isrjournals

International Journal of Advanced Research in Electronics, Communication & Instrumentation Engineering and Development

Volume: 3 Issue: 1 Jul,2021,ISSN_NO: 2347 -7210

AI BASED PAINTING ROBOTIC ARM

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ABSTRACT—*The traditional painting method requires labours to work in hazardous environments. Since the evolution of robots, there had been many advances made in the industries to aid the labours working in it. Previously many approaches were developed to solve the difficulties faced during the painting process but those robots were not intelligent since they used sensors and actuators. They are usually designed for doing the repetitive tasks that at times requires human intelligence too. Therefore, our aim is to design and develop a painting robotic arm based on artificial intelligence to overcome the drawbacks in the earlier robots. This robot is capable of detecting the tinted areas in the wall and to paint them automatically. It is made intelligent by using AI algorithms such as SciPy and NumPy with which the image of the wall to be painted is captured, thresholded and segmented in order to calculate the dimensions and axes of the same. This is made possible by using object-recognition and image segmentation process.*

***Keywords*—AI, NumPy, image processing, wall painting, robot arm**.

1, INTRODUCTION

Robots are nowadays used for divergent functions. Starting from simple level robots like pick and place robots to complex level robots like military and space robots; they have made progress in technology. For the first time ever, a robot was granted a citizenship too. Humans found robots amusing when they first created them, but now they are used for aiding humans in various fields. Currently robots are even designed to act as an alternative to humans for various repeated, mundane and dangerous tasks. A robot's uniqueness changes based on the background it is been employed in. For example, we have robots in our home cleaning the floor, as a supplementary to the nurses in the hospitals to lift the patients, for carrying our luggage's and also interacts with us as a way to respond to our instructions. They can also look over home safety and energy consumption. We even have hotel served completely by robots (with some human help) and also robots working in restaurant kitchens. They also play a vital role in industry, shipping and military purposes. These are some examples of the real capabilities of robots, which may seem as hearsay, but had been made possible through research and the technological evolution over the last few years. Yet there are more applications of robotics and this is not the end of the robotic world.

2.ROBOTIC ARM.

2.1 Construction of Robotic Arm.

The AI based automatic wall painting robot includes assembling of two main parts. They are,

1 Rigid base

- Frame
- Servo motor
- Power supply
- Raspberry pi
- Arduino uno
- Motor driver
- Metal segment

2 End effectors

- Web camera
- Immersible Motor
- Spray Tube

2.2 Working of Robotic Arm.

Joints are the important feature that enables the robot to perform the basic function of it. Joints are equivalent to human joints. They are used to join the two successive firm bodies in the robot. These are called linear joints.

The robotic arm's base is fixed with three servo motors that are connected together with these linear joint. Some joints allow the arm to rotate 180 degrees, those joints are called rotatory joints.

- The base platform placed on the surface remains fixed.
- The first frame is fixed to the base.
- The second frame is mounted to the first frame in which the end effector is mounted.
- The end effector moves in order to reach all sides of the component, and to reach any height.

Thus, the robotic arm works as below,

- The servo motor fixed to the base of the arm helps to move the robot to the desired location.
- The frame supporting of the end effector moves to and from to reach the desired position.
- The end effector sprays the paint in the area through spray tube which is connected to the immerse.

3. SYSTEM ANALYSIS.

3.1 Existing System

The existing system is an Automatic Paint Spraying Machine Using IR Sensor which is designed to achieve low cost painting equipment. Here the presence of wall is detected using IR Transmitter and IR receiver. The robot just paints the wall of given dimension. Here the DC motor controlled by the microcontroller signals is responsible for the movements of the robot's arm. The robot is affordable, reduces paintings pressure for labours to reduces time intake.

Disadvantages:

- The robot doesn't know when to stop so it keeps painting even after reaching the end of the wall.
- Electric shock is always there.
- System is costlier because the life of the parts used in it is very short.
- They don't use AI algorithms and not AI-based.

3.2 Proposed System

In the existing system, the presence of wall is detected using IR Transmitter and IR receiver. It does not use any AI algorithms. So, the robot doesn't know when to stop so it keeps painting even after reaching the end of the wall. Hence, to overcome this problem an AI based robotic arm is designed. The proposed system is based on artificial intelligence which allows image processing in order to detect and paint the tinted areas of the wall. The image is taken by the robot using web cam which is fixed to the end effector of the robotic arm that feeds or streams the image of the wall in real-time to Raspberry Pi. The robot measures the dimensions of the wall and the Raspberry Pi converts the image into binary codes and transmits the analog signal to Ardiuno. Using those dimensions and signals, the servo motor moves and paints accordingly.

