Department of Computer Science & Engineering
The University of Texas at Arlington

Project Charter
CSE 4316: Senior Design I
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Winter Soldier
Out Reach Robot

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Revision History

Revision	Date	Author(s)	Description
0.1	09.19.2019	JC	document creation
0.2	10.11.2019	JC, JM	complete draft

Contents

1 Vision

To get people interested in Computer Science and Engineering by showing a project that displays what graduates with these majors can accomplish.

2 Mission

We are going to build an drawing app for a tablet that connects with a robotic arm. The robotic arm will draw whatever is drawn on the tablet.

3 Success Criteria

Upon completion of the system, we expect the following success indicators to be observed:

- System is able to function for at least 60 minutes of activity (copying what someone draws) without the need for reboot.
- System is able to copy what the user draws with 70 percent accuracy.

Within 1 months before the delivery date, we expect the following success indicators to be observed:

- Application is able to communicate with robotic arm.
- System is able to function for at least 5 minutes of activity (copying what someone draws) without the need for reboot.
- System is able to copy what user draws with 30 percent accuracy

Within 2 months before the delivery date, we expect the following success indicators to be observed:

- Robotic arm is complete and able to draw.
- Application is complete.

Within 3 months before the delivery date, we expect the following success indicators to be observed:

- Application on tablet is able to run, but not 100 percent complete.
- Robotic arm is able to draw basic lines on paper with basic movements.

4 Background

The purpose of this project is to wow potential students of computer science/engineering with a project that will be able to be completed in the span of two semesters. Most people are interested in things of the future. While we may use robots today in certain applications, robots are not yet common place. A robotic arm drawing what you draw on a tablet will be used to provide that wow factor. It will make the student think if a robotic arm can copy what I draw on this tablet what else can it do? This system will let the potential student know if they choose to pursue engineering they too can work of technologies of the future if they decide to do so.

5 Related Work

The current robotic arms which are capable of mimicking the humanâs drawing/writing interaction into motion is currently made more as a commercial product. The robot found to perform is called Line-us, a smaller portable robotic arm capable of mimicking motion on paper for recreating the drawings.The main customer of the robotic arm worked on for this project is currently Dr. Tiernan at UTA who will be using the arm to encourage schoolchildren into engineering fields. This arm will be better as it will be more appealing to children and can be used at a certain lab or room for entire school classrooms, rather than for individual use. The robotic arm will be more stronger compared to the material used in the Line-Us robot. It will also be more durable for future semesters on ahead for other senior design teams to expand on and also to be kept in UTA for the purpose of showing off to freshmen or high schoolers interested in computer science engineering. The speed of the robot will also be greatly increased compared to the Line-us robot as there will be better support provided by the 4 or 3 bar linkage in the robotic arm used for the project. Having a four-bar linkage provide three moving links, with one fixed link and four other pivot points, making the movement more robotâs movement more fluid.
Reference of Line-Us robot arm doing similar task: https://blog.hackster.io/this-tiny-robot-arm-draws-recreates-whatever-you-draw-on-screen-870b6632407f

6 System Overview

Current working plan/solution: Inverse Kinematics is to be used for the programming of the robotic armâs movement as IK is used in situations where the desired end effectorâs position is known, but the joint angles need to be figured out. It decides how to drive motors controlling the arm to a certain position in a 2D or horizontal direction (X and Y direction) to make a drawing using various parameters. The distance needed for each each movement of the arm, along with itâs velocity, acceleration, position the numbesr of joints links is the possible information needed to process how the arm moves to the desired coordinates in the 2d space/paper. Having less motors controlling each joint reduces the complexity which goes into replicating a drawing. The end goal of the project is to rotate the various joints of the robotic arm in such a way that the end effector can be controlled. The end effectorâs placement in the 2D space is makes the final drawing as the end effector holds the pen or pencil making the drawing. But in inverse kinematics this is done by getting input for orientation of the end effector and rotating the arm joins accordingly to reach the desired location to make the drawing.
Controlling a robot in a 2D space can be best done by using only having 2 degrees of freedom for the robot. The armâs rotational joints work using âpure rotationâ, i.e. when a body rotates about a non-moving axis. Along with calculating the force needed for each individual movement, the length of each link is to be factored in. The length of the arm/link is perpendicular to the force acted upon the joints in each drawing action. The current plan is to send the drawing from tablet using a wired connection using USB from the tablet. An alternate method would be to use a haptic sensor for the pencil/pen used by the person making the initial drawing to be sent using Bluetooth signal from the Android application on tablet to robotic arm. An IR gesture sensor may be used too to find the right movements of the hand

to be fed into robot to copy.
Future links for reference: https://robotics.stackexchange.com/questions/299/how-can-the-inverse-kinematics-problem-be-solved http://billbaxter.com/courses/290/html/img1.htm IR gesture sensor for recording hand movements: https://www.youtube.com/watch?v=hCahI7ZRbOA

7 Roles & Responsibilities

The stakeholders are the teams members working on this project which are Jesee, Alex, Sedick, Pratikshya and Jeswin. The project sponsor is Dr.Conly, he is our point of contact for the customer as well. The team members responsibilities are divided as follows. Jesee and Sedick will work on the operation of the robotic arm. Alex, Pratikshya and Jeswin will work on the application for the tablet used to draw. All team members will work on the communication between the two. The scrum master will remain Jesee for all scrums, his main responsibility will be communication with the project sponsor.

8 Cost Proposal

Preliminary Budget:
For this project, we would need a robotic arm and tablet as an absolute minimum.
Our estimations of these products are as follows:
Robotic Arm: 800—2000 USD
Electronic Tablet: 300—500 USD
Electronic Stylus: 5 USD
Electronic Tablet: 300—500 USD
Funding Sources:
CSE Department: 800 USD
Surplus Funding (via other groups): 300—1705 USD

9 Facilities & Equipment

Facilities:
Central Nedderman Libraries
ERB Senior Design Engineering Labs
Equipment:
Robotic Arm, We will need to purchase this.
Electronic Tablet, We will need to purchase this.
Stylus, We will need to purchase this
Robotic Arm API, We will need to download this.
Drawing Board, We will need to purchase this.
Miscellaneous Material

10 Assumptions

1. Access to the tablet and robotic arm to be used for the project will available by the end of the 2nd sprint cycle.
2. The tablet and the robotic arm will allow USB connection to one another for communication.
3. The testing and customer sites shall provide ample power for the robotic arm to function.
4. The code for the tablet and robotic arm can be written in any language of our choosing.
5. The 3D printers shall be available to create pieces to modify the robotic arm as needed (things such as creating a device to more efficiently hold a stylus, for example).

11 Constraints

The following list contains key constraints related to the implementation and testing of the project.

- Final prototype demonstration must be completed by May 1st, 2020
- Total development costs must not exceed $1000
- The robotic arm should not have any sharp edges.
- The arm should accept G-code created by inputting the SVG file.
- The drawing app will not run on IOS devices.

12 Risks

Risk description	**Probability**	**Loss (days)**	**Exposure (days)**
Delays in shipping of the arm and other equipments required	0.10	20	2.0
Incompatibility between the tablet and the arm	0.50	30	10
Errors in control software and hardware	0.30	20	6
Power system connected to robot being disrupted	0.10	10	1
Internet access not available at installation site	0.30	3	0.9
Risk of improper installation	0.4	20	8

Table 2: Overview of highest exposure project risks