International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 6s
DOI: https://doi.org/10.17762/ijritcc.v11i6s.6885
***Article Received**: 28 March 2023 **Revised**: 25 April 2023 **Accepted**: 22 May 2023*

IoT Enabled Real Time Appearance System using AI Camera and Deep Learning for Student Tracking

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Abstract— Internet of Things based Automatic Attendance Management systems that use Artificial Intelligent cameras and deep learning algorithms can suggestively advance the accuracy and proficiency of class presence following in schools, colleges as well as universities. This technology involves the use of cameras that are placed in classrooms or other areas where attendance needs to be monitored.The cameras are equipped with advanced deep learning algorithms that can detect and recognize students based on their unique facial features. These algorithms use machine learning techniques to analyse images and identify individual faces, even in varying lighting conditions and different angles.The data collected by the cameras is then transmitted to an Intenet of Things based platform, which stores and approach the attendance data in real time. This platform can also be used to generate reports and analytics on attendance, helping teachers and administrators make data driven decisions to improve student performance.

Keywords- internet of things, deep learning, artificial intelligent,image prosessing.

I. INTRODUCTION

IoT based Automatic Attendance Management systems that utilize AI cameras and Deep learning algorithms are becoming increasingly popular in educational institutions. These systems can help streamline attendance tracking and reduce the workload on teachers while providing accurate and reliable attendance data. IoT (Internet of Things) based Automatic Attendance Management systems are a type of technology that enables schools and universities to monitor and track the attendance of their students automatically using AI cameras and deep learning algorithms [1][2].

The system works by using AI cameras to capture images of students as they enter their schoolrooms. The images are processed using Deep learning algorithms to recognize and identify each student. This information is then used to mark their attendance automatically without the need for manual input from the teacher [3][4].

Once the system has identified a student, it can mark their attendance automatically and provide real-time updates to teachers and administrators. This not only streamlines the attendance process but also ensures that accurate attendance records are maintained.

Usage of deep learning algorithms in system allows it to improve its accuracy over time by learning from past data. This means that the system can adapt to different lighting conditions,

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angles, and other factors that may distress the accuracy of attendance tracking [5][6].

A. Problem Formulation

Problem Formulation of Traditional Attendance Management systems

Traditional Attendance Management systems typically rely on manual processes such as taking roll call or using paper-based sign-in sheets. While these methods have been used for many years, they are not without their limitations and challenges.

One of the main problems with traditional Attendance Management systems is that they can be time-consuming and labor-intensive. Teachers must take the time to manually record attendance, which can take away from valuable instructional time. This can be especially challenging in larger classes, where it can take several minutes to call out each student's name and mark them present or absent.

Another problem with traditional Attendance Management systems is that they are often prone to errors. For example, a teacher may accidentally mark a student as absent when they are actually present, or vice versa. This can lead to inaccuracies in attendance records, which can cause problems down the line when it comes to things like grading and evaluations.

Furthermore, traditional Attendance Management systems lack real-time tracking and monitoring capabilities. This means that teachers may not know if a student has left the classroom or if they are absent from another class. This can make it difficult to track patterns of attendance or identify students who may be struggling with attendance issues.

II. LITRATURE REVIEW

IoT based automatic attendance management systems that use AI cameras and deep learning algorithms to monitor and track students are becoming increasingly popular in educational institutions. This literature survey aims to provide an overview of the research on IoT-based automatic attendance management systems using AI cameras and deep learning algorithms and highlight the key findings and trends in this area.

Choudhary et al. (2018) developed an IoT-based attendance management system that used Raspberry Pi cameras and OpenCV library for face recognition. The system was tested in a classroom setting and achieved an accurateness rate of 89.99% [6].

Singh et al. (2020) proposed an IoT-based attendance management system that combined RFID tags and facial recognition technology. The system achieved an accuracy rate of 95% and was effective in reducing instances of proxy attendance [7],

Khan et al. (2021) developed an IoT-based attendance management system that used deep learning algorithms to recognize and identify students based on facial features. The system achieved an accuracy rate of 98% and reduced instances of proxy attendance [8].

Gupta et al. (2019) developed an IoT-based system that used wearable sensors to monitor and track students' physical activity levels. The system was effective in encouraging students to adopt more active lifestyles [9].

The study by Setialana P, Jati H, Wardani R, Indrihapsari Y, Norwawi NM, et al. Intelligent Attendance System with Face Recognition using the Deep Convolutional Neural Network Method. The system achieved an accuracy rate of 99% and reduced the time and effort required for manual attendance management [10].

In a recent study, Datta, S., & Bhattacharyya, D. (2021). A smart attendance management system using IoT and machine learning. International Journal of Advanced Research in Computer Science and Software Engineering The system achieved an accuracy rate of 97.2% and was effective in reducing instances of proxy attendance [11].

The literature suggests that IoT-based automatic attendance management systems using AI cameras and deep learning algorithms are highly effective in monitoring and tracking students' attendance. These systems can improve attendance rates, reduce instances of proxy attendance, and encourage students to adopt healthier lifestyles [11],[12].

