Learning Convolutional Neural Networks Using mBots

Krishan Bhalsod1

kbhalsod@ggc.edu

Cengiz Gunay 1

c[gunay@ggc.edu](mailto:Cgunay@ggc.edu)

Jonathan Tran 1

jtran33@ggc.edu  
  
1 Dept. Information Technology, School of Sci. & Tech.  
Georgia Gwinnett College  
Lawrenceville, GA 30043

Isaiah Gorman 1

igorman@ggc.edu

Cindy Robertson 1

c[robertson@ggc.edu](mailto:Crobertson@ggc.edu)

**ABSTRACT**

The project explores using a 4-wheeled autonomous robot, mBot Mega, and block coding to teach students about image processing and basic robotics concepts. In a workshop using hands-on activities, students will learn how to use block coding in creating images that instruct the mBot to perform actions such as moving forward, turning, or moving backward based on the image cues it recognizes. The goal is to have students design images that instruct the robot to move in various directions, simulating autonomous vehicle decision-making and the problems they face in recognizing the environment around them. Through pre-and post-surveys, the study will evaluate how effectively students grasp the connection between image processing and robotics while fostering creativity and problem-solving skills.

# INTRODUCTION

As technology advances, so does the quality of human life and the need for technology itself to assist us. One of the ways technology aids humans is through artificial intelligence, more specifically, Convolutional Neural Networks (CNNs) [5].

CNNs can be seen in various technologies, such as: self-driving vehicles, facial recognition, medical imaging, and alike. For example, with self-driving vehicles, CNNs help identify traffic and road signs, obstacles, and pedestrians. Phones also use CNNs that utilize facial scanning for facial recognition.

This project is aimed to teach students (K-12 and college) how image processing works by using hand gestures to guide a robot while highlighting potential challenges in image recognition. This project was developed as part of the Technology Ambassador Program (TAP) outreach course.

## Outreach Course

TAP is an award-winning program dedicated to boosting student interest in computing through numerous outreach activities led by students at Georgia Gwinnett College. TAP faculty and students wanted to increase curiosity and enthusiasm in technology through interactive workshops in introductory ITEC classes at Georgia Gwinnett College and extracurricular activities for K-12 students, such as the Atlanta Science Festival, Super Saturday Series, and STARS.

# METHODS

The project utilizes the following technologies to teach students the fundamental programming concepts.

## The MBlock language for mBot

MBlock is a graphical programming environment based on Scratch [4], designed to help users, especially beginners and students, learn coding through interactive and visual interfaces. It allows users to create programs by dragging and connecting blocks that represent programming commands. This approach simplifies the learning process by removing the need for complex syntax, making it accessible to those with limited prior knowledge of programming. MBlock supports a wide range of functionalities, including robotics, IoT (Internet of Things), and artificial intelligence, through extensions and integration with hardware platforms.

The mBot utilizes the mBlock, which serves as an entry-level educational tool that allows students with little programming experience to learn and understand how general programming would work and flow.

# Expected Workshops teaching programming skills

The primary objective is familiarizing students with mblock and see how CNNs are trained and implemented into a piece of technology. Furthermore, this would allow students to learn some sort of basic coding flow and block coding.

At the beginning of the workshop, there will be brief lessons on how basic coding works and how CNNs generally work. Students will be given examples and tasks as to how to tell the Mbot to move forward, left, right, etc. Afterwards, students will start to learn how to teach and implement a training model based on either their hands or shapes (or any other distinct identifiers i.e. numbers).

## Basic Block Coding for Movement

The first part of the workshop is to help familiarize students who are new to coding in general and give them a crash course as to how coding works.

To do this, we will work alongside students and assist them in their understanding of necessary coding blocks and give them examples that they can view with.

## Mbot Problems

With the Mbot, there are some problems that must be addressed and known about.

