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

Volume: 2 Issue: 1 Apr,2016,ISSN_NO: 2347 -7210

Development of robot for automatic wall painting, writing, drawing and crack detection

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Abstract **- This paper presents a new prototype that aims to design, develop and implement Automatic Wall Painting Robot which helps to achieve less human interaction and low cost painting equipment. Despite the advances in robotics and its wide spreading applications, interior wall painting has shared little in research activities. Despite the fact that the utilization of spreading robotized frameworks for inside painting was at that point indicated to be attainable and helpful, a ton of tests must be completed later on to convey an exceedingly self-governing robot for inner part painting. A new approach is proposed using raspberry pi, the robot which can be operated by both manual and autonomous. The autonomous robot can be controlled using an android mobile where the application was installed. The existing approach gives feasible analysis for time and labor. It is not easy to correlate the work and people because painting an elevated building is very risk and time consuming. In this paper, the robot is mounted on equipment which permits it to move up and down, left and right along the exterior walls of a building. It is also equipped with sensors which measure indentations and protrusions in the wall surface and making it possible for painting. IR is used to enhance the current approach to detect cracks on the wall and gives indication such that we can rectify in prior from elongation of damage. In addition, it is very effective on time management and completes it without an error and would offer the opportunity to reduce or eliminate human exposure to difficult and hazardous environments. Finally, it is expected that the conceptual model of the wall painting robot would be efficiently used in various applications in wall finishing and maintenance of other architectural and civil structures such as commercial buildings, towersand high-rise storage tanks.**

Index Terms—**Painting robot, automation, wall painting, PIC, Infrared.**

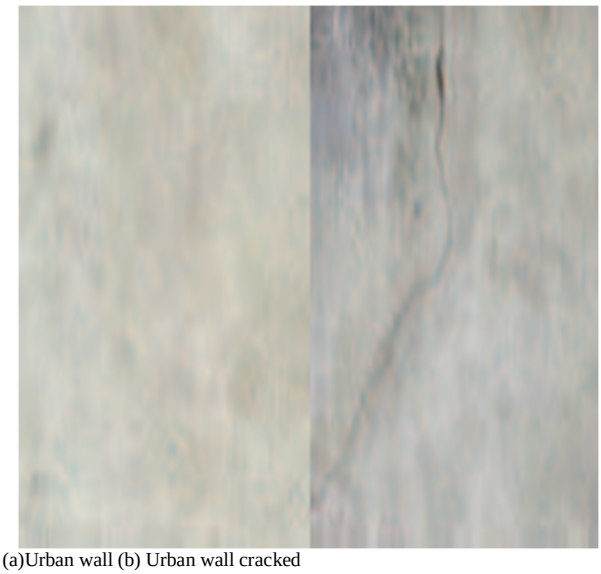
I.INTRODUCTION

Fast globalization and interconnectivity create the major driving force in creating and enhancing chance. Therefore, the society has to acquire new trends of innovation to prosper in their ways of life. The community has revolutionized due to the interconnectivity greatly compared to some years back when usage of technology did not exist. Saving human labor numbers and timing are only the two main advantages; besides them we must consider the opportunity to reduce or eliminate human exposure to difficult and hazardous environments, and to improve the quality of such works which would solve most of the problems connected with safety when many activities occur at the same time.When construction workers and robots are properly integrated inbuilding tasks, the whole construction process can be better managed and savings in human labor and timing are obtained as a consequence. These factors motivate the development of an automated robotic painting system. Valuable experiments were led to verify how convenient is carrying on painting works through robots. The task of painting is a time consuming one. Automation in this fieldwould at least substitute humans in applying the paint, thus saving the valuable labor hours of working.Also, the fact that long exposure to paint and varnishes damages the human health has been proving. So the advent of automation willhelp to get rid of this hazard. The automated painting robot was to be designed with the vision to facilitate easy wall painting.Results of comparisons at full scale between laborand robotized execution showed that there are significant savings in labor, depending on the labor rate, when auxiliary work is considerably lessened.Through the performance of full scale experiments, it was possible to show that robots are always more profitable than human work when highly autonomous robots are adopted. The feasibility of highly autonomous robots is shown by a number of papers which pictured the reduction of auxiliary work from labor.

