Automated Team Attendance Tool: A Campus-Wide Solution for TBL Courses

Angela Schauer  
*Iowa State University*

Lance Demers  
*Iowa State University*

Nathan Oran  
*Iowa State University*

Brandon Johnson  
*Iowa State University*

Connor Sullivan  
*Iowa State University*

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Abstract
Problem Statement: Attendance is an important part of Team Based Learning, and instructors must take time during each class to go through roll call. This time adds up and by the end of the semester, can equal to multiple lectures worth of time. Although a handful of attendance tools exist, none of these tools are adapted to team-based classes, and none of them record the attendance without any interaction from the instructor or student side.

Disciplines
Educational Technology | Engineering Education

Comments
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Authors
Angela Schauer, Lance Demers, Nathan Oran, Brandon Johnson, Connor Sullivan, and Mohamed Y. Selim

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Angela Schauer, Lance Demers, Nathan Oran, Brandon Johnson, Connor Sullivan, Mohamed Y. Selim

Problem Statement
Attendance is an important part of Team Based Learning, and instructors must take time during each class to go through roll call. This time adds up and by the end of the semester, can equal to multiple lectures worth of time. Although a handful of attendance tools exist, none of these tools are adapted to team-based classes, and none of them record the attendance without any interaction from the instructor or student side.

Solution
The proposed tool will record attendance at no time-cost to the instructor and the students. An image will be taken of the classroom, which will then be processed with object detection software (YOLO) to verify if a student is in a seat. An email will be sent to the instructor with attendance. This will all happen automatically after the instructor enters the class schedule and seating chart into the program. Note that the actual image is not sent to the instructor to preserve the privacy of the students.

Intended Users and Uses
Professors will use the application to automate attendance image capture. A secondary use case that has been proposed is to use this software for COVID-19 positive cases contact tracing.

Design Approach
We knew there would be many third-party systems to interact with, so we wanted to utilize the facade pattern between any third-party components. We designed our code to be compatible with any third-party platform to be easier to interchange information. We decided to use the Raspberry Pi because it is cost-effective, and its processing capacity is enough for our intended project. Since we were using a Raspberry Pi, we knew we needed software that would be small enough to fit on the limited storage. For that reason, we used YOLOv3 since it could provide all of the object detection needs that we have while also being lightweight enough to be put on the Raspberry Pi. One limitation we found with YOLOv3 is that it had trouble detecting large numbers of objects packed tightly together. To solve this issue, we decided to split up the image into four quadrants, then we run the object detection algorithm on the partitioned sections to improve the detection accuracy.

Technical Details

<table>
<thead>
<tr>
<th>Hardware:</th>
<th>Software:</th>
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<tbody>
<tr>
<td>- Raspberry Pi 4</td>
<td>- Python</td>
</tr>
<tr>
<td>- Raspberry Pi Official camera</td>
<td>- YOLOV3</td>
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<td>- Mount</td>
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<td>- Camera</td>
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Results and Findings
Although YOLO uses deep learning for detection, the accuracy degrades when identifying objects closely grouped. Our proposed solution is to split the image into four quadrants, then we run the object detection algorithm on each quadrant, then combine the results from each quadrant.

Testing
Due to the restrictions of COVID-19, and an in-person basis of this project, it was difficult to test our system on an actual classroom. However, we used images of lecture halls to do some initial testing with the object detection software. We were able to set up the Raspberry Pi and take an image of a classroom at Iowa State University with volunteers seating in the classroom. An additional test was done with a few more subjects at an off campus site. The team working on the database used MySQL Workbench and Postman to test the API.

Future Work
Although this work is functional, we still need to apply it to a large classroom to enhance the accuracy of the attendance capturing when having large number of students. Also, the usage of multiple cameras can be introduced to capture the attendance of classroom that are having some obstacles. Finally, this project can be used for COVID-19 positive cases contact tracing if the students are forced to use the same seat every class.

Non-Functional Requirements:
- Should be as accurate as previous attendance methods.  
- Should be as accurate as previous attendance methods. 

Operating Environment:
- Classroom
- Good line of sight
- Proper lighting
- Internet access

Standards:
- Hardware
- Schematic
- Bill of materials
- Software
  - Source code
  - Online comments
  - External documentation

User Process
- Classes, Classrooms, Professors, Seating Arrangements, and Capture times are stored in a Database and accessed through an application interface named ASP.NET Core API.
- The Raspberry Pi will retrieve all class data and capture times for its classroom at the start of each day.
- Once the Raspberry Pi Camera captures the image, it will be processed via YoloV3 to detect present students.
- Then, Yolo Data is compared to the seating chart information from the professor, and compile the attendance for the class.
- Finally, the Raspberry Pi drafts an email with the attendance report to send to the professor (images are not sent to the professor).