured by CCTV and the images in the database match, then attendance will be done and the report submitted. To build this system, the Python language was used. For developing systems, software is required, such as PyCharm or Spyder. We also need some libraries, like the OpenCV library and the Cattle Recognition library. The CNN algorithm is used for cattle recognition. Django, HTML, CSS, JavaScript, MySQL, and Bootstrap technologies will be used. In conclusion, the Automatic Attendance Monitoring System through CCTV provides an effective solution for the traditional attendance system. Provides high security and accuracy.

Keywords: - CCTV, AAMS, CNN, Cattle Recognition, Machine Learning

Introduction

Machine learning is the ability of a machine to learn something new without being explicitly programmed. The machine learns from its experience or history. It is a type of artificial intelligence that predicts outcomes [1]. Machine learning algorithms like CNN (Convolutional Neural Network) extract features from the input data. Machine learning is the best technology [2]. AI is utilized all over; it is important for software engineering, which contains design acknowledgment and computational learning hypothesis in simulated intelligence [3]. AI depends on input information. The detected images will be saved in the database, and they will be recognized too [4]. In other countries, image-processing-based security systems are used for security purposes. Sometimes the appearance sheet may be lost. To overcome such issues, a smart attendance management system is needed [5].

This system saves money, provides accuracy in results, and also reduces reliance on humans. Taking attendance in random field is a difficult task [6]. Taking attendance using counting and updating on sheet techniques is a much more time-consuming process. For security purposes, traditional cameras have live streaming and recording video facilities [7]. By improving the efficiency of cameras, they can be used in big dairy farms & grazing yards for automated attendance monitoring and security purposes [8].

When a cattle (cow or buffalo) enters into a corridor the are streamlined in single line, their body features, skin texture & RFID tag numbers are detected and recognized using a recognition algorithm. CNN is the basic building block of this system [9]. Before the recognition process, a training dataset was created. For creating the dataset, real-time photos are used. After capturing images, it will create a dataset and store data in a data folder for the attendance process. As compared to the existing systems, this system reduces the workload. It is useful for security purposes and can be implemented in real-time applications [12]. Image processing is also a very interesting and recent topic that will be useful for many security applications [13].

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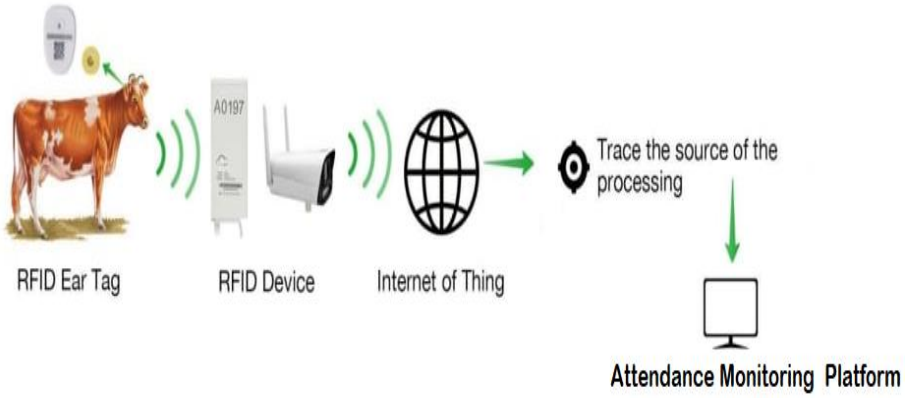

Figure 1. RFID tag & Cattle Attendance Monitoring System

Literature Review

[1]The intelligent CCTV camera is essentially implemented using machine learning in Python [14]. This project mainly focuses on how we can change the traditional CCTV camera [15]. Manually detecting attendance in the big dairy farm & grazing yard is a very difficult task. The main aim of this work is to reduce the human labour and make the attendance system efficient and time saving [16]. The proposed framework depends on cattle location and acknowledgment calculations. This framework recognizes the participation with the assistance of acknowledgment innovation [17]. In this system, the cattle are recognized and the attendance is marked and stored in the database which can also be exported. This system is very useful for security purposes and can be used in all real time applications [18].

Any Dairy Farm or grazing yard that relies upon individuals should represent its workers as an initial phase in this day and age. Consequently, making and keeping a legitimate administration framework costs the different associations a lot of cash [19]. In numerous nations, government associations and instructive establishments track worker participation utilizing paper-based techniques. For instance, to record the participation of every understudy, the name must be called toward the start of the course [20][21]. To record participation, these obsolete practices should be supplanted with present day ones. Consequently, a great deal of work and examination has been finished in this space utilizing current advancements [22]. Specifically, the programmed acknowledgment of a particular individual cattle in light of separating elements, for example, RFID Tag, Images from different angle acknowledgment is important to specialists [23].

