

# Automatic Wall Plastering and Repairing Robot using Artificial Intelligence

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**Abstract**— Due to increase in population, the demand for the civil construction increases proportionally. The major activities like plastering, painting, flooring, roofing, etc are carried out manually or manual assisted and lead to more fatigue, with arbitrary qualities, shortages of skilled labor, etc. Because, the civil R&D activities in robotics and automation is less concentrated. So in this research, an attempt had been made and succeeded in developing an intelligent automatic wall plastering and repairing robot, which can plaster and repair the plastering for both commercial and residential buildings with good quality. These had been achieved through sensor, microcontroller and the actuators. The developed robot was validated by testing with the brick wall with cement mortar and the performance found satisfactory.

**Keywords**-Plastering; Robot; Automation; cement morta.

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## I. INTRODUCTION

Revolution in the automation and robotics addressed many issues in most of the field of engineering and technology. But the application of the robotics in civil construction has not been up to the satisfactory level. Now a day's due to higher demand for the residential and commercial buildings, fierce competition exists between the building contractors. To survive and sustain in this competitive construction sector, contractors has to equip their construction methodology in such a way to perform the highest output without compromising the quality of the work, with as minimum cost and time. Thus there exist a confliction between the highest output, and the parameters such as quality, accuracy and precision. Inturn leads to requirement of skilled labours and inturn increases the cost of construction. Even the skilled constructor/mason will suffer from high fatigue and results with less efficient constructions on prolonged working. Various stages of the construction are brick pattern arrangement, plastering, roofing, flooring, painting, etc. Among these stages, in this paper, plastering process is taken into consideration for automation.

Plastering is the process of applying a layer of cement mortar over the brick wall to provide strength and good appearance for the building. So, the above mentioned problems can be solved by designing and constructing the automated robot which can plaster and repair the wall in shortest time and with good quality. This research also concerned with safety levels of the workers. So automation of plastering process can provide a solution on the safety aspects of both worker and machine. This research is to design and develop an automated wall plastering machine which is capable of plastering the cement mortar on the vertical walls without human assistant. The ultrasonic sensors have been used to identify the damages

in the wall and that also plastered by the machine. It consistently maintain the quality of the plaster, reduce the demand for the skilled labour, increases the construction speed, it also eliminates the usage of tools like trowels, floats, hammers, screeds, a hawk, scratching tools, utility knives, laths, lath nails, lime, sand, etc and having many more advantages. So the robot can be used for construction of buildings, apartment, complex, shops, homes, industries, etc..

## II. LITURATURE SURVEY

In general, the growth of a country is mainly dependent on the infrastructure, agriculture and industries [6]. Hence the constructional sector having prime economic significance to many countries. In most countries, amount to 10–20% of the GNP is for the construction industries [1] and thereby making a largest economic employing sector. Plastering is the construction or ornamentation work done with plasters or cement mortar over the walls [2]. Failing to allow the plastering to fully cure can lead to excess shrinkage and cracking on the lines after the walls have been plastered [4]. The various types of surface finish are (a) smooth finish, which is more smooth and can be obtained by smoothing using wooden float, rather than a steel trowel. is to be used. (b) roughcast finish is for rural or coastal areas, which is splashed on to the surface as a wet mix and left rough. The maximum sizes of sand, crushed stone or gravel vary from 12.5 mm to 6.3 mm. (c) pebbledash finish is most durable of all finishes and is generally free from effects. This gives a rough texture and is obtained by means of small pebbles or crushed stone, graded from 12.5 mm to 6.3 mm being splashed on to a fresh coat of and left exposed. (d) textured finishes are now becoming very popular and may be obtained in a variety of ways in many different designs. Special effects can be obtained by scraping the surface of the rendering with a

straight edge hacksaw blade or with the edge of a steel trowel. Apart from this, commercial wall plastering machines are available [3]. But these machines are not having the self alignment capability, which is very much essential for the flat and smooth plastering of the wall. Also these types of wall plastering machines are used to plaster the entire wall and cannot be used to re-plaster the patches and damaged plastered walls.