3.3. SYSTEM ARCHITECTURE:

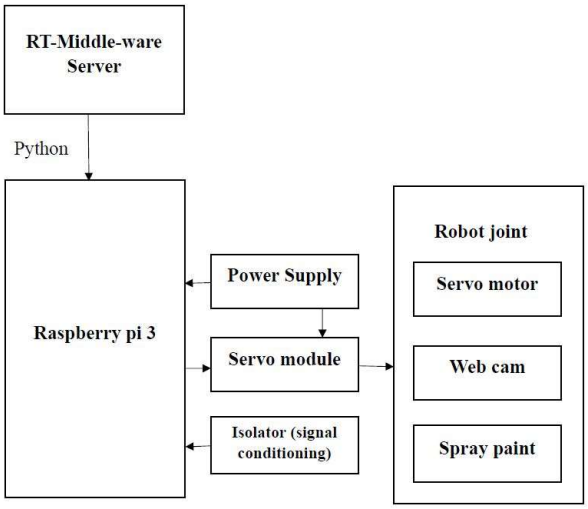

Fig 3.1: Architecture Diagram

Explanation:

The overall architecture consists of 4 major components

- RT-Middleware server
- Raspberry pi 3
- Servo Module and
- Robot joint

Middleware server

RT-Middleware is a programming platform used in robotics technology w the here e python program is written.

Raspberry Pi 3

The python program is uploaded in raspberry pi 3. When the webcam captures the image of the area the raspberry pi calculates the dimensions and axis of the tinted areas and it sends the calculated dimensions in the form of analog signal to the Arduino Uno.

Servo Module

The Arduino Uno and motor driver together forms the servo module. The motor driver is used to run the servo motor. The Arduino Uno converts the analog signal into integer and sends it to the servo motor. According to the calculated dimensions (coordinates), the servo motor rotates. Then the immersible motor is used to spray the paint on those tinted areas.

Robot joint

The robot joint has 2 parts, servo motors and end effector. The servo motors help in the movement of the robotic arm. The end effector of the robotic arm is mounted with an immersible paint which sprays the paint in the area to be painted and a web camera that feeds or stream the image of the area in real-time to Raspberry Pi. The robotic arm is also provided with power supplies.

3.4 DATA FLOW DIAGRAM

The image of the area to be painted is captured by the web camera. NumPy and SciPy are open-source library files used in python programming. SciPy can read jpg and png images directly, without using PIL (python imaging library) So, those and are stored in NumPy images captured through the webcam are read by SciPy arrays' NumPy is a powerful N-dimensional array object. The tinted areas of the wall are detected through image segmentation and edge detection.

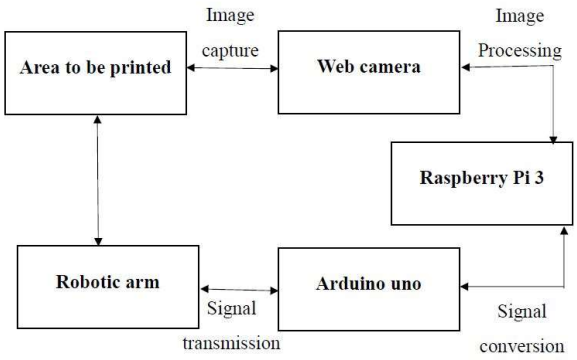

Fig 3.2: Dataflow Diagram

The dimensions and axis of the tinted areas are calculated. Raspberry pi sends the calculated dimensions in the form of analog signal to the Arduino Uno which then converts the analog signal into integers then it is sent to the to the servo motor. According to the calculated dimensions (coordinates), the servo motor rotates. The servo motor rotates according to the dimensions (coordinates). Then the immersible motor is used to spray the paint on those tinted areas.

4 METHODOLOGIES

- Image segmentation
- Signal conversion

Image Segmentation

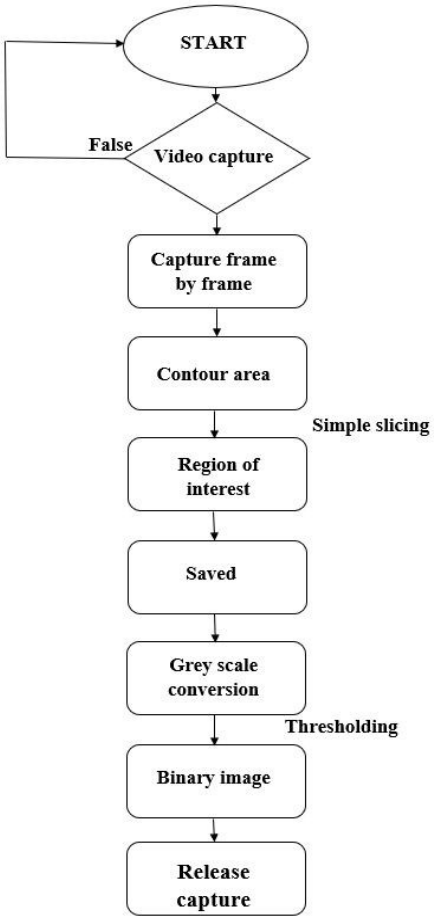

Fig 4.1: image segmentation

The robot starts its function by capturing the image of the wall to be painted via web cam. The video is captured frame by frame and is displayed in the contour area. The region

of interest i.e., the tinted areas or the area to be painted is selected by simple slicing to get the largest contour area. Then the image is saved and converted to greyscale. Thresholding process is done, to again convert this greyscale image to binary image and then the capture is released. Fig 4.1 shows the image segmentation process.

