Six Barriers to End-User Robot Programming with ABB Easy Programming

1. Objectives

End-user programming refers to the practice of allowing individuals with limited or no formal programming experience to create or customize software applications to suit their specific needs and tasks. In their 2004 work, Ko et al. studied the barriers that end-user programmers face when interacting with Visual Basic.NET. They devised six specific categories of end-user programming barriers:

- **Design barriers:** *"I don't know what I want the computer to do..."*
- **Selection barriers:** *"I think I know what I want the computer to do, but I don't know what to use..."*
- **Understanding Barriers:** *"I thought I knew how to use this, but it didn't do what I expected..."*
- **Coordination Barrier:** *"I think I know what things to use, but I don't know how to make them work together..."*
- **Use Barriers:** *"I think I know what to use, but I don't know how to use it..."*
- **Information Barriers:** *"I think I know why it didn't do what I expected, but I don't know how to check..."*

The objective of this project is to study the extent to which these barriers apply to robot programming. Our focus is specifically on block-based programming of industrial robots using the ABB Easy Programming tool.

2. Tools

ABB Wizard Programming
A block-based programming environment developed by ABB. The wizard programming environment is available in all collaborative robots produced by ABB, and can be accessed using the robot's teach pendant or simulated in their offline programming software, RobotStudio.

Figure 1. User implementing code in ABB Wizard Programming.

ABB RobotStudio

RobotStudio is an offline programming and simulation environment developed by ABB. Users can install RobotStudio on Windows-based computers and simulate real scenarios using the family of robots produced by this manufacturer.

ABB CRB 15000

Also known as GoFa, the CRB 15000 is a one-armed collaborative robot produced by ABB. It is made to be safe around humans and easy to use. This is the robot we will use in our study.

Figure 2. CRB 15000.

3. Research Questions

1. **RQ1:** Do the six barriers to end-user programming manifest in ABB Robot Easy Programming? How do they present?
2. **RQ2:** Are there any additional learning barriers specific to ABB Robot Easy Programming?

4. Existing literature, studies, and resources

Papers:
1. Ko et al. "Six Learning Barriers to End-User Programming Systems" VL/HCC 2004 – https://ieeexplore.ieee.org/document/1372321
2. Ko et al. "The State of the Art in End-User Software Engineering" ACM CSUR 2011 – https://dl.acm.org/doi/abs/10.1145/1922649.1922658
3. Weintrop et al. "Blockly goes to work: Block-based programming for industrial robots" – https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8120406
4. Weintrop et al. "Evaluating CoBlox: A Comparative Study of Robotics Programming Environments for Adult Novices" – https://dl.acm.org/doi/pdf/10.1145/3173574.3173940

Links:
1. (Webpage) ABB Wizard Easy Programming – https://new.abb.com/products/robotics/application-software/wizard
2. (Video) Introducing Wizard easy programming – https://www.youtube.com/watch?v=2l-IKmdcJsM
3. Meet ABB collaborative robot: GoFa. – https://www.youtube.com/watch?v=npOCofThQ7o
4. (Video) How to program collaborative robot GoFa with Wizard Easy Programming – https://www.youtube.com/watch?v=zPnEOQX4jUA
5. (Video) ABB Wizard Easy Programming 1.3 – https://www.youtube.com/watch?v=KduqW6EQ67E

5. Research Plan

1. Write a simple program using ABB Easy Programming (learn the environment)
2. Come up with a set of learning tasks (similar to Table 1 in Six Barriers paper) appropriate for ABB Easy Programming.
3. Prepare an experiment to evaluate how these learning barriers apply to the tasks defined in Step 1:
   a. **Define how users will access the experiment:** This experiment can be executed in-person or online. For an in-person experiment, the ABB GoFa available in our laboratory can be used. For an online experiment, a simulated environment needs to be created in RobotStudio. In such case, users are required to have RobotStudio installed on their computers.
   b. **Define how data will be collected:** The learning barriers can be evaluated in multiple ways. Data can be captured while users are performing the experiment, or in a post-experiment evaluation (e.g., questionnaires). Independent of which option will be used, it is important to define how data will be collected in the process.
4. Deploy learning tasks in a class (or recruit participants) and use Slack to provide assistance. Collect data on: (1) what they were stuck on; (2) how they became stuck; (3) how they tried to become "unstuck".

5. Organize and analyze the collected data.