### III. PLASTERING METHODOLOGY

Plastering is the process of art and requires skill to plaster the wall. Figure 1 represents the plastering operation using trowel. Initially the trowel is loaded with mortar and kept at inclined angle, such that the leading edge should be away from the wall. The gap between the trailing edge and the wall should be equal to the thickness of the plastering. Then the trowel should be moved upwards with pressure, so that the cement mortar will get stick with the wall. As the amount of plaster reduces, the leading edge will need to gradually be flattened towards the wall. Thus all the mortar will be pasted over the wall. The processes have to be repeated and the trowel without mortar will be used to flatten the plastered surface. Providing the correct angle of trowel is essential for proper plastering and requires skill.

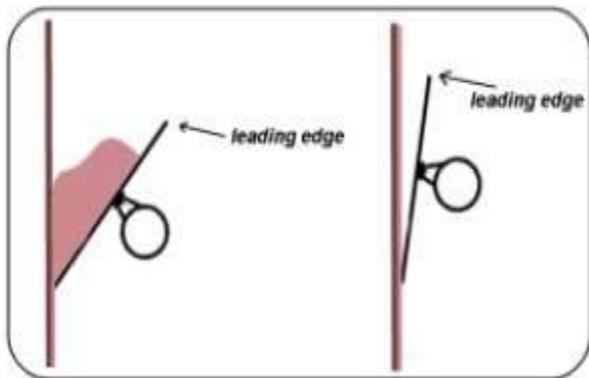


Figure 1 : Manual Plastering Process

The plaster can firm up with the wall because of the natural setting characteristic of the cement or binder and also due the moisture being sucked out of the plaster by the backing coat. The pressure applied through the trowel should be even to get the flat surface without waviness. Also increasing or decreasing the angle of the trowel will lead to scrape plaster off and hollow cavities inside the plaster. This plastering methodology is crucial to maintain all times. Similarly the flattening of the plaster wall should be done quickly after applying the cement mortar, because the setting time of the cement mortar is very less.

### IV. AUTOMATIC PLASTERING ROBOT

The primary objective of the plastering robot is to plaster the wall quickly such a way that the plaster should be flat, smooth, without moisture and defects. To achieve these goals, the cement mortar is allowed to squeeze out through a small gap with high pressure produced by moving the spool or poppet [5]. The movement of the poppet is controlled by a high torque motor. The pressurized mortar will stick with the wall and the pressure supports for the faster setting [7]. In order to maintain the plastering thickness, ultrasonic sensor and the microcontroller is used. The ultrasonic sensor present in the robot used to measure the gap between the setup and the wall. Based on the error in the gap, the microcontroller sends the pulse signal to the transverse motor and move the plaster setup accordingly, thereby maintaining the gap and thickness of the plastering. Sometime the plaster may fail to stick with the wall and may have damages in the plastering. These is rectified when the setup moves from top to bottom, ie the setup has to move upward by doing the plastering process and once it reaches the top level, it has to move downward for plastering the next segment of the wall. During the downward motion, the ultrasonic sensor checks the thickness of the plaster indirectly by measuring the gap. If any deviation or error found, than the plastering has to done in that segment. Thus the developed robot is not only used to plastering but also to check the quality of the plastering and repair the damaged plaster. The developed automatic wall plastering machine is shown in the figure 2.



Figure 2 : Automatic Wall Plastering Machine

The gap for squeezing the mortar depends on the type of the mortar and its property. The composition of the mortar

mix will vary from application to application. So in this project, for initial experimental purpose, the gap and the mortar mix have to be done manually. The speed of the upward movement or the plastering speed can be controlled by the variable speed motor. This should be decided based on the curing time of the prepared cement mortar. The developed robot having provision for controlling the speed of the upward motion using a rheostat setup and having separate provision to add the fast curing liquid catalyst with the mortar mixture. Even though, the finished appearance of the wall is highly dependent on the standard of the wall construction.

