International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Automatic Tile Gap Filling Machine based on Computer Vision

Dhrupad M A[1], Athul M K[2], Arjun das P P[3] , Ridhev P[4], Vabhith N V[5]

[1-3]*Mechanical Engineering, TKM College of Engineering, Kollam, India*

Abstract - *At present, method for tile gap filling operation is done manually. Which in turn, results a lot of problems such as uncleanness, imperfection, high time consumption, need of skilled labor, wastage of material so on. So, there is a need for doing this process perfectly without human effort. The automated tile gap filling machine will solve most of the problems and the process can be done in a better way with minimum human effort. As the name says, it is an automated guided vehicle which can fill the gap between the tile automatically while the vehicle moves., Our objective is to simplify the gap filling work by maximizing the quality of work and minimizing the usage of the material as it is very essential to apply the mortar or paste (comprised of powder and water) in between tiles This machine can be used for any size if the filling is done with spacer. This means there should be equal gap between the tiles (4mm). The device consists of 3 drivers and control system. The forward movement of the machine is done by the detecting the edge of the groove and obstructions. For this, Raspberry pi board , Arduino ,sensors, cameras, and control systems together are used.*

***Key Words*: *ATGF*,**

1. INTRODUCTION

A tile is a manufactured piece of hard-wearing material such as ceramic, stone, metal, or even glass, generally used for covering roof, floor, walls, showers, or other objects such as tabletops. Alternatively, tile can sometimes refer to similar units made from lightweight materials such as perlite, wood, and mineral wool, typically used for wall and ceiling application. So, these tiles are laid side by side until the entire surface is covered. This process is called Tile flooring. After laying the tiles on the floor the labors should be placed a 4 mm gap (standard width) between each tile for the proper flooring process. So, the flooring process is completed after filling these gaps with proper mortar paste.

Automatic tile gap filling machine is an automated vehicle with a automation control system, which can fill the gap while traveling. It consists of a charging cylinder, driver, platform with wheels, camera, and controls. The cylinder and piston are made of aluminum alloy and a nozzle . Compared to conventional method this automatic device can perform the tile gap filling process with minimum material and maximum perfection.

2.1 METHODOLOGY – PROBLEM DEFINITION

The problem was identified while observing tile laying work in a construction site. We understand that there are several problems related with conventional tile gap filling method. They are,

- Time consuming
- Wastage of material
- Uncleanliness (filling material spreads over the tile)
- Hectic work (Need close attention)

There is a demand of an automated tile gap filling machine to solve the above said problem.

2.2 DATA COLLECTION

In this stage, all data and information related to tile flooring, tile gap filling from workers and through other mediums such as, nature of tiles, gap between the tiles, conventional methods, time duration, way of doing the work, availability of machine are collected.

2.3 IDEA GENERATION

This is one of the most important stage, based on the requirements and pain points which are involved, developed some ideas. They are,

- Manually operated
- Remote control
- Automatic control

2.4 SCREENING OF IDEAS

After considering the features and constraints of different options it is found that automatically control system is better than other two methods because the work could be completed without workers and the same could be done in a better way with minimum human effort.

2.5 CONCEPTUAL DESIGN

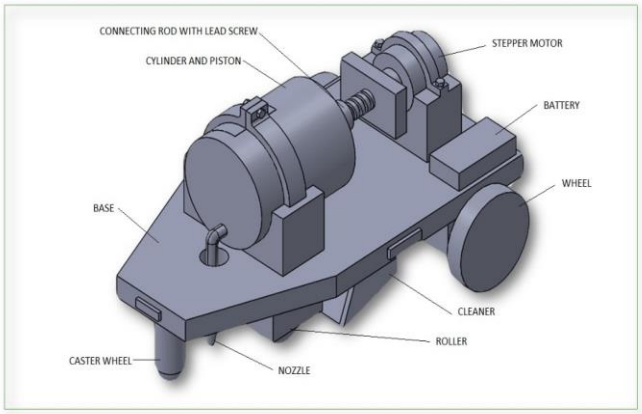

Fig -1: Design of Automated Tile gap Machine

3. LITERATURE REVIEW

Agostino (2010) described about ceramic floor tiles and flooring using ceramic tiles. This article was very helpful for preparing the floor substrate for laying ceramic tiles by bonding ceramic tiles. It explains how a ceramic tile can be lay on the floor and all the standards should obey while this flooring process. It also illustrates all the drawings of flooring with standard proportions.

