ITSP Final Documentation

WALL PAINTING ROBOT

Dell'Arte

ITS-21053

Keywords

Dell'Arte, Wall painting, Painting spider, Painting Bot, ITSP paint, Wall art, Painting

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Inspiration for Idea

First of all wall painting is everywhere and everyone is fascinated by a decorated wall as compared to a simple one and also we sometimes talk about the beautiful decorations of painting artwork but if we look at the hard work people do behind it. People do a lot of hard work on this fascinating artwork. While staring at this situation we came up with an idea that what if all this hard work be done by a bot as many of the things in this generation are done by robots. So that inspired us to build up a wall painting bot.

Problem Statement

Ever wondered how tedious it is to paint an image you desire on a wall of your house? One can't deny that doing such work is time-consuming and requires great human skills. Even more challenging than this would be if you want to do the same multiple times.
Our project is a simulation of a robot that provides a solution to such a problem letting one paint their desired image with ease and multiple times they want. It's a simulation of primitive design where binary colors are simulated for printing.

Existing solutions in the Market

As we have searched so far, it went tough to find a wall painting robot, but we came across some industrial painting arms. However, those were only for painting, not for making graffiti and artworks, and there were some systems to print images on a wall using UV printing. However, their approach was very different in terms of the printing method, and in fact, UV printing on walls is costly and requires much maintenance. Also, they can paint high-quality paintings at a reasonable resolution.
So, currently, we stand in a unique position to provide binary printing at a good resolution for much cheaper than UV printing.

Proposed Solution

We Designed a primitive model for a robot and simulated its movement and working while designing all 3D parts of it into SOLIDWORKS. We also assembled all parts to show the complete model we imagined which is much flexible while painting. Further, we designed a python script in blender that simulates a primitive program that will control the robot. Blender script can further be used to develop programs enabling us to control the robot in real life such as developing an Arduino file and using an Arduino microcontroller.

Brief Description

Our wall printing robot contains a chassis that holds the battery , paint, air compressor, and the most important part of our printing which we call spider. We have used universal joints to make our robot more flexible in movement which also reduces skidding while painting. motor all this is done for precision as our chassis will be the only one who will move our spider in horizontal direction w.r.t wall and all that matters in the project is precision in the mapping of our spider. And now we have two standing rails on which our spider will map in the vertical direction it travels in the vertical direction with the help of a screw which in turn also connected to the stepper motor and makes spider travel in vertical direction w.r.t wall now a compressor is connected to a nozzle at the center of the spider and around it there are 4 solenoids each has a piston-like structure which contains paint and in turn connected to a paintbox which provides paint to piston-like structure and due to solenoid which makes piston come at the center and split the paint in front of air nozzle which will spray paint on the front wall.This is the short description of our project.

Progress

WORK PROGRESS

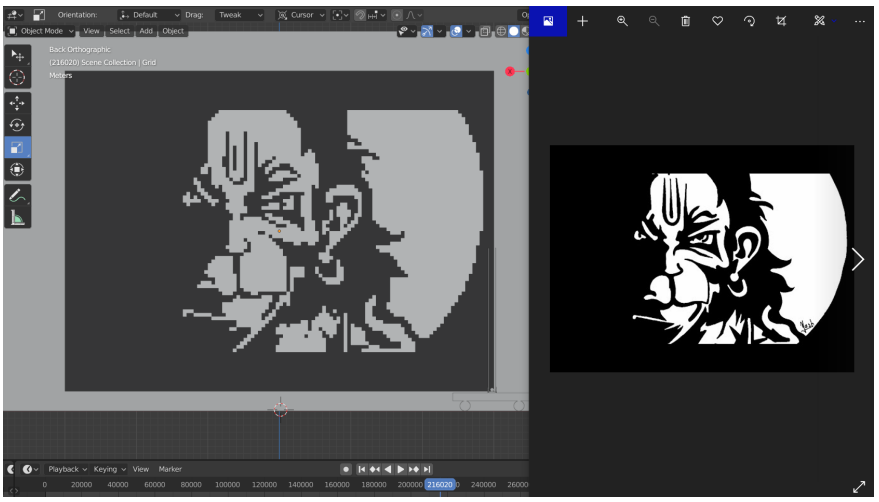
Initially we had to design the basic structure and we listed the functionality that our robot should have. We explored many mechanisms and techniques like universal joints, developed a mechanism for coupled turning which saves the robot from movements which causes skidding otherwise,Mechanism even makes it possible for robots to move diagonally.
We researched upon printing techniques available and then came up with a custom model for controlling spray painting which uses solenoids and compressed air.
There are sensors for the robot which tells the robot its position or whether it is aligned with the wall or not. Some of them are ultrasonic and IR proximity sensors. precise control of the printing spider is achieved by screw controlled height and high gear ratio.

