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Computer Vision Controlled Automated Paint Sprayer Using Image Processing And Embedded System

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***Abstract*—** The paper presents a smart approach for a real time painting of walls in continuous flow. Image processing in today's world grabs massive attention as it leads to possibilities of broaden application in many fields of high technology. The camera senses the colour of the wall. This information is processed for robot to paint different places. The painting process is based on a 2 phase operative methodology defined as, 1) A self-learning step where the apparatus learns to identify the colour of the wall 2) An operative selection process where the painting location is detected and painted using a decisional algorithm. It aims in classifying the walls and its objects based on its colour. The robot is programmed to carry the paint gun to the location and paint it. This eliminates the monotonous work done by existing system. It achieves high accuracy and speed. The project involves camera that senses the object and sends the signal to the microcontroller. The microcontroller sends signal to the circuit which drives various motors of the robot. Based on the detection the climber moves to the specified location and starts painting.

***Keywords*—**Automated painting machine- Painting- Tall buildings painting- Fast painting- Painting with image processing- colour detection painting.

I. INTRODUCTION

Determining real time and highly accurate characteristics of objects in a fast flowing stream would open new directions for industrial painting processes. The present paper relates to an apparatus and method to classify wall shades, using electronic systems on the basis of colour and paint. Recent advancements in electronics and printed circuit board technology opens new perspective for the industrial application in this field. By another way this project can be treated as an automated painting system & can be designed by the following way. It synchronizes the movement of climber to carry the painting machine. It aims in classifying the object based on colour and painting them accordingly, thereby eliminating the monotonous work done by the existing system. This achieves high accuracy and speed. The project involves camera that senses object's colour and sends signal to the microcontroller. The microcontroller sends signal to the circuit which drives various motors of the robot to carry painting machine and paint the specified location. Based upon the colour detected, the robot moves to the specified location, and paints accordingly.

II. EASE OF USE

A. Manual Process

In Manual Process humans paint the walls and surfaces manually. This may result in uneven painting, time delay in painting and physical tiredness.

B. Use of Robotic Arms and sprayers

Robotic Arms and sprayers are widely used in industrial painting of objects. It consists of a robotic arm attached with a spray gun. The robotic arm moves the spray gun to the location and the sprayer paints the

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surface. However, this is highly power consuming and designed for a specific painting purpose. This cannot be used to paint walls in continuous flow.

III. GENERAL TERMS

The commonly used general terms like abbreviations and acronyms and the units of measurement are listed below.

A. Abbreviations and Acronyms

The commonly used abbreviations and acronyms are MKS, CGS, dc, and rpm. MKS is for Meter Kilogram Second, CGS for Centimeter Gram Second, DC for Direct Current and RPM for Rotations Per Minute.

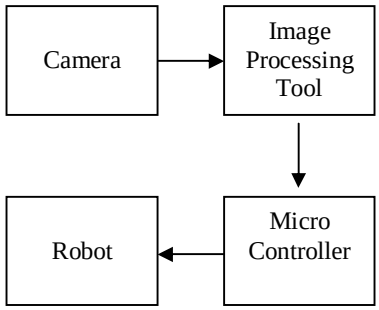
B. Units

- Use SI (MKS) and not CGS.
- Decimal points: “0.25,” not “.25.”
- Powers “cm3,” not “cc.”

IV. OVERVIEW OF THE SYSTEM

Among the various types of the separation system, robotic based system is very efficient and popular because of its autonomous behaviour and accuracy. Our robot classifies objects based on its colour. The object is pictured using a camera and the image from the camera serves as the input to the image processing tool. The tool processes the image and gives signal to the microcontroller. The microcontroller controls the vertical and horizontal movement of the robot and the also controls the spray timing of the compressor.

A. Block diagram



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B. Functional units

The system consists of two functional units, they are as follows

- Colour Detection
- Controlling

Colour Detection

To distinctly identify one object from other or to detect a particular colour image processing is used. This includes a camera which captures the image and sends it to the image processing tool. The image processing tool processes the image and gives control signal to the microcontroller.