Michal et al., (2014) discussed about WSN (Wireless Sensor Network) for traffic monitoring using Raspberry Pi board. Here in this paper, they introduces low-cost non-intrusive sensory that can collect traffic data based on Raspberry Pi single board computer. Image information acquired by Raspberry Pi HD camera module is analyzed for moving objects presence. After evaluation of detected object count, size, class and motion vector object properties are sent to server node by RF transceiver. Sensor low-power consumption ensures possibility to operate from battery for an extended period of time.

Peihua Qiu (2005) discussed about the edge detection in image processing and the mathematical relations used for edge detection. Here there are several types of edge detection in image processing are explained they are Edge Detection Based on Derivative Estimation, Canny's Edge Detection, Edge Detection By Multilevel Masks, Edge Detection Based On Cost Minimization and Edge Linking Technique. He also explained all the classifications and mathematical relations of the above mentioned methods.

Saraladevi and Sedhumadhavan (2017) discussed about the identification of a particular zone with prior information using wireless. Here for wireless transmission, they have used a Raspberry Pi board. Their main objective behind this was to prevent accidents while travelling by detecting the circumstances. It helps the people in prior information by controlling the vehicle speed while travelling near to particular zone. Here they are discussed about the methodology and fabrication details of such a system and implementation of this system into real life. They included all the connection diagrams and flow charts which are used for the fabrication process.

Yusaf (2014). In this paper they analyze the working principle of an Arduino. Here they have explained all the hardware and software side of Arduino, how to connect each components of its and some of codes or program used in Arduino.

Arduino is an open-source platform used for constructing and programing of electronics. It can receive and send information to most devices, and even through the internet to command the specific electronic device.it uses a hardware called Arduino uno circuit board and software programme (Simplified C++) to programme the board. In these modern days, Arduino are used a lot in microcontroller programing among other things due to its user friendly or easy to use setting, like any microcontroller.

4. COMPONENTS OF THE MACHINE

Automatic Tile gap filling machine is mainly divided into two systems

- Mechanical system
- Automation components

4.1 Mechanical Components

4.1.1 Base

Base should be strong enough to withstand all the loads and vibration during its working. It must have adequate strength to withstand the static and dynamic loads. So the design of the base is very important.

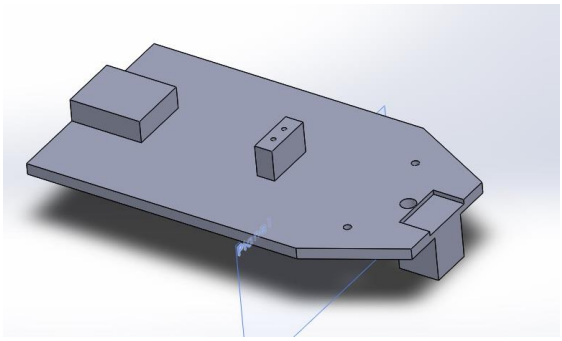

Fig -4.1: Base of the structure

4.1.2 Cylinder – Detachable

It is made up of aluminium alloy to reduce the weight of the whole system. Tile joint filler material is filled into it through the front opening of the cylinder, and it is closed by using a cylinder cover, which is easily removable. It is kept horizontally on the body to provide better stability and easy movement of the piston through it, in which the piston slides through the cylinder. Hence the material inside the cylinder flows through the nozzle to the gap between tiles. Major function of cylinder is to store the tile joint filler material in semisolid state. Therefore, inside of the cylinder must be smooth for the free movement of the tile powder. Already it is mentioned that aluminium alloy is used for the cylinder material due its desirable properties. Aluminium alloy has adequate strength to withstand the internal pressure acting on the walls while compressing the tile joint filler which is filled in it in the form of semisolid state. Aluminium Alloy is less in weight hence the overall weight of the machines can be reduced by selecting the cylinder material as Aluminium alloy.

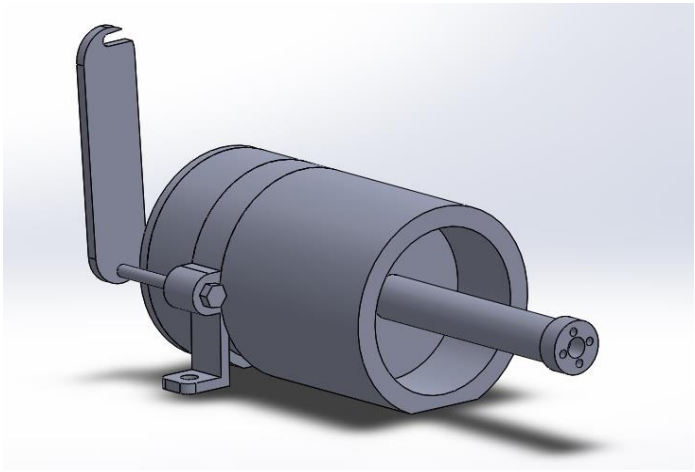

Fig. 4.2 Solid work 3D model of Cylinder, Piston, Connecting Rod and Bracket assembly