Cattle detection & acknowledgment is perhaps of the most valuable application and assumes a significant part in the innovation area. Exact Cattle detection & acknowledgment is a significant issue in validation, particularly with regards to presence control [24] [25]. The proposed framework uses different calculations like Hoard (histogram of arranged inclination), CNN (convolutional brain organization) and SVM (support vector machine). After the cattle is perceived, the participation reports are produced oversaw and put away in succeed design [26]. The framework is analysed in different circumstances like lighting, head developments and the variety of the distance between the cattle and the cameras [27].

Proposed System

Capturing and counting the number of cattle's in grazing yard & big dairy farms and storing the data in a database is the main objective of this work. Smart CCTV is useful for live attendance monitoring systems. When cattle (Cow or Buffalo) enters the corridor in a straight line, CCTV will detect the number on the RFID Tag and other features like colour, texture, skin of cattle and save it in the database. You can also check the specific day's attendance report [28].
The Existing systems contain different systems for live streaming of videos. Earlier, to store the images, a database was not used. This is much more time-consuming and less secure. The advantages of the proposed system are that it detects cattle and stores the data in the database. Smart CCTV is used to count the number of cattle and capture the images [29]. It also saves the timing, including milliseconds, and stores it in a database. In this system, security is higher than in the existing system. This system can be used in grazing yard & big dairy farms for attendance tracking [30].

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Figure 2. Use Case of Attendance using smart CCTV.

Methodology

Computer vision and deep learning techniques are combined to perform cattle recognition and attendance tracking. For Cattle recognition, it uses OpenCV's detection algorithm and deep learning model [31].

For easy access and manipulation, the attendance log is stored in JSON format. The system provides a user-friendly interface with the recognized different breed of animals individually and a bounding box around their body, as well as displaying the video stream [32]. The attendance marking process is automated and requires cattle recognition technology to recognize individuals, mark their attendance, and store it in a respective file. It also reduces the chances of malpractice or error in counting [33]. The system is reliable and efficient for attendance tracking in various fields. When cattle enter the scanning area, their entire body is detected with RFID tag number and recognized using a recognition algorithm. CNN is the basic building block of this system. Before the recognition process, a training dataset was created. For creating the dataset real-time photos are used. For accuracy purposes, minimum images of students/employees should be captured [34].

After capturing images, it will create dataset and store data in data folder for attendance process. Cattle recognition is an interesting topic because different features of every cow or buffalo and other animals in use [35].

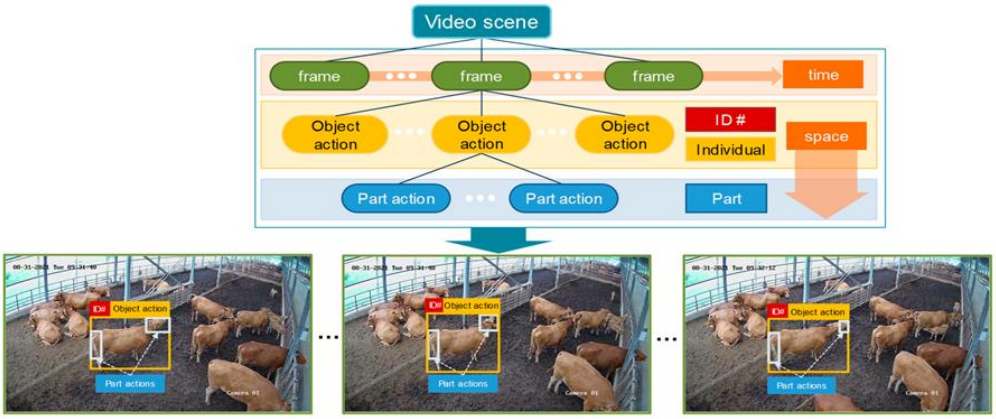

Figure 3. Real Time Monitoring System through video framework.