In ref. [1] a prototype of highly autonomous plastering robot was tested in a full scale construction site: it is able to measure the size of theenvironment and to execute its operations autonomously, under the control of an operator, using rangemeasuring sensors scanning in one or two planes. Even if good results were obtained inside a room, further sensors would be needed to perform the same operations in an apartment or in whole buildings.

Considering that fromprevious research the feasibility of such a system was demonstrated, now it is necessary to develop a highly autonomous robot for wall painting that must be able to move in the construction site

with minimum operator intervention. In addition, the final arrangement of this prototype is thought to be able to perform not only fast and efficient painting, but also high quality pictures, working in a way similar to theone of printing machines. In this way users will be allowed to draw pictures on the interior surfaces of building walls obtaining good aesthetic results even if with low preliminary testing level, in order to infer the results thatwould be obtained when working investments.The model is referred to the determination of the paint quality (uniformity and saturation) with dependence to some parameters that affect it.In this project painting was executed using a spray gun with its on/off control nozzle. The automation is done through the android mobile. It can do both automatic and manual painting by sensing and scanning the wall. Weknow it is very risky to paint outside wall at elevated height but at now we are using a prototype model to show the painting process.



(a)Urban wall (b) Urban wall cracked

Fig. 1.Walls in real world environment observed by system using camera.

1. We used camera to recognize the cracks in the challenging walls with occlusions and varynumbers and scales of crack occurrences.
2. Painting is efficiently conducted by robot arm w consists of motors which permits it to move up and down, left and right along the exterior walls of a building.

II. LITERATURE REVIEW

Interesting examples of automated construction processes are the CIC [2] and the SMART systems acronym for Computer Integrated Construction: it requires the use of a mobile construction system moving throughoutthe building site. Even if it requires the adoption of readymade products and it would be difficultly applied for different construction technologies, however it laid the foundation of automation in the building sector wit of robots and control systems. Another similar example is represented by the S.M.A.R.T. system, developed by Shimizu Corporation, which encompasses also the design and management phases in the automated construction process. The very interesting contribution given by the fore [4] and [5] are more specific for the execution of building and economic . In particular y varyingwhich consists [3] CIC is the construction with wide use mentioned tasks. They are developing the multi which has been used to perform a number of experiments on wall painting using a spray gun with I operated by connections of the robot's controller. Through full scale experiments it was shown that, according to the break-even point technique, robots are always more profitable than human work when highly autonomous machines are adopted. This holds because one operator may supervise also two different robots; in this way it is convenient also for cheap labor markets. This is due to the fact that human workers are released to the simultaneous performance of complementary subtasks,improve the profitability of the whole system.

TAMIR was tested also in the execution of other tasks like plastering, as performed in [6], about which there is however less information available. The main purpose of these experiments was connected with the necessity to develop highly autonomous machines for building sites: even if that problem is not completely solved, however first good results have been obtained, which perorate the feasibility of this technique. All these experiments follow the approach of testing human ergonomics prototypes. At the same time, another school of thought is working onminiaturerobots, which can be used for a number of purposes. Some of them are climband diagnostic [7]; climbing robot for curtain wallfor miniature navigation [8]. These robots have been developed because they are more lightweight and move at high speed, thus allowing operations that would be very cumbersome, and sometimes impossible,heavy and slow automatic machines. Among the wide variety of applications where they can be used, there is also the possibility to adopt them in construction: they could be used to access high rise building walls or dangerous environments and perform many operations, including wall painting. They can constitute also one valid alternative to the painting robots thus far presented, because their lightness enables them to quickly move throughout every job site, despite the presence of obstacles or other operators.

Other applications of miniature robots in different fields of research strengthen the validity of our proposal and the interest in this approach. In [9] system for miniature robots is investigated. The author observes that untethered miniature robots with physical dimensions around or lower than 10 cm do not permit powerful onboard computers because of their size and powerful constraints. This limit has reduced in the past their functionality to that of remote controlled robcontribution.

