

Fabrication of Automated Utensil Washing Machine

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ABSTRACT : We are living in an era of automation. From cars, cellphones, research production etc., everything is going autonomous. This paper deals with the concept of automated utensil cleaning machine. The project involves development of fully automatic utensil washing machine in which utensils are just dumped for cleaning. The utensils pass through a series of automated processes such as washing, Soap application, scrubbing, washing to get them completely cleaned. This project involves development of machine which is completely automatic which we just put the utensils to be cleaned and they are cleaned automatically. The Proposed paper can clean few different types of vessels. The paper aims to solve the problem of time as well as labour in the current approach of utensil washing on commercial scale by providing a unique solution to automated utensil washing machine using conveyor. The utensils are cleaned in multiple passes thereby providing an advantage over the single pass approach. The proposed concept discussed in the paper can clean utensils automatically with minimum human intervention making it easy to clean utensils in commercial establishments.

KEYWORDS: Automated, utensils, Washing, clean etc.

I. INTRODUCTION

We are living in twenty first century. This is the era of automation and is involved in every field such as research, production, entertainment, transportation, communication etc. As far as our project is concerned we are going to use automation in the field of cleaning. It's really unfair when we have to indulge our important time for cleaning and it becomes very much difficult for us to clean the utensils in a short time. From past 20 years automation in every field is increasing rapidly. Human always tries to reduce his mechanical efforts with the help of mechanical linkages of robots. In that automation home appliances and household working machines are getting special demand. In western countries this automation has is growing rapidly. In earlier years the many home appliances has invented and were globally accepted Washing utensils is most commonly done activity in the world, in most of families people wash dishes by hand which is straining to muscles and detergent is chemically harmful.. As far as manual process is concerned in houses of India, washing is done by hand scrubbing which is straining to the muscles through its energy and postural requirements. It may also lead to clinical, anatomical disorders and back pain which may affect the operator's health. Many of their household chores are performed by the women and some can be very physically challenging and time-consuming. So in several ways in which we can improve their lifestyle, and one aspect that we can improve on is the way they wash their dishes. Currently the chore of washing dishes is performed by the women, and can be very labor intensive as it is done for up to several hours each week. The same can be experienced in marriage ceremony with caterers face the problems in washing utensils. The proposed paper discusses the concept of automatic utensil washing machine which can wash utensils one by one by feeding it to the conveyor.

II. LITERATURE REVIEW

A brief literature survey was carried out to study the work done by other research scholars in the same field to understand the scope of the topic and the drawbacks of the current research work. This section describes some of the current research work in this field.

J.HOUGHTON- "Table furniture dish cleaning machine" [1] (1850): This paper discuss on invention of semi-automatic dish washing machine. This paper tells about brief idea of semi-automatic dish washing machine construction and their design. He constructed a cylindrical vessel which is of metal or wood. One side of cylinder say one forth, is left open from near the top to bottom. Inside the cylinder there is a vertical shaft, resting on the center in a socket on the bottom, and which passes up through and above the top or cover of the cylinder. Through the top of this shaft there is hole, through which pin passed, by means of it he gave it a rotary motion. Connected to this shaft is a

cylindrical rack or crib, which is supported by shaft. The diameter of crib is so much less than that of cylinder as it allows revolving freely within it. There is inclination of about 30 degrees downward and outward from the center of the shaft. On the bottom of rack the hoop is placed on the edge about midway between the shaft and outer rim of the rack. Dishes and other articles of table furniture are placed within the rack upon the conical rack in any position in which they can empty themselves, and so that their surfaces will be exposed to the direction of the buckets in the revolution of the rack. Boiling water is poured into a machine from the top of it. The rack or crib containing things is made to revolve by giving rotary motion to the shaft. At the same time the crank is turned where water is taken up by the buckets and thrown into the rack upon the surfaces of its contents, and continued until they are fully washed. After standing few minutes, they became dry and taken out, ready for use without wiping and have good surface. The design indicates that the construction of the machine is made to wash the dishes. For this he had constructed a cylindrical vessel with a shaft resting upon, the rack within a conical rack, a hoop to hold a table furniture in a combination with a curb. The whole system is supported with a frame and by these mechanical means, cleansing the surface of dishes without uses of hand, the all parts are being arranged, combined and operated substantially as to work as a complete machine.[1].

J. G. GOCHRAN- “Dish washing machine” [2] (1886): This paper gives brief idea described about improvement of dishwashing machine. It related to improvement in machine washing a dishes in which a continuous stream of either soap-soda or clean water is supply to crate holding the rack or cage hot water is supply to crate is rotate so as to bring the greater portion thereof under water. In this research paper improvement of designing elevation of machine and it part. The author builds the machine and measures the dishes and inside wire compartment each specially designed to fit either plate’s cups or saucer. The wire chamber placed inside a wheel that lay flat inside a copper boiler. A motor turned the wheel while hot soap water squirted up from the bottom of boiler and rained down on the dishes. The result indicates that model is first reliable hand powered machine use s a water pressure instead of scrubber to clean the dishes inside the machine. [2]

Odesola & Afolabi- “Design, Fabrication and Performance Evaluation of a Domestic Dish Washing Machine” [3] (2012): This paper discusses about the design, fabrication and performance evaluation of a domestic dish washing machine. The objective of this work is to design and fabricate a dish washing machine that is efficient and easy to operate. Stainless steel and mild steel was used for the construction of the machine considering their availability, cost reduction and corrosion resistance. The result indicates that the dishes are cleaned by spraying hot water rather than cold water typically, between 55 to 75 °C (130 to 170 °F) to loosen the sticky and oily substances. A mix of water and detergent is used for cleaning purposes, followed by clean water to remove the detergent residue. This work has established the fact that washing machines of different capacities can be manufactured locally in Nigeria without compromising standards. [3]

Dhale A. D. - “Design and development of semiautomatic dishwasher” [4] (2015): This paper discusses about the design, construction and evaluation of a dish washing machine. The capacity of the machine was 20 plates per minutes (i.e. 1880 plates per hour). The designed dishwashing machine is very efficient and easy to operate The result indicates that the detergent used is quite diluted and is biodegradable, with no phosphates, enzymes, or citrus additives. This leads to less requirement of detergent and cleaning is done mostly by use of water. This might leave a greater ecological footprint than other methods of dishwashing. Also series of test were carried out in order to determine the performance and efficiency of the machine. This was done by comparing the rate of washing with the designed dish washer to the handwashing. [4]

Pranali Khatake- “Design of Gears in SemiAutomatic Dish Washing Machine” [5] (2016): This paper discuss about design of gears in semi-automatic dish washing machine. Why semi-automatic dish washing machines are more popular in India as compared to fully automatic dish washing machine, Automatic dishwasher uses large amount of water, time and is costly. And because of all these reasons, the usage of automatic dishwasher in our country is very less. Use of semi-automatic dishwasher, they can reduce time as well as efforts of human also. The result indicate that in India semi-automatic dish washing machines are used than fully automatic dish washing machine as it is cheap, preferably gears are used in these semi-automatic dish washing machine with belt drive for better life and high efficiency. Paper focused on design of gears used in semi-automatic dish washing machine. [5]

Shaila S. Hedao- “Design and fabrication of semiautomatic dish and utensil washing machine” [6] (2016): This paper discusses the main objective of semiautomatic dishwashing machine is to reduce the cost of fully automatic dish washing machine and giving good cleaning performance. It required less energy and less water consumption. Time of washing dish can be adjusted as per customer requirement. In this system rotary jet technology is used to clean utensils. Any type of utensil will be washed in this system, No electronic circuit will be used multi jet system will be used to

clean utensil from all side. The result indicates that by using galvanized iron material for inner & outer part, the overall weight of the assembly is also reduced. The capacity of machine is to wash 24 pieces of dinner set at a time by using two rotary jets controlled by single pump using parallel connection. [6]

Shilpa N. Dehedkar- “Design of basic model of semiautomatic dish washer machine” [7] (2016): This paper gives a brief idea and analysis of the semi-automatic dish washer machine. It also states the mechanisms incorporated in this model for the process of washing the dish. In this research the dishwasher operates with help of DC motor, universal motor, conveyor belt and microcontroller for time delay. Microcontroller is used to provide delay to universal motor, DC brush motor & DC geared motor. Dish which is placed on the conveyor belt enters the first washing chamber where it is cleaned with soda water and scrubbed with the brushes. This is then passed to next chamber where it is rinsed with the clean water and finally moves out as a complete washed dish. The result indicates that the model is built with very basic material and can be more standardize by altering motor used. The product designed has minimal operating cost, cost effective, eco-friendly and it can be used with almost zero efforts. [7]

III. METHODOLOGY

IV.

This section deals with the brief methodology implemented in fabrication of the utensil washing machine.

Material survey and selection:

During this phase, the optimal materials required for the entire project are outlines. This involves carrying out a deep study of materials available in the market and choosing the most appropriate ones for development of the automated dish cleaning and washing machine.

Fabrication of conveyor for single pass of utensils:

The utensils to be cleaned are to be sent over the conveyor. After the material survey the conveyor is proposed to be fabricated which can carry the unclean utensils over it.

Fabrication of utensil loading mechanism:

In this phase the utensil loading mechanism is fabricated which can load the utensils one by one on the conveyor. The mechanism loads the utensils from the loader which is used to hold the unclean utensils

Interfacing the sensors for utensil detection and cleaning system activation:

In this project the utensils passing over the conveyor are detected using the sensor interfaced to the microcontroller. This phase involves interfacing the sensor to the microcontroller and programming it to detect the utensils. Once sensed by the microcontroller, the cleaning and washing systems are activated which clean the.

The cleaning system and automatic washing system:

In this phase the cleaning system and the automatic washing system is developed. This involves fabricating the cleaning mechanisms which consists scrubbing brushes to clean the utensils when sensed by the sensor. The brushed clean the unclean plates thoroughly and the microcontroller then signals the washing system to wash the utensils after scrubbing. The Scrubbing system happens over a separate table so that scrubbing can happen effectively

Assembly and testing:

This phase involves assembling all the components fabricated in the above steps so as to form a fully automated utensil washing machine. The machine is tested for various parameters for reliability at the end and possible performance improvisation is done.

V. MATERIALS

1. Frame: In this section, the whole accessories are to be mounted on a frame, which is made up of Mild steel. The total necessary assembly of frame is to be made by using an arc welding. Frame contain Three chamber assembly, on the first and third chamber conveyor are placed and in second chamber scrubbing and washing mechanisms are placed.
2. Conveyer belt: The conveyor belt is designed in such a way that water can be easily removed from the belt and roller type conveyor can be used. The diameter of roller is 26mm.
3. Power supply requirement: Power supply requirement of automatic Utensils washer machine
 - 1) For brush motor - 24V DC geared motor
 - 2) For AC water pump - 230V 50Hz
 - 3) 24V DC geared motor Automatic Utensils washer machine requires 230V AC as well as 24V constant DC s power supply.



4. Water Tank: Water tank act as reservoir. It is made of mild steel of thickness 1.6mm and its dimensions are 900*900*125. Capacity of the water tank is 100litres.
5. DC Geared Motor: It's supplied with 24V DC supply .Its main function is to rotate the brush assembly and conveyor belt attached to it .
6. DC Water Pump: 230V, 50 Hz AC supply high pressure water pump is used in this utensils washing machine. There is one water storage tank used in utensils washing machine.
7. Pipes :CPVC pipes are used for connecting nozzles and pump. Pipe has the dimensions of 3/4 inch with outer diameter of 28mm and inner diameter of 25mm. This kind of pipes can withstand high pressure and temperature.

VI. DESIGN CALCULATIONS

1. Selection of Motor for conveyor-

For designing the motor of conveyor roller, we need to consider the weight of Roller and the utensil. After fabrication of the roller we know that the weight of roller is 0.8kg. Let us assume that the weight of the utensil maximum to be 2kg

Therefore the total mass acting on the conveyor roller is 2.8Kg

$$W = 2.8 \text{ Kg}$$

Therefore, Total Force.

$$F = w \times 9.81$$

$$F = 2.8 \times 9.81$$

$$F = 28.30 \approx 29N$$

We know the Radius of the Roller= 12.5 mm

Therefore, the motor torque required to drive a load of 29N

$$T = F \times r$$

$$T = 29 \times 12.5$$

$$T = 362.5 \text{ N} - \text{mm}$$

$$T = 0.3625Nm$$

Therefore, the motor with torque of 0.3625 Nm needs to be selected.

Power of the motor required:

$$P = \frac{2\pi NT}{60}$$

Assume the Motor speed $N = 10$

$$P = 0.379 \text{ Watt}$$

Therefore, motor power of 0.379 Watt is required to drive one roller of conveyor.

Number of rollers on conveyor = 14

Therefore, total power required for 14 rollers = 14*0.379

$$= 5.315 \text{ Watt}$$

Hence Motor Chosen: 6 Watt

As there are 2 conveyors used in our project so we need to use 2 motors of 6 watt.

2. Force acting on utensil during scrubbing action –

W = Weight of Scrubber Brushes + Weight of the holder assembly.

$$W = 4.2Kg$$

As the scrubbing action required is of high speed with medium torque so we assume the motor to be selected of 60 rpm and 17 watt

$$P = \frac{2\pi NT}{60}$$

$$T = \frac{P * 60}{2\pi N}$$

$$= \frac{17*60}{2\pi*60}$$

$$T = 2.7056 Nm$$

$$T = 2705.63 Nmm$$

$$T = F * r$$

$$F = T/r$$

$$= 2705.63/75$$

$$= 36 N$$

Hence force acting on utensil while scrubbing is 36 N

3. Dimensions of Water Storage Tank -

The entire body of water storage tank is made of plain sheet G.I. which is of dimension, Length = 900mm, Height = 125mm and Width = 900mm. Volume of Water storage Tank = 100 liters.



Fig.1: The Complete Assembly



Fig.2: The Utensil Loader Mechanism



Fig.3: The Primary Conveyor Assembly



Fig.4: The Utensil Carrier Mechanism:



Fig.5: Utensils Washing By Using Speed Spray



Fig.6: View of Machine From Other Side

VII. WORKING PRINCIPLE

The figure below shows the final assembly of the project 3D modeled in a 3D modeling software.