Implementation Details

- The first step in implementing cattle recognition is to use a cattle recognition library, such as the cattle recognition library from Dlib or the `cv2.module from OpenCV.
- Set up the library to use RestNet or VGGImage, or other pre-trained deep learning models, to recognize Images.
- Use the identification of 27 different features like colour, texture skin, body feature, landmark points to increase the precision of cattle recognition by capturing minute details of those cattle from figure 4.
- Integration with Pre-trained Deep Learning Models - Select an appropriate pre-trained deep learning model, such OpenMP, VGG16, or RestNet, for exact tag number recognition [36].
- Load the trained model by utilizing the relevant libraries or frameworks, such Keras or TensorFlow.
- If needed, adjust the pre-trained model to better suit the unique needs of the attendance tracking system.
- Workflow for Cattle Detection and Recognition- Use Open-CV to capture frames from CCTV cameras.
- Locate and identify the cattle in the obtained frames by using the cattle detection module.

- Use the previously trained deep learning model to extract characteristics or embedding's from the identified cattle's. Evaluate the retrieved features by contrasting them with the features of people you know who are kept in the database.
- Based on feature similarity, compare the recognized cattle with the database's closest match.
- If a match is discovered, enter the identified cattle's attendance in the database.
- Handling Unknown cattle - Create a system to deal with situations in which detected cattle does not correspond with the database the some other cattle (Cow or Buffalo) may have enter in the yard [37].

Figure 4. Live Feed & Status of Cattle

Keep track of unidentified cattle so administrators can manually verify them or examine them later. It might optionally include functionality like manual insertion of unknown cattle into the database or automated enrolment database. With this system we can even manage to take the real time feeding, resting, standing conditions of all the cattle's.

- Performance Optimization - Improve the speed and efficiency of the cattle recognition pipeline, particularly when handling the real-time processing of video feeds from many CCTV cameras.
- To increase speed and scalability, make use of strategies like batch processing, multi-threading, or GPU acceleration.
- Validation and Testing -Undertake extensive testing to assess the cattle recognition system's performance, dependability, and accuracy. Utilize test datasets with a range of cattle images taken in various environments to evaluate the resilience and generalization capacity of the system. Verify the correctness and consistency of the system's performance by comparing it against ground truth attendance data [38].

System Architecture

There are two primary parts to the system architecture: the front-end and the backend.

- Database management, attendance monitoring, and picture processing are all done on the backend.
- Administrators may check attendance data and control the system using the user interface that is provided by the front end.

Execution of Backend:

- Using pre-trained deep learning models, the cattle recognition library is implemented on 27* cattle recognition points. From figure 4.
- Image Processing with Open-CV: Capture frames from CCTV cameras that are installed on the property using Python and the Open-CV package.
- Use algorithms for cattle identification and recognition to pinpoint specific people in the collected frames.
- For tasks requiring cattle identification and recognition, use pre-trained deep learning models like deep neural networks.
- MySQL database integration: Create a MySQL database to related data, health details, and attendance logs.
- Create a connection using the necessary libraries, such as pymysql, between the Python backend and the MySQL database.
- Local Memory Storage for Pictures: Save the pictures of cattle you recognize locally on the computer's hard drive.
- To make it easier to get and refer to the images while tracking attendance, arrange them in a logical manner [39].

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Flask for Frontend Implementation:
Development of User Interfaces- Employ Flask, a lightweight Python web framework, to create the front-end user interface.
Create easily navigable websites that let managers check attendance records, look up specific users, and adjust system preferences.
Data Presentation- Retrieve attendance data from the MySQL database and display it on the front end in a tabular style.
Provide administrators with the ability to look for attendance data using certain parameters, such tag number, or date, by implementing search and filter features.
Security and Authentication- To guarantee that only individuals with the proper authorization may use the frontend interface put user authentication and access control methods in place.
For user authentication, utilize third-party libraries like Flask-Login or the built-in Flask capabilities.
Integration and Testing- Construct a coherent system by integrating the frontend and backend components.
Test everything thoroughly to make sure that everything functions as it should, including front-end interactions, picture processing, attendance tracking, and database activities [40].
Carry out integration testing to confirm the system's end-to-end functionality and spot any possible problems or errors.

Installation:
Install the automatic attendance tracking system locally or on an appropriate server.
To guarantee the dependability and security of the system, configure the required network settings, security precautions, and access controls.
Give system administrators the documentation and training resources they need to properly administer and maintain the system.

Algorithm Implementation
The problem with recent systems is that a tradition counting must be done for the checking of cattle's. An automatic attendance monitoring system is a solution for such problems.