We tried to animate the movement of our robot in blender using python scripts. We created a rough model of our bot using GUI and the grid using python scripts. Opencv is used for taking image input then manipulating it followed by thresholding to extract binary information for printing. Script creates an animation showing movement that the spider would go through in real life. This script with further modification can be used as a base file that will be fed into the microcontroller in the real model to work as shown in the simulation.

Work-Flow distributed across the duration between the review meets :

- *Initially we were planning to simulate the bot using ROS and Gazebo. So we started learning ROS and also concentrated on modelling the bot on Solidworks.*

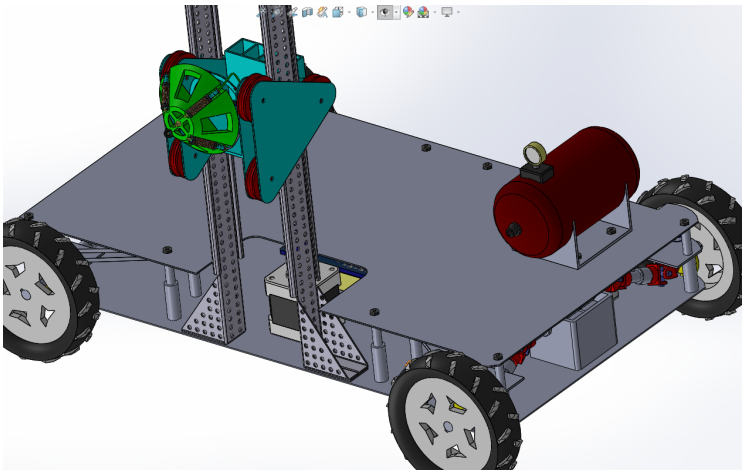
- *We went through many mechanical changes in our model to come up with the final look we have. We switched traditional turning methods to universal joints and proposed a complete new method for turning in which wheels are coupled for power as well as turning.*
- *We had completed modelling many parts in solidworks. Then we decided to animate the whole bot in blender using a python script. The primary reason for this shift is that in ROS we can simulate to show the movement of the bot but we can't show the final image which is painted by the movement of the bot.*
- *Till now we completed assembling the parts of the bot in solidworks and also we completed printing an image in blender using python scripting.*
- *Image shown below is an animation completely created by the script in which a pixel is shown being drawn id black. Left image is the output binary matrix and the right one is the input image we fed.*