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Controlling

When the microcontroller receives the control signal from the image processing tool, it knows the exact location of the robot. Now it controls the actuators and moves the robot to the desired location. Now it also triggers the sprayer and paints the location.

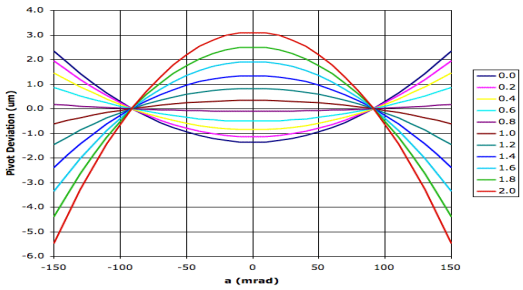
V. COMPONENTS

A. Camera

A camera with a minimum of 1Mpix resolution is used so that image processing is not affected. To paint at night, night vision cameras are used.

B. Image processing tool

To process various colours of the image and locate the position for painting, image processing is used. Here MATLAB is used for image processing. Each and every pixel is compared with the predefined threshold value set based on the colour of the wall. Now the machine uniquely differentiates between two objects (Example: differentiates between walls and windows). The differentiation pattern is as shown in the figure below.



MATLAB

MATLAB a numerical computing environment and fourth-generation programming language. developed by MathWorks, allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model Based Design for dynamic embedded system. MATLAB users come from various backgrounds of engineering, science, and economics. MATLAB is widely used in academic and research institutions as well as industrial enterprises.

C. Microcontroller

Microcontroller serves as the brain of the overall system. Atmega328 is used as microcontroller.

ATMEGA328

It is a high Performance, low power AVR8-Bit Microcontroller with Advanced RISC Architecture. It has 131 Powerful Instructions with 32 x 8 General Purpose Working Registers. It can process up to 20 MIPS Throughput at 20 MHz with on chip 2-cycle Multiplier. It comes with High Endurance Non-volatile Memory Segments with 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory 256/512/512/1K Bytes EEPROM and 512/1K/1K/2K Bytes Internal SRAM.

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It comes with Two 8-bit Timer/Counters with Separate Pre scale and Compare Mode and one 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode. It also has real time counter with Separate Oscillator.
It has Six PWM Channels and 8-channel 10-bit ADC in TQFP and QFN/MLF package and also 6-channel 10-bit ADC in PDIP Package.
It has Programmable Serial USART, a Master/Slave SPI Serial Interface, Byte-oriented 2-wire Serial Interface (Philips I2C compatible) and a Programmable Watchdog Timer with Separate On-chip Oscillator and On-chip Analog Comparator.

Special Microcontroller Features
Power on Reset and Programmable Brown-out Detection
Internal Calibrated Oscillator
External and Internal Interrupt Sources
Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
I/O and Packages
-23 Programmable I/O Lines
Operating Voltage of 1.8 - 5.5V
Low Power Consumption at 1 MHz, 1.8V
– Active Mode: 0.2 mA
– Power-down Mode: 0.1 µA
– Power-save Mode: 0.75 µA

D. Robot

The robot nests the camera, controller. The robot consists of two major parts for locomotion in horizontal and vertical direction. For vertical movement a climber is used and for horizontal movement a wheeled robot with suspension system is used.

Vertical Movement

The vertical motion is made by a robot which can climb poles and reach till the top of pole with a very high speed.

Horizontal Movement

The horizontal motion is made by a robot which has a high level suspension system which can travel on any surface without changing the vertical axis of the climber.

E. Formula

To find the time required to paint a surface, the following formula is used.
$T= (240 \pi^2 * Rv * Rh) / (RPMv * RPMh)$
Where,

Rv is the radius of vertical movement's wheel in meters,
Rh is the radius of horizontal movement's wheel in meters,
RPMv is the rpm of vertical movement's DC motor
RPMh is the rpm of horizontal movement's DC motor

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