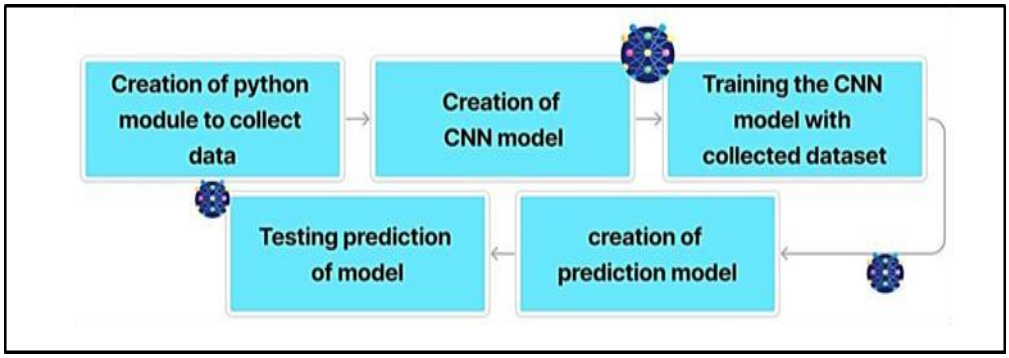

Figure 5. Flow Diagram

Using CCTV and cattle recognition systems, we are going to analyse the accuracy of the system. Also, accuracy of IN-OUT time of cattle's from grazing yard to dairy farms. The CNN algorithm (machine learning algorithm) is used for performing cattle recognition. Up to 30000 - 50000 images will be generated. Multiple features of cow and buffalo are recorded during the training and stored in a database.

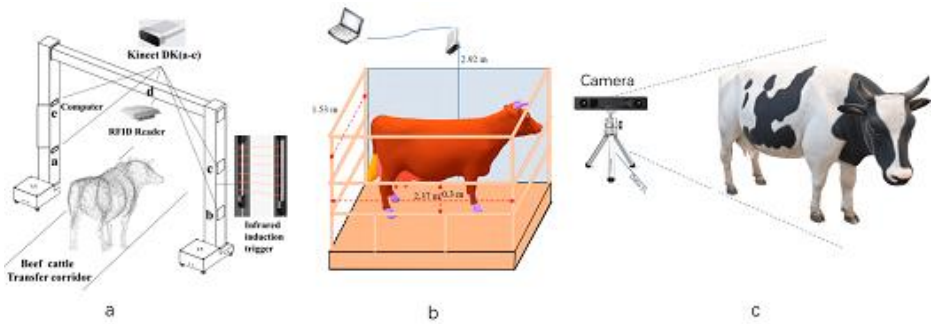

Figure 6. Extracting Cattle Features

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Here all the data is configured the current image match the trained dataset and other features like height weight is calculated, during the capturing of attendance this data is feedback to system then attendance will be marked and a report will be generated. NumPy is used to generate reports after attendance, and records are stored in a database.

Expanded Mathematical Model for Automatic Attendance Using CCTV
Variables and Notations:

- **Image Processing:**
- Let I(t)I(t)I(t) represent the input image frame at time ttt, captured by the CCTV camera.
- Let P(I)P(I)P(I) represent the image pre-processing function, which improves image quality (e.g., lighting adjustment, noise reduction).
- **Cattle Encoding:**
- Let E(x)E(x)E(x) be the Cattle encoding function that converts a detected Cattle xxx into a high-dimensional vector (Cattle embedding).
- **Live Video Frame Processing:**
- Let Fvideo(t)F_{video}(t)Fvideo(t) represent the live video frame at time ttt, where ttt is a continuous time variable.