The major issue is that the surfaces of the entire wall should at same level. The maximum tolerance limit set for the robot is 3mm deviation. This is satisfied by providing rail guide for the robot for the transverse motion, so that the alignment of the robot might not be changed. On the other hand, the ultrasonic sensors maintain the gap, if any misalignment occurs. The robot can also be used for the emerging social needs, like measures against aging workers, increase of renewal works, repair work, inspection, etc. Initially, the developed automatic plastering machine has to be placed near the wall which needs to be plastered. The robot has a mercury level gauge, which is used to level the machine with respect to the surface and the wall. For faster plastering operation, rail can be fixed which guides the robot for the transverse movement of the robot. Without rail, for every movement, the ultrasonic sensor detects the distance for identifying the gap and adjusts the robot arm, so the process consumes more time. The ultimate aim is that the machine should be perfectly leveled.

Then the cement mixture which consists of cement and sand in the ratio approximately around 1:4 is poured into hopper of the tray or based on the application. Then the squeezing gap is adjusted based on the setting time of the cement mortar. The tray is lifted to a maximum height of 8 meters and has been achieved by means of the chain sprocket mechanism driven by AC motor. Linear movement to the tray assisted by vertical guide ways. To increase the pressure and the flow of the mortar, a spool controlled by motor and power screw has been used. Thickness of the mortar has been achieved by adjusting the gap between the wall and the robot plastering arm. The gap can be varied between 0.5 inches and 1 inch.

The setting of the mortar depends on the speed of applying and pressure exerted over the mortar. The required speed can be obtained by the variable speed motor and rheostat arrangements. The smoothing out and levelling of the plaster is done immediately by the levelling bar held firmly below the plastering arm. For perfect finish, scratch coat have to be given for 3-8 inch thickness and than second base coat followed by lime finish coat. The design of automatic

plastering machine consists of three stages such as Mechanical design, Electronic design and embedded programming. The enhanced automatic wall plastering machine is controlled by AtMega microcontroller with RS232 interface. It is to control the vertical movement of the arm and the horizontal motion of spool. The controller receives the input from the user and from the ultrasonic sensor.

The special features of the automatic wall plastering robot are as follows,

- \* Self adjusting capability : the gap between the arm and the wall can be adjusted automatically to keep the plastering flat and smooth.
- \* Pressurized Mortar : the cement mortar is applied under high pressure and which makes the mortar to stick with the wall firmly.
- \* Error Detection : The improper plastering is checked while moving in the downward direction and can be re-plastered during the downward movement of the arm.
- \* Automatic Movement : It can plaster the wall automatically by moving up and down in vertical direction.
- \* Mortar Thickness: It has special design for adjusting the thickness of plastering/salleri/cement mix.
- \* Controller : It has microcontrollers for controlling the motor to automatic extend of cement flow and to automatic movement of hopper for cement discharge/plastering.

## V. CONCLUSION

Automatic wall plastering robot has been developed to apply the mortar on the vertical walls with pressure and having the capability of self adjusting the mortar thickness. The developed model had tested and the performance found satisfactory. The developed automatic plastering machine will solve the issues like shortage of labour, raise in labour cost, etc. It is observed that the wastage of mortar is reduced more than 60 % and thereby reduces the raw material requirement. It also having the capability of repair the damages in the plastering. It improves the quality of the plastering process and the reduces the time of plastering.

## VI. FUTURE SCOPE

Even though many areas of civil constructions are automated like concrete pouring machines, plastering machine, etc. But masonry work which is an important and major process in a construction process still being manually done. The quality of the wall work will be reflected on all other process in the construction. So that can be automated. Similarly the mortar preparation is influenced by many parameters like type of wall, wall pattern, usage, etc. so an intelligent system can be build to prepare the mortar.

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