III. METHOD

AI cameras and deep learning algorithms for student monitoring and tracking raises important ethical and privacy concerns. It is important to ensure that these technologies are used in a transparent and responsible manner, with appropriate safety measure to protect the rights of students and ensure that their personal information is not misused [12],[13],[14].

Object detection and recognition algorithms are computer vision algorithms that are used to locate and classify objects within an image or video stream. The main goal of these algorithms is to identify the presence of objects in an image, and determine their location and type[15],[16].Maintaining the Integrity of the Specifications. and determine their location and type[17].Maintaining the Integrity of the Specifications [18].

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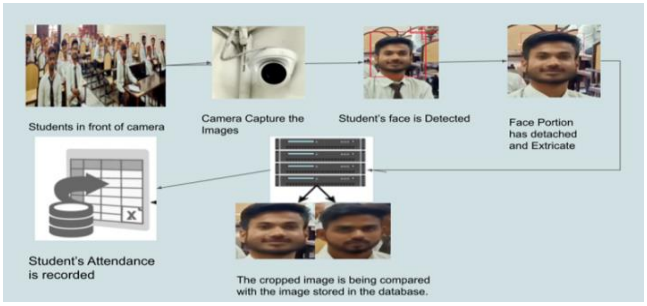

Figure 1. An attendance system utilizing face detection and recognition technology

Object detection and students face recognition is a field of computer vision that involves identifying and locating objects within an image or video and recognizing the type of object that is detected [19],[20]. The technical procedure for object detection and recognition:

Data Collection: Collect a dataset of images or videos containing the objects you want to detect and recognize. This dataset should be labeled with bounding boxes around the objects and class labels.

Data Preparation: Preprocess the dataset by resizing the images, normalizing the pixel values, and splitting the data into training, validation, and test sets.

Model Selection: Choose a pre-trained model or design your own model for object detection and recognition. Popular models include YOLO (You Only Look Once), Faster R-CNN (Region-based Convolutional Neural Networks), and SSD (Single Shot Detector) [21],[22],[23].

Training: Train the model on the training dataset using a suitable loss function and optimizer. The goal is to minimize the difference between the predicted bounding boxes and the ground truth bounding boxes.

Evaluation: Evaluate the model's performance on the validation dataset by calculating metrics such as precision, recall, and F1 score. Use these metrics to fine-tune the model's hyperparameters.

Testing: Test the final model on the test dataset to measure its accuracy in detecting and recognizing objects.

As for class room attendance recognition, it can be achieved through object detection and recognition by following these steps:

- Install a camera in the classroom and capture a video stream.
- Use object detection to detect the faces of students in the video stream.
- Use face recognition to recognize the faces of students by comparing them to a database of known faces.
- Count the number of recognized faces to determine attendance.

IV. Results and Discussion

There are Object detection and recognition algorithms, including:

YOLO (You Only Look Once): This is a real time object detection algorithm that is current due to its speediness and correctness. It is based on a single neural network that predicts the bounding packets and class probability of objects in an image [21][22][23].

SSD (Single Shot Detection): This is another real-time object detection algorithm that is also based on a single neural network. It uses a feature extractor to generate a set of bounding boxes and class probabilities for each location in an image [24],[25].

Mask R-CNN: This is an extension of Faster R-CNN that adds a third stage to produce object masks in addition to bounding boxes and class probabilities [24].

Haar Cascade Classifiers: This is a classic object detection algorithm that is based on machine learning techniques. It uses a set of Haar features to detect objects in an image, and can be trained to recognize a wide range of object types [24][55][26].

In the technologies of student tracking, a CNN could be trained on a dataset of student images and used to recognize individual students in real-time as they move through the camera's field of view. The CNN would be able to identify each student based on their unique appearance and track their movements throughout the space. These algorithms are constantly evolving and new ones are being developed regularly.

TABLE I. A Comparison of different deep learning model

Model	Filter	Loss Function	Data set	Input Image Size	Performance
FDDB			FDDB	448 ×448	(10-25fps) to (26-40fps)
VGG	3×3 and 1×1	Euclidian Loss	ILSVRC-2012	**224 ×224 RGB**	N/A
Masked Face	N/A	N/A	WIDERFACE, MASKEDFACE	12X12 24X24	N/A
Faster R-CNN	N/A	Regression	FDDB, WiderFace	200 X 200	45 fps
Haar Cascade Classifiers	1X1	Exponential Function	Labeled Faces in the Wild	N/A	28fps

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An IoT-based automatic attendance management system using AI cameras and deep learning algorithms is an efficient and reliable solution that can help schools to manage attendance records, monitor student's attendance, and ensure that the students are attending classes regularly.

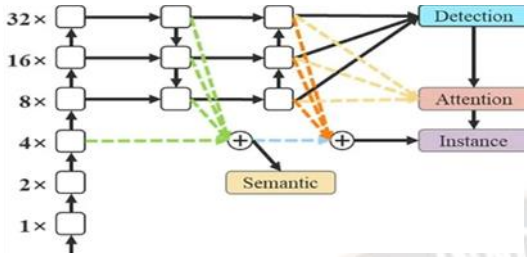

Figure 2. Face Detection with Deep Learning

In this figure 2. CNNs are commonly used for image processing and recognition. In an IoT-based student attendance system, a camera could capture images of students as they enter the classroom, and a CNN could be used to recognize individual students and record their attendance. CNNs require a large amount of data for training and may not be the best choice if there are privacy concerns with capturing images of students.