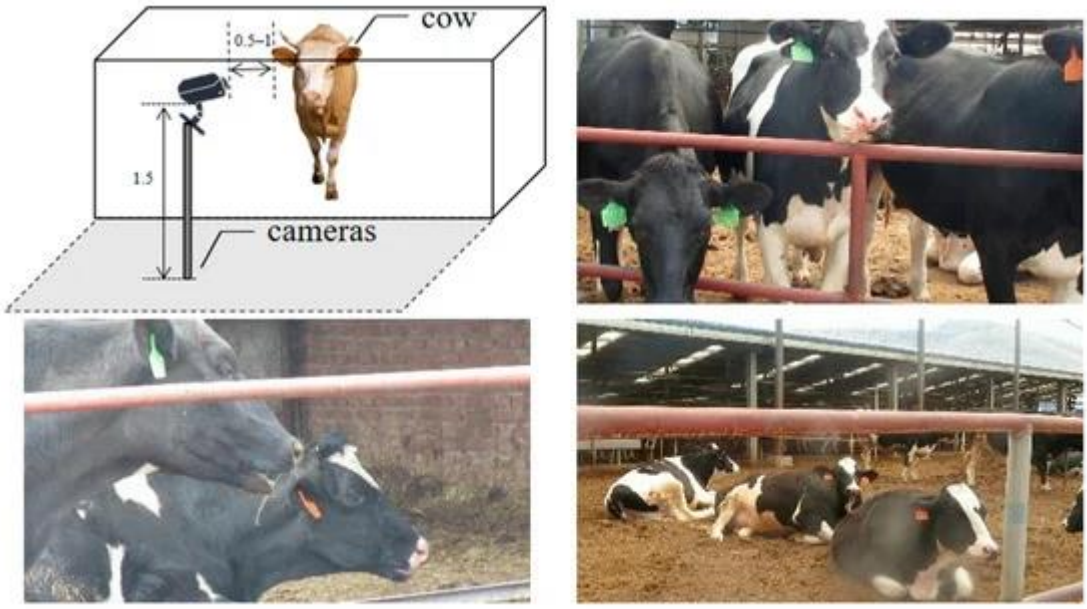

Figure 7. Cattle Detection Features through Camera

- **Cattle Detection in Current Frame:**
- Let D(P(I))D(P(I))D(P(I)) be the detection function that processes the pre-processed image P(I)P(I)P(I) and locates potential Cattles within the frame.
- Let {x1,x2,…,xn}\{x_1, x_2, \dots, x_n\}{x1,x2,…,xn} be the set of detected cattles in the current frame at time ttt.

- **Cattle Encoding in Current Frame:**
- Let E(xi)E(x_i)E(xi) be the encoding function that converts each detected cattle xix_ixi into a cattle encoding viv_ivi, where viv_ivi is a high-dimensional vector: vi=E(xi)v_i = E(x_i)vi=E(xi)

- **Matching:**
- Let M(vi)M(v_i)M(vi) be the cattle matching function that compares the cattle encoding viv_ivi with stored encodings {vdb1,vdb2,…,vdbm}\{v_{db1}, v_{db2}, \dots, v_{dbm}\}{vdb1,vdb2,…,vdbm} in the student database.
- Let Match(vi,vdbj)\text{Match}(v_i, v_{dbj})Match(vi,vdbj) represent the cattle matching function: Match(vi,vdbj)={1if vi matches vdbj (student j)0otherwise\text{Match}(v_i, v_{dbj}) = \begin{cases} 1 & \text{if } v_i \text{ matches } v_{dbj} \text{ (student \(j \))} \\ 0 & \text{otherwise} \end{cases}Match(vi,vdbj)={10if vi matches vdbj (student j)otherwise

- **Bounding Box and Display:**
- Let B(xi)B(x_i)B(xi) represent the bounding box drawn around the detected cattle xix_ixi in the video frame.

- Let N(j)N(j)N(j) represent the display of the tag corresponding to the matched encoding vdbjv_{dbj}vdbj.

- **Attendance Marking:**
- Let A(j,t)A(j, t)A(j,t) represent the attendance status for cattle jjj at time ttt. It is updated based on recognition and time validity: A(j,t)={Presentif Match(vi,vdbj)=1 and time t is within hours otherwise A(j, t) = \begin{cases} \text{Present} & \text{if } \text{Match}(v_i, v_{dbj}) = 1 \text{ and time } t \text{ is within class hours} \\ \text{Absent} & \text{otherwise} \end{cases}A(j,t)={PresentAbsentif Match(vi,vdbj)=1 and time t is within class hoursotherwise
- **Loop Continuation:**
- Let LLL represent the loop function that processes each subsequent video frame. The loop continues until the end of the session. L=while session is active, process next frame at time t+1L = \text{while session is active, process next frame at time } t+1L=while session is active, process next frame at time t+1

Mathematical Formulation:

1. **Live Video Frame Processing:**

Fvideo(t)=Live frame capture at time tF_{video}(t) = \text{Live frame capture at time } tFvideo(t)=Live frame capture at time t

2. **Image Processing:**

P(I(t))=Preprocessed frame of I(t)P(I(t)) = \text{Preprocessed frame of } I(t)P(I(t))=Preprocessed frame of I(t)