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III. BLOCK DIAGRAM

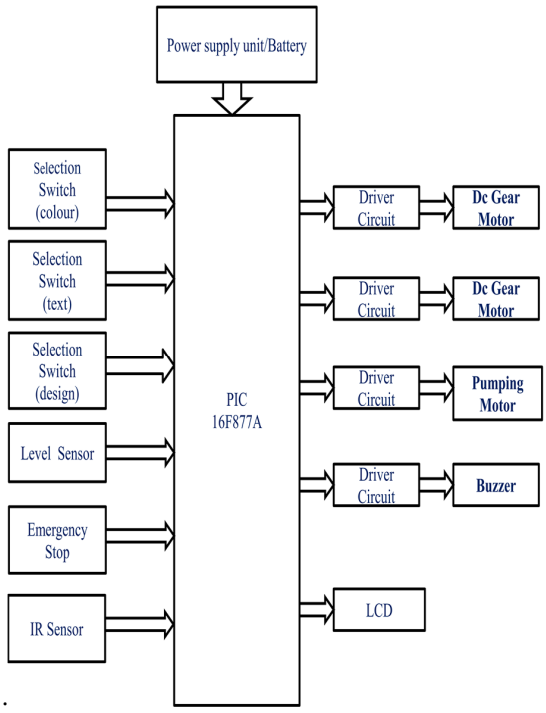

Fig. 2. Block Diagram for Automatic Wall painting, writing, drawing and crack detection

IV: PAINTING PROCESS

The paint robots were introduced for the human in whichit can help people from the untrusted painters. Normally a strange painter is suspected to be untrusted in the absence ofthe owner, so the mobile painting robot can vanish that fear and make the owner to get comfortable with their work. So a person can paint their need by using the paint robots evenfrom any place just by providing commands to their robot in such a secured way. Presently automation is mostly spread in the field of industrial engineering, where there are a lot of patented prototypes, like robots for painting cars, buildings, aircraftsand so on. The major parts used in this project are PIC (16F877A), L293D motor drivers, DC motors. The process is carried out using the robot arm. The motor parts in the arm enable the robot to rotate in the desired directions, microcontroller programming is done to drive the motor.

. V: ROBOT STRUCTURE

A. Robot Arm:

The robot arm has the capability to paint the wall by holding the brush or sprayer. Without fixing a sprayer or brush it can perform pick and drop operations which is used as general purpose robot. The material in which the robot armmade is high quality plastic.

The motion requirements for the robot arm are as follows:

• The weight of the arm is 658gm.
• The dimension of the robot arm is 9”L*6.3”W*15”H.
• It consists of five motors namely M1, M2, M3, M4, and M5 in arm part.

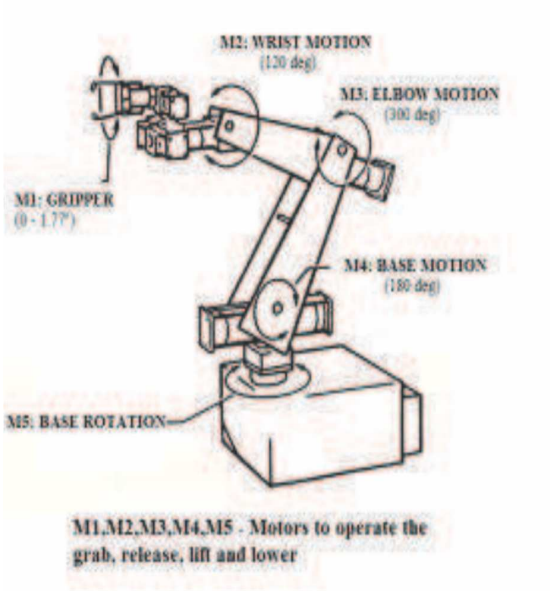

Fig. 3. Structure of robot arm

The structure of robot arm explains the following:

1. The motor M1 is used to hold the sprayer and itacts as a gripper
2. The motor M2 is used for the Wrist motionwhich can rotate up to 120deg.
3. The motor M3 is used for the Elbow motionand it can rotate up to 300deg.
4. The motor M4is used for the Base motion and it can rotate up to 180deg.
5. The motor M5 is used for the Base rotation willmove around using the chase.

M1 consists of two wires namely yellow and black. M2 and M3 consists of blue and black wire. M4 and M5 consists of orange and black colour wires. The wires present in the motors are connected to the microcontroller circuit respectively.

B. Chassis:

The chassis part consists of four geared motors to drive the wheels, so that it can rotate all around the required directions.L293D DC motor driver is used to run the DC motors. The arm part is fixed above the chassis.