4.1.3 Piston

The joint filler material is stored in the semi solid state and it is squeezed through the nozzle as the forward movement of piston in the cylinder. Piston pushes the semi solid material present in the cylinder through the nozzle. So, the basic function of the piston is to compress the semi solid tile joint filler material in the cylinder. Piston is powered by a DC motor which is connected to connecting rod and lead screw.

Piston has a 3mm groove for piston rings. These piston rings will provide proper tight and will avoid leakage through the sideways of the cylinder.

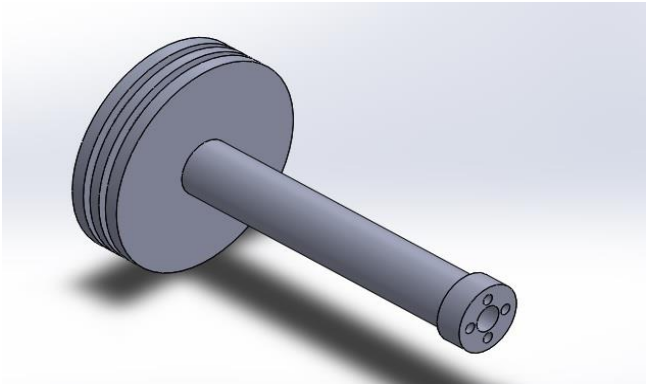

Fig. 4.3 solid works 3D model of Piston and Connecting rod assembly

4.1.4 Connecting rod with Lead screw

The connecting rod will be connected to piston with an attachment of a ball bearing and the lead screw will be inserted into the connecting rod. The lead screw will transmit the rotational motion from the motor to the connecting rod. Then the connecting rod will convert the rotary motion into linear motion of the piston. These are the major components of Automatic tile gap filling machine. If the piston rotates itself then there will be a chance for changing the quantity of supply through the nozzle so we must arrest the rotation of the piston and the connecting rod. The lead screw will move through inside the connecting rod with the help of a ball nut which is fixed on the connecting rod .It will be made of copper alloys and it is connected to the shaft of motor with the help of a coupler. The rotational motion from the motor will transmit through the lead screw and the connecting rod to the piston. Thus, it will attain linear motion when it reaches to piston.

Fig. 4.4 solid works 3D model of connecting rod

4.1.5 Nozzle

Nozzle is just a narrow opening provided to discharge the material. It is the part which direct the tile powder paste into the tile gaps. The nozzle is made of copper or aluminum alloys to get proper strength. Nozzle is a cone shaped object which used to flow the filler material into the tile gap at proper quantity. Nozzle is tapered length of tube that causes a fall of pressure head. Nozzle is connected to the cylinder by threads. Threads are used to avoid leakage of filler material and simplicity in assembly.

Fig. 4.5 Nozzle

4.1.6 Roller and Cleaner

Roller and cleaner are finishing components of Automatic tile gap filling machine. After filling the correct amount of filler material in the gap, it is necessary to press the filled material for the compact and complete filling of the gap between the tiles. It is a circular shaped roller which has a width great or than the groove i.e., 4 mm. we selected a roller which has 20mm for the uniform pressing of the filler material and ensures complete filling of the gap. Here, after filling the material into the gap, the roller is passed over it and excess material is carried by the cleaner and which is stored in the cleaner. It is then removed from the cleaner.

4.1.6 Wheels

Wheels are the important one, which helps to move the machine through the tile gaps. The whole loads of the machine including base weights are acts on the machine. There are three wheels, two back wheels and one front wheels (caster wheel).

