Natural Language Control for XY Gantry Systems

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Abstract

This proposal outlines a project that aims to design a system which will be used to control an XY Gantry using Natural Language. This system will use Natural Language Processing to translate human instructions into precise, specific motor control sequences to control the Gantry's movements. The goal of this project is to enable the control of robotic systems for users without special programming or robotics knowledge.

1 Introduction

In many fields of research and industry, XY Gantry systems are used extensively to perform precise movements along a plane of two-axes. One example is the process of 3D printing, where many machines use a XY Gantry to print each layer of a 3D object. The main issue with these systems is that they often require technical expertise and the knowledge to use specialized programming or command interfaces. The goal of this project is to eliminate these technical requirements, and make the use of these systems more accessible by translating human language directly into motor commands.

This project will utilize concepts of Natural Language Processing (NLP) to convert natural human commands into specific movement instructions for the Gantry. This approach will allow users to express their goals through a set of simple English phrases, and the system will return a sequence of commands that will guide the Gantry to perform their desired actions.

2 Sample Interaction

Below we outline a sample interaction with our system, that is used to demonstrate how we believe it should be used.

Sample Input

Can you draw a circle for me centered at the middle of the canvas that roughly takes up half of the area on the page?

Sample Output

```
{
  "task": "draw_circle",
  "center": {"x": 0, "y": 0},
  "radius": 4,
  "speed": 200,
  "commands": [
    {"action": "move", "x": 4, "y": 0, "
        speed": 300, "gcode": "G0 X4 Y0
        F300"},
    {"action": "wait", "duration": 100,
        "gcode": "M400"},
    {"action": "pen_down", "gcode": "M03
        "},
    {"action": "arc", "direction": "
        clockwise", "x": 4, "y": 0, "
        center_offset": {"i": -4, "j":
        0}, "speed": 200, "gcode": "G2
        X4 Y0 I-4 J0 F200"},
    {"action": "pen_up", "gcode": "M05"}
  ]
}
```

Explanation

In the example given, the system took human instructions for drawing a circle in our Gantry, and outputted a JSON object with the relevant G-Codes for each step of the process. This creates a response that is both readable for a human, and ready to be passed to a program to execute these commands.

These G-Codes are generated by interpreting the human instructions and directly guide our Gantry to perform the task which was asked by the person.

3 Impact

A system like this could have great impacts towards a number of different fields and applications.

It could be used for Automating Manufacturing by making it easier for operators to control Gantry systems, for tasks like cutting, tracing, packaging,

etc. without the need for the technical skills needed to control the system themselves.

Similarly it could be used in field like medicine and surgery, by allowing surgeons and doctors to instruct a robot to perform extremely precise procedures with the precision of a machine.

Just as importantly a system like this could be a step in a better direction for accessibility issues. Having systems for inexperienced users to control robotic systems, could enable normal citizens to take advantage of the physical abilities of these systems. Without the need for a technical background.

4 Conclusion

This project outlines a system that would allow human instructions to be directly interpreted and executed by a XY Gantry, and potentially other robotic systems down the line. It highlights an ability for NLP to bridge the gap between the ambiguity of human language and precise instructions needed to control machines and robotic systems. By simplifying this interaction between people and machines we aim to make advanced technology more widely accessible regardless of background or education. Technology like this would allow us to introduce the benefits of extremely precise machines to the everyday audience.