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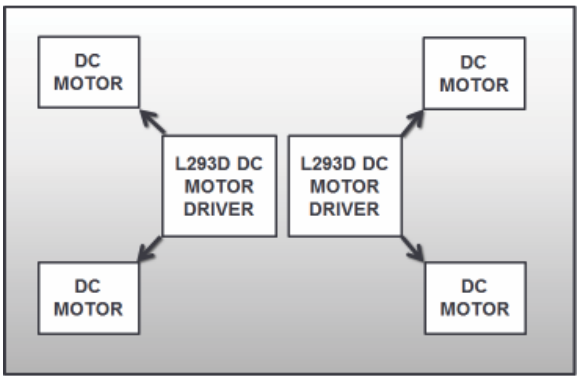

Fig. 4. Motors connected in Chassis

C. L293D Motor Driver:

L293D drive 4 DC motors in one direction, or drive 2 DC motors in both the directions with speed control.The driver greatly simplifies and increases the ease with which you may control motors, relays, etc. from microcontrollers. It candrive motors up to 36V with a total DC current of up to 600mA.

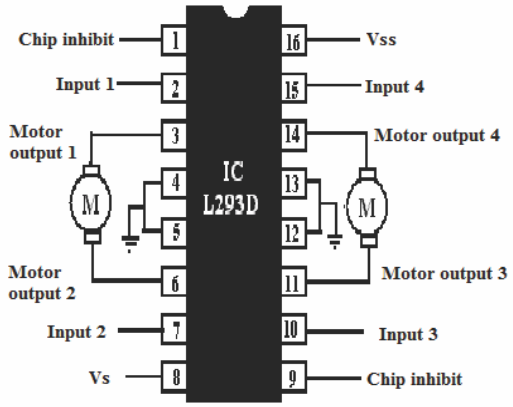

Fig. 5.L293D motor driver connecting two DC motors

Connect the two channels in parallel to double the maximum current or in series to double the maximum input voltage. This motor driver uses screw terminals for easy connections, mounting holes for easy mounting, back EMF protection circuit, onboard heat sink for better heat dissipation and more efficient performance. This motor driver is perfect for robotics.

VI. PIC (16F877A)

Microcontroller **PIC16F877A** is one of the PIC Micro Family microcontroller which is popular at this moment, start from beginner until all professionals. Because it is very easy to use **PIC16F877A** and use FLASH memory technology so that can be write-erase until thousand times. The superiority this RISC Microcontroller compared to with other microcontroller 8-bit especially at a speed of and his code compression. **PIC16F877A** have 40 pin by 33 path of I/O.

PIC16F877A perfectly fits many uses, from automotive industries and controlling home appliances to industrial instruments, remote sensors, electrical door locks and safety devices. It is also ideal for smart cards as well as for battery supplied devices because of its low consumption. EEPROM memory makes it easier to apply microcontrollers to devices where permanent storage of various parameters is needed (codes for transmitters, motor speed, receiver frequencies, etc.). Low cost, low consumption, easy handling and flexibility make **PIC16F877A** applicable even in areas where microcontrollers had not previously been considered (example: timer functions, interface replacement in larger systems, coprocessor applications, etc.). In System Programmability of this chip (along with using only two pins in data transfer) makes possible the flexibility of a product, after assembling and testing have been completed. This capability can be used to create assembly-line production, to store calibration data available only after final testing, or it can be used to improve programs on finished products.

Fig. 6. Final Setup

VII. CRACK DETECTION

Infra-Red sensors are used to detect the crack in the wall during painting. Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000Pm. The wavelength region which ranges from 0.75 to 3Pm is known as the near infrared regions. The region between 3 and 6Pm is known as the mid-infrared and infrared radiation which has a wavelength greater higher than 6Pm is

known as far infrared. Infrared technology finds applications in many everyday products. The key benefits of infrared sensors include their low power requirements, their simple circuitry and their portable features.

Infra-Red Sensors:

An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

VII. CONCLUSION

Special robots and automation technology have the potential to increase productivity by performing tasks efficiently and improving working conditions through applications that limit the exposure of humans to safety hazards. Our project is a prototype model for providing automation in painting, texting and drawing using PIC microcontroller .And also it reduces space by using. Thus this process seems to be easier when compared to others.

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