Since the machine is back wheel drive, two motors are provided separately for each wheel for the drive. Front wheel is a caster wheel which is free to rotate. Wheels provides linear motion to the machine. Back wheels are made of plastics which have sufficient strength to withstand the load on the wheels. There is possibility to slip the wheel on the smooth floor to avoid this problem wheel is covered with rubber which gives proper grips on the tile floor. Wheel diameters are determined according to the loads and linear speed required. These are explained in the upcoming sections

Fig. 4.5 Drive wheels

4.2 Automation components

4.2.1. Arduino Uno R3

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source

Fig. 4.8 Arduino UNO

hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

4.2.2 Raspberry Pi Board

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. Here we are using,

Name of Part	Specification
Chipset	Broadcom BCM2837
CPU	1.2GHz quad-core 64-bit ARM cortex A53
Storage	MicroSD card or via USB-attached storage
Memory	1GB LPDDR2-900 SDRAM
Graphics	400MHz VideoCore IV multimedia
Interfaces	Camera interface (CSI) Display interface (DSI)

Table 4.2 Specs of Raspberry Pi

Fig. 4.8 Raspberry Pi3

4.2.3 Logitech Webcam

Webcam is used for the detection of tile gap. It is mainly connected to the raspberry pi board which acts as an input to the board. It takes videos of the tiles and pass information to the raspberry pi board. It is then converted to grey scale range(0-255). This webcam is not affected by background noise and is good for dim or poorly backlight settings. It is 5 megapixels HAD camera and it has automatic light correction capacity

Fig. 4.9 Logitech Webcam

4.2.4 Ultrasonic sensor

It is a proximity sensor which is used to detect the nearby objects and pass the information to Arduino. Here this sensor is used to detect the walls and control the movement of the machine according to the program which is written in the boards

It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound it calculates the distance.

Fig. 4.10 Ultrasonic Sensor Working

4.2.5 DC Motor

Motions like linear movement of the vehicle, piston are driven by dc motors. Motor gives drive to the wheels and lead screw of the machine as well. Three DC motors are used for the driving purpose, two motors are connected to the wheels and one motor is connected to lead screw. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

Fig. 4.11 Geared DC Motor

4.2.6 L293 Motor Driver - Arduino

The Motor Driver is a module for motors that allows you to control the working speed and direction of two motors simultaneously .This Motor Driver is designed and developed based on L293D IC. L293D is a 16 Pin Motor Driver IC. This is designed to provide bidirectional drive currents at voltages from 5 V to 36 V.

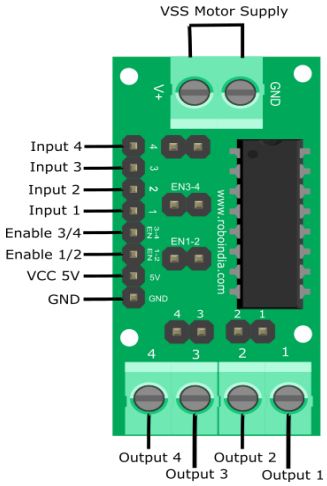

Fig. 4.12 L293D Motor Driver pins

4.2.7 Lithium-ion battery

An intercalated lithium compound as one electrode material, compared to the metallic lithium used in a non-rechargeable lithium battery. The electrolyte, which allows for ionic movement, and the two electrodes are the constituent components of a lithium-ion battery cell. Here we are using 12 v dc

4.2.8 Cp2 102 USB to TTL

USB 2.0 Mini module connects host computer (Windows Linux) to a Arduino or other micro controllers. Built in UART, USB Controller for connecting Full Duplex asynchronous serial device to a USB host.

Fig. 4.13 Cp2 102 USB to TTL

5. ATGFM AUTOMATION WORKING

The automation is mainly done by image processing technique (Thresholding) using raspberry pi3 board. Here we mainly using Arduino Uno board, L293 motor driver, 12 v dc gear motor, cp2 102 USB to TTL etc., webcam

Since raspberry is a mini mother computer, it has a memory card for booting purposes and programs are loaded into it. So, when the battery is connected to raspberry pi and Arduino both becomes on condition and raspberry starts to boot. Afterwards raspberry will send the start signal to Arduino then Arduino sends instructions to motor drivers for the traction of the wheels. Here programs are loaded sequentially with respect to requirements. These orders are termed as flags. So, each flag denotes each operation of the system.

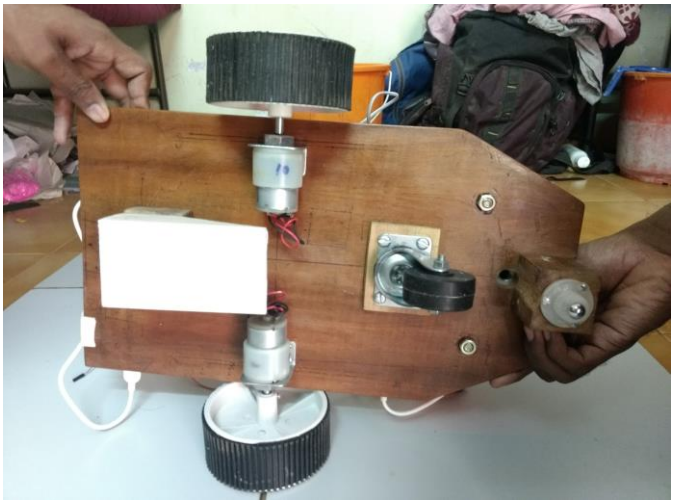

Fig 5.1 Bottom side of the Machine

At starting, the vehicle starts to move with the help of 2-wheel motors and at the same time the motor which is