Signal Conversion

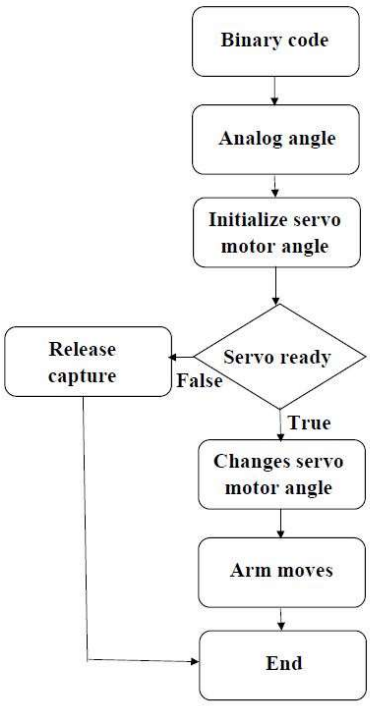

Fig 4.2: signal conversion

The binary code is generated from the image captured. The raspberry pi sends this binary code as an analog signal to the Arduino Uno. The Arduino Uno receives the signal and converts it into integers so that the dimensions and axes of the wall is calculated. The servo motor which has an initialized angle receives these streams of integers from Arduino Uno when it is ready and rotates and changes its angle. The arm thus moves accordingly and paints the tinted areas of the wall. If the servo motor is not ready, then the angle remains as the initial value and the arm does not make any movement. Fig 4.2 shows the signal conversion process.

5. RESULTS AND DISCUSSION

Area to Be Captured

The robot starts its function by capturing the image of the wall to be painted via web cam. The video is captured frame by frame and is displayed in the contour area. The region

of interest i.e., the tinted areas or the area to be painted is selected by simple slicing to get the largest contour area.

Fig 5.1: area to be captured

Image Processing

After capturing the area. The largest contour area of the images converted to greyscale. Thresholding process is done, to again convert this greyscale image to binary image and then the capture is released. The image is taken by the robot using web cam which is fixed to the end effector of the robotic arm that feeds or streams the image of the wall in real-time to Raspberry Pi. The robot measures the dimensions of the wall and the Raspberry Pi converts the image into binary codes and transmits the analog signal to Ardiuno.

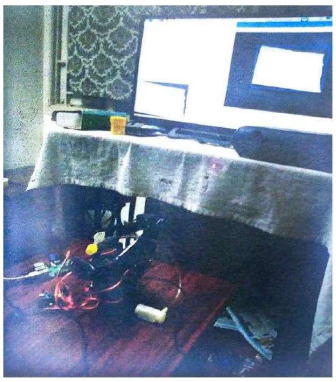

Fig 5.2: image processing

Painting The Area

The binary code is generated from the image captured. The raspberry pi sends this binary code as an analog signal to the Arduino Uno. The Arduino Uno receives the signal and converts it into integers so that the dimensions and axes of the wall is calculated.

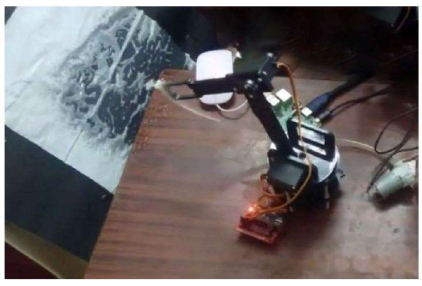

Fig 5.3: painting the area

The servo motor which has an initialized angle receives these streams of integers from Arduino Uno when it is ready and rotates and changes its angle. The arm thus moves accordingly and paints the tinted areas of the wall as shown in Fig 5.3.

Overall Structure

Robotic arm includes assembling of two main parts. They are Rigid base and End effector. Rigid base includes Frame Servo motor, Power supply, Raspberry pi, Arduino uno, Motor driver, Metal segment. The End effector includes Web camera, Immersible Motor and Spray Tube. The overall hardware set up is shown in Fig 5.4.

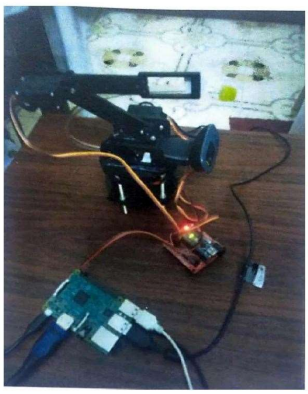

Fig 5.4: overall structure

6. CONCLUSION AND FUTURE SCOPE

Conclusion

The AI Based Painting Robotic Arm has been assembled and implemented. The system uses web camera to capture the area to be painted. The dimensions of the painting area are calculated through image segmentation. The robot gets rid of the hazards caused due to the manual painting since the chemical substances in the paint causes primary health issues to the human painters along with eye and respiratory machine problems. The robot is affordable, reduces paintings pressure for labours, reduces time intake. The painting mechanism uses the concept of image process so as to scan the objects and boundaries that is necessary to paint the wall and omit the obstacles accordingly.

Future Scope

The efficiency in painting can be improved by increasing the speed and accuracy. The robot can be made fully automated for reducing the human work force. The rigid base can be made mobile and can be implemented in the future.

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