3. **Cattle Detection and Encoding:**
   - Detect Cattles in the pre-processed image: D(P(I))={x1,x2,…,xn}D(P(I)) = \{x_1, x_2, \dots, x_n\}D(P(I))={x1,x2,…,xn}
   - Encode the detected cattles: vi=E(xi)for each xiv_i = E(x_i) \quad \text{for each } x_ivi=E(xi)for each xi

4. **Cattle Matching:**

Match(vi,vdbj)=1if vi matches with vdbj\text{Match}(v_i, v_{dbj}) = 1 \quad \text{if } v_i \text{ matches with } v_{dbj} Match(vi,vdbj)=1if vi matches with vdbj

5. **Bounding Box and Name Display:**
   - Draw a bounding box around each detected Cattle: B(xi)B(x_i)B(xi)
   - Display the corresponding student's name for matched Cattles: N(j)for matched vdbjN(j) \quad \text{for matched } v_{dbj}N(j)for matched vdbj

6. **Attendance Marking:**

A(j,t)={Presentif Match(vi,vdbj)=1 and time t is validAbsentotherwiseA(j, t) = \begin{cases} \text{Present} & \text{if } \text{Match}(v_i, v_{dbj}) = 1 \text{ and time } t \text{ is valid} \\ \text{Absent} & \text{otherwise} \end{cases}A(j,t)={PresentAbsentif Match(vi,vdbj)=1 and time t is validotherwise

7. **Loop Continuation:**

L=Continue processing the next frame until the session ends.L = \text{Continue processing the next frame until the session ends.}L=Continue processing the next frame until the session ends.

Flow:

- For each live frame Fvideo(t)F_{video}(t)Fvideo(t), pre-process the image using P(I)P(I)P(I).
- Detect Cattles in the frame and encode them using E(xi)E(x_i)E(xi).
- Compare each encoding viv_ivi , with the database for a match.
- If a match is found, draw a bounding box around the Cattle and display the student's name.
- Update the attendance status for each recognized student.
- Continue processing the next frame until the session ends.

This model integrates all the necessary components of image processing, encoding, detection, and matching, as well as the continuous operation of the system during the monitoring session.

Conclusion

This automated attendance monitoring system offers seamless registration, and cattle profile management. It efficiently tracks attendance through cattle recognition, accurately recording entries and exits from the grave yard, grazing yard to dairy farms or feeding area. Performance is optimized for real-time processing, ensuring reliability across multiple cameras. It is an Automatic Attendance Monitoring System leveraging cattle recognition technology, has achieved remarkable success with an accuracy rate of approximately 95.38%. This exceptional performance can be attributed to the meticulous integration of essential libraries and the utilization of advanced deep learning pre-trained models. Through the strategic incorporation of requisite libraries such as Open-CV and Dlib, coupled with the deployment of state-of-the-art deep learning pre-trained models, our system has been able to surpass expectations in accurately identifying cattle's from a single image of tag. By harnessing the power of these resources, our project has delivered a robust solution capable of streamlining attendance tracking processes with unparalleled precision. The utilization of

deep learning pre-trained models has significantly enhanced the system's ability to recognize cattle's with high accuracy, even in the presence of varying environmental conditions and physical ability of cattle. Our commitment to leveraging cutting-edge technologies and employing best practices in software engineering has culminated in the development of an Automatic Attendance Monitoring System that not only meets but exceeds industry standards for accuracy and reliability.

As a result it stands as a testament to the transformative potential of integrating advanced technologies into traditional domains, offering organizations a powerful tool to optimize attendance management processes with unparalleled efficiency and accuracy.

Limitations & Future Studies

In the event that the image of a worker is shown, participation can be checked. For better precision 300-500 pictures of every cattle are taken. 300 Pictures for each cattle in a bigger association would consume a gigantic volume to store the pictures. The preparation time for our classifier requires around 20 seconds for every individual cattle. Thus for some representatives, it would require an extremely lengthy investment to prepare. However preparing the classifier isn't something that should be oftentimes finished, yet it would be better assuming a classifier taking lesser time while keeping up with the precision can be fabricated. The on-going model is 99.38% Exact. Precision when individual cattle are back confronted. Picture adjustment dealing with Extreme dim and light issue for recognizing picture. It is more relevant and productive in the security field. Cattle detection & acknowledgment is exceptionally successful for low-level masters to perceive crooks, and programming organizations are utilizing the innovation to help clients of big diary farms. This innovation is additionally utilized in different fields, for example, getting to classified records of cattle profile, and health monitoring of cows & buffalo. This venture has an easy to understand UI that spotlights on web improvement and information base administration.

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