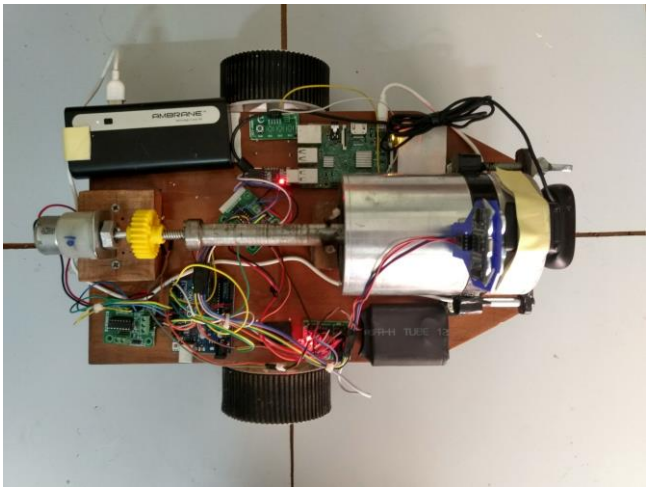

Fig 5.2 Top view of the Machine

attached to connecting rod gets drive and pushes the filling material inside the cylinder. As it moves forward, the filling is carried out between the tiles. Which will occur only at the time of vertical movement of the vehicle and will stop when the ultrasonic distance sensor detects the wall. Afterwards it should take left direction with the help of steering action of the motor(based on the predetermined logic). It is done by rotating each wheel opposite according to the direction. Unlike the previous stage in this movement there will be no filling. Which means the motor which is connected to sleeve of the piston will be idle. The main these logical operations are done by the help of image processing technique (thresholding). Here, the input device webcam captures real time video of the movement and will give this input value to the Raspberry pi. In this case, a preset value is given to differentiate tile and tile grooves. Based on this value, it can easily differentiate what is groove and what is tile. Then it follows the pattern.

This explains the basic working of automating tile gap filling machine.

5.1 Image processing technique

Image processing is the process of performing some mathematical functions and operations on an image or video. The output that we get after image processing is a set of parameters or some altered image. There will be a delay as the camera loads up and grabs an image. Afterwards should see the image appear in a new window. The image data is a 2-dimensional array of pixels, and each pixel is a tuple of 3 values: the relative intensity of the red, green, and blue colors in the range 0 to 255 (inclusive). We can access a given pixel in the image by treating the image as an array, and by providing a tuple of the x and y position of the pixel.

6. CONCLUSION

This project is mainly focused on the time consumption and quality of the work in terms of want of skilled workers and wastage of material. So, implementing this project we can easily run the construction side flooring works without any human intervention. Suppose if a multi-story building tile furnishing is to be done manually, it would take a great amount of time or may be couple of days, whereas by using an automatic machine the time period could be drastically reduced .The following are main advantages,

- Tile gap uniformity.
- Cleanliness.
- Less wastage of material
- Total outlook of the floor
- Less time consumption
- Since it is a portable device, it can be easily transported to everywhere according to the requirements.

REFERENCES

[1] Agostino, D. **(2013).** Ceramic Floor Tiles, US International Conference for Architectural Engineering, Vol 8, 2, Pages 01-12.

[2] Michal Kochlan, Michal Hodon, Lukas Cechovi, c., Jan Kapitulík, Matus Jure, C., **(2014).** WSN for Traffic Monitoring using Raspberry Pi Board, Proceedings of the Federated Conference on Computer Science and Information System, Vol 2, 1, Pages 1023-1026.

[3] Peihua, Qiu, **(2005).** Edge Detection in Image Processing, Wiley Series in Probability and Statics, Third edition, pages 187-231.

[4] Saraladevi, B. and Sedhumadhavan, S. **(2017).** Identifying a Particular Zone with Prior Information Using Wireless, Proc. IEEE Conference on Emerging Devices and Smart Systems (ICEDSS), Vol 17, 2, Pages 272-278.

[5] Yusuf Abdullahi, B. **(2014)**. The Working Principle Of An Arduino, Electronics, Computer and (ICECCO), 2014 11TH International Conference,vol 14, 3, Pages 01-04