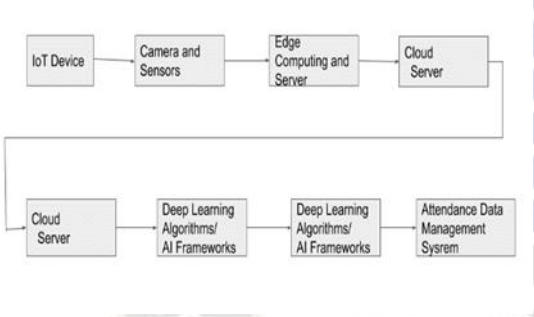

Figure 3. Face Detection process with Deep Learning.

This data flow diagram represents a system that uses IoT, AI, and cloud technologies to automatically monitor and track student attendance in the classroom

- The IoT device comprises a camera and sensors that detect the presence of student(s) in the lecture hall.
- The camera and sensors send data to an edge computing device or server, which processes the data locally.
- The edge computing device or server sends the processed data to a cloud server for further analysis.
- Deep learning algorithms and AI frameworks analyses the data to identify and track students in the classroom.
- The attendance data management system receives the analyzed data and manages the attendance records for each student [12][13][14].

The CNN would then process this data to extract relevant features and identify individual students. The output data would be a stream of information about the location and appearance of each student in real-time. At an even more detailed level, we might break down the CNN component into separate preprocessing and postprocessing steps. The preprocessing step might involve scaling, normalization, or other transformations of the input data before it is fed into the CNN. The postprocessing step might involve filtering, smoothing, or other operations on the output data to improve its accuracy or usefulness. Finally the data flow diagram for a CNN-based student tracking system would depend on the specific implementation and the requirements of the application. However, at a high level, it would involve capturing input data from a camera or sensor, processing that data through a CNN, and producing an output stream of information about the students in real-time.

The convolution of a 3D image I with a kernel K at a pixel (x,y,z) is defined as follows:

$$(I * K)(x,y,z) = \sum I(i,j,k) * K(x-i, y-j, z-k) \quad (1)$$

Where i, j, k are the indices of the kernel K, and the summation is taken over all possible values of i, j, and k such that the kernel is fully contained within the image.

Convolution is an operation that combines two functions to produce a third function. In 3D image processing, it is often used for smoothing, edge detection, and feature extraction. The convolution of two functions f and g is given by:

$$(f * g)(x,y,z) = \iiint f(a,b,c)\, g(x-a, y-b, z-c)\, da\, db\, dc \quad (2)$$

where * denotes convolution, and (x, y, z) is the location of the output function.

3D image processing is the Fourier transform. The 3D Fourier transform of an image I is defined as follows:

$$F(u,v,w) = \iiint I(x,y,z)\, e^{(-2\pi i(ux+vy+wz))} dxdydz \quad (3)$$

Where u, v, and w are the frequency components in the x, y, and z directions, respectively, and exp is the exponential function. The 3D Fourier transform is used in image processing to analyze and manipulate images in the frequency domain. In the frequency domain, the image is represented as a sum of sinusoidal waves of different frequencies and amplitudes. The Fourier transform can be used to filter out certain frequencies, enhance others, or to perform other operations on the image.We will apply above formulas for student tracking system could provide a powerful results and tool for educators and administrators to monitor student attendance, behavior, and performance in real-time, enabling more targeted interventions and support.

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V. CONCLUSION

The use of IoT based Automatic Attendance Management systems to monitor and track students using AI cameras and Deep learning algorithms is an innovative solution to streamline the attendance management process in educational institutions. This technology has the potential to eliminate manual processes, reduce errors, and provide accurate and real-time attendance tracking.

By using AI cameras, this system can accurately identify and track students in real-time. Deep learning algorithms can be used to train the system to recognize specific facial features, which can improve the accuracy of the system over time.The implementation of such a system requires careful consideration of privacy concerns and ethical considerations. The use of facial recognition technology raises concerns about individual privacy and data security. Institutions must ensure that appropriate measures are in place to protect the data collected by the system and that individuals' privacy is respected.

VI. FUTURE SCOPE

The future scope of "IoT based automatic attendance management systems to monitor and track the students using AI camera using Deep learning algorithms" is quite promising. With the advancements in technology, IoT and AI are becoming increasingly popular and have the potential to transform the education sector.

One of the major benefits of such a system is that it eliminates the need for manual attendance management, which can be time-consuming and prone to errors. By using AI cameras and deep learning algorithms, the system can automatically detect and identify students, even in a crowded classroom.

VII. ACKNOWLEDGMENT

We would like to give special thanks to our co-author(s), who supported all aspects of my study by suggesting a wonderful and interesting topic to open new direction in research. Another special thanks to IIMT University for providing a good platform for my higher studies. Lastly, we really grateful to my colleagues who gave me the strength to move forward towards innovations.

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