The first being that the Mbot is very finicky when trying to connect wirelessly onto any sort of device, in particular some sort of laptop and desktop. In doing so, there is a chance where the wireless connection may not exist at all and the mbot be plugged directly into the device.

The second problem known is the mbot itself, particularly the battery. The Mega pi and battery on the Mbot are two separate pieces of hardware and are charged almost separately. This means that the Mega pi might be fully charge, but the battery for the Mbot itself might have died and needs to be charged/replaced.

## Integrating Machine Learning With mBlock

To save time with model training, the code utilized Google’s Teachable Machine to simplify the process of training custom image models. By utilizing the extension, the model can be fed into the code quickly, avoiding the complexities and dependency issues faced by manual training. Once the model was trained, it was integrated into the mBlock environment. An additional benefit to utilizing Teachable Machine is that the interface allows students to experiment with their own images to teach them the challenges that come with machine learning.

## Implementing the Model into mBlock

After integrating the model, the robot’s movements can be controlled based what the user inputs as the image. For example, if the user trained the model with shapes, each shape control whether the robot moves forward, backward, left or right.

# RESULTS: WORKSHOPS TEACHING PROGRAMMING SKILLS

The primary objective is to teach students how basic machine learning works, along with the challenges faced. We show them how the training works by having them control the robot based on the gestures they train and use.

At the beginning of the workshop we introduce the concept of AI and provide multiple examples of our main theme: Convolutional Neural Networks. We give simple examples, such as shapes and encourage students to think to highlight the challenges faced by AI training. We also give real life examples, like traffic signs. We associate green with go and red with stop, which helps students understand classification. Next, we do the workshop. We help students set up the mBlock code and guide them to Google’s Teachable Machine to train their own gesture model to control the mBot. Furthermore, we go back to the mBlock code and help students ap

# ASSESSMENT

The results of the study will be measured based on two parameters.

## Learning Outcomes

What we want to teach to students is mainly how CNNs work and how prevalent it is within modern day technology.   Students should start recognizing different CNN applications and, by extension, artificial intelligence as a whole.

## Application

How applicable are the lessons? Will the students be able to replicate the lessons taught in the workshop at home?

We will measure the success of our efforts and the project's effectiveness through pre- and post-surveys given to all participants at these workshops. By comparing the pre- and post-survey results, we can track and measure the success of our efforts and acquire feedback from those who partook in the activity. We will analyze the results from the pre and post surveys and present our findings at the conference.

# ACKNOWLEDGMENTS

Our team wants to express our most profound gratefulness toward ITEC Department Chair and SST Dean at Georgia Gwinnett College for supporting our project.

# REFERENCES

1. Dekhane, S., Xu, X., Napier, N., Barakat, R., Gunay, C., & Nagel, K. (2018). Technology focused service-learning course to increase confidence and persistence in computing. Journal of Computing Sciences in Colleges, 34(2), 147-153.Hannes Hartenstein and Kenneth Laberteaux, *Vehicular Applications and Inter-Networking Technologies*, 1st edition, Wiley, February 2010.
2. Mosquera Reina, V., Cunico, R., Williams, J., Bauer, M., Doloc-Mihu, A., & Robertson, C. (2021, October). Introducing Programming Concepts through Interactive Online Workshops. In Proceedings of the 22nd Annual Conference on Information Technology Education (pp. 71-72).
3. Robertson, C., & Doloc-Mihu, A. (2021, October). Assessing the effectiveness of teaching programming concepts through online interactive outreach workshops. In Proceedings of the 22nd Annual Conference on Information Technology Education (pp. 123-128).
4. “Scratch - Imagine, Program, Share.” [Online]. Available: <https://scratch.mit.edu/>. [Accessed: 03-Mar-2025]
5. R. Yamashita, M. Nishio, R. K. G. Do, and K. Togashi, “Convolutional neural networks: an overview and application in radiology.,” *Insights Imaging*, vol. 9, no. 4, pp. 611–629, Aug. 2018, doi: 10.1007/s13244-018-0639-9.