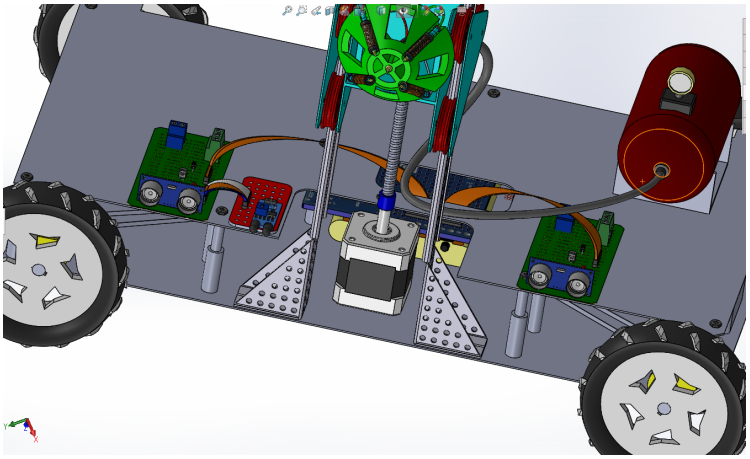


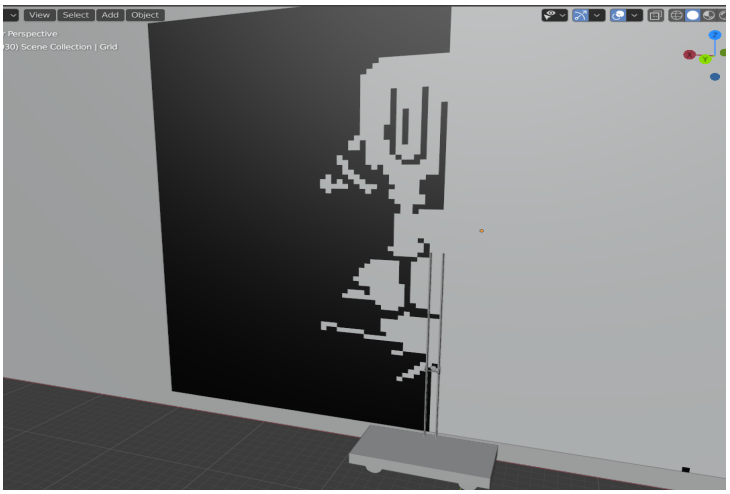
Challenges (Difficulties faced and how you overcame it)

- *Prevention of skidding was a trouble because we couldn't afford skidding that goes unknown to robots. So we decided to use a universal joint. This feature actually minimize the skidding by providing more flexibility to the robot and also enables turning of coupled wheels*
- *We wanted a precise control over vertical motion, we explored many mechanisms but then we chose a screw controlled mechanism using a stepper motor. This is much superior than other mechanism like belt-gear mechanism or pinion mechanism*
- *Scripting was the most challenging task because we didn't have a properly explained resource for scripting in blender and online documentation of functions was poorly explained. So we had less flexibility on scripting but still we have added few optimisations and managed to make it work.*

Results







Below is a link to a video showing the combined result of our simulation:
https://drive.google.com/file/d/1VJzyBC9RiwRJT-EWXg9FL0RBcbVH-nqX/view?usp=sharing

A link to our complete files we developed during ITSP timeline is followed below:
https://github.com/Venovan/ITSP

Below is link to our Final presentation:
https://docs.google.com/presentation/d/1k40DKr1J0i__blfU0JT--axPspoTVUiSXwGCareKo0k/edit?usp=sharing

Learning Value

We have learned about

- *Mechanical System*
- *Mathematical modelling*
- *Solidworks*
- *Blender Scripting*
- *Arduino and ROS Basics*
- *Common Digital Circuits*
- *Management and Working Together*
- *Printing Methodology and Techniques*

Software/ Hardware used

SOFTWARE USED:

- *SOLIDWORKS*
- *OPENCV*
- *BLENDER*

Suggestions for others

- *We would suggest them to modify the spraying technique while atomising our paint particles in air while in front of compressor connected nozzle and while this atomising other color particles may come to it get bind to each other and then splitted on wall such that they can perform color mixing this is the primitive thought if you could modify and develop this then multi color bot can be made and can use more precision thing to get more good picture quality .*

Contribution by each Team Member

- *Apart from dividing work, we worked inter-departmentally to ensure that different bot components work hand in hand.*
- *Vishal was responsible for researching and getting the most appropriate model and the basic structure of the robot, along with the research of the printing technology and printing head design.*
- *Dheeraj designed the wheel system and spraying technique of the bot*
- *Rahul and Dheeraj made each and every part in Solidworks and then assembled it completely.*
- *Prashul and Vishal were working on the ROS part, but we had to cancel it and shift to Blender after significant progress.*
- *Prashul was responsible for the scripting in python.*
- *Overall we worked as a team, and in the whole process, we learned to manage not only our work but working in a group.*

References and Citations

- *Motors in the model were designed using a motor downloaded from GrabCAD https://grabcad.com which is a dedicated site for sharing CAD files.*
- *We learned from a guide named Blender Python API by CHRIS CONLAN about blender scripting link to which is*

https://drive.google.com/file/d/1rW_BxMFN0ydKuJ3RNZH9kDPRXIOlcQWx/view?usp=sharing

- *OpenCV https://opencv.org is an open source library we used for image processing.*
- *Python documentation https://docs.python.org/3/*
- *Spray painting https://en.wikipedia.org/wiki/Spray_painting*
  https://www.sciencedirect.com/topics/engineering/inkjet-printing
  We studied a lot of different articles on spray painting, inkjet printing technology to understand it better and also studied types of different inks and its properties
  https://dtm-print.eu/en/pages/dye-versus-pigment.html

Disclaimer

We have Mostly worked with open source resources only except Solidworks which was under the license by IITB.

Licenses

- *We have used SOLIDWORKS under IITB licence*
- *OPENCV is an open source library*
- *BLENDER is also an open source platform*