World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:16, No:05, 2022

Machine Learning Approach for Automating Electronic Component Error Classification and Detection

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Abstract : The engineering programs focus on promoting students' personal and professional development by ensuring that students acquire technical and professional competencies during four-year studies. The traditional engineering laboratory provides an opportunity for students to "practice by doing," and laboratory facilities aid them in obtaining insight and understanding of their discipline. Due to rapid technological advancements and the current COVID-19 outbreak, the traditional labs were transforming into virtual learning environments. Aim: To better understand the limitations of the physical laboratory, this research study aims to use a Machine Learning (ML) algorithm that interfaces with the Augmented Reality HoloLens and predicts the image behavior to classify and detect the electronic components. The automated electronic components error classification and detection automatically detect and classify the position of all components on a breadboard by using the ML algorithm. This research will assist first-year undergraduate engineering students in conducting laboratory practices without any supervision. With the help of HoloLens, and ML algorithm, students will reduce component placement error on a breadboard and increase the efficiency of simple laboratory practices virtually. Method: The images of breadboards, resistors, capacitors, transistors, and other electrical components will be collected using HoloLens 2 and stored in a database. The collected image dataset will then be used for training a machine learning model. The raw images will be cleaned, processed, and labeled to facilitate further analysis of components error classification and detection. For instance, when students conduct laboratory experiments, the HoloLens captures images of students placing different components on a breadboard. The images are forwarded to the server for detection in the background. A hybrid Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs) algorithm will be used to train the dataset for object recognition and classification. The convolution layer extracts image features, which are then classified using Support Vector Machine (SVM). By adequately labeling the training data and classifying, the model will predict, categorize, and assess students in placing components correctly. As a result, the data acquired through HoloLens includes images of students assembling electronic components. It constantly checks to see if students appropriately position components in the breadboard and connect the components to function. When students misplace any components, the HoloLens predicts the error before the user places the components in the incorrect proportion and fosters students to correct their mistakes. This hybrid Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs) algorithm automating electronic component error classification and detection approach eliminates component connection problems and minimizes the risk of component damage. Conclusion: These augmented reality smart glasses powered by machine learning provide a wide range of benefits to supervisors, professionals, and students. It helps customize the learning experience, which is particularly beneficial in large classes with limited time. It determines the accuracy with which machine learning algorithms can forecast whether students are making the correct decisions and completing their laboratory tasks.

Keywords : augmented reality, machine learning, object recognition, virtual laboratories
Conference Title : ICICML 2022 : International Conference on Intelligent Communications and Machine Learning
Conference Location : Sydney, Australia
Conference Dates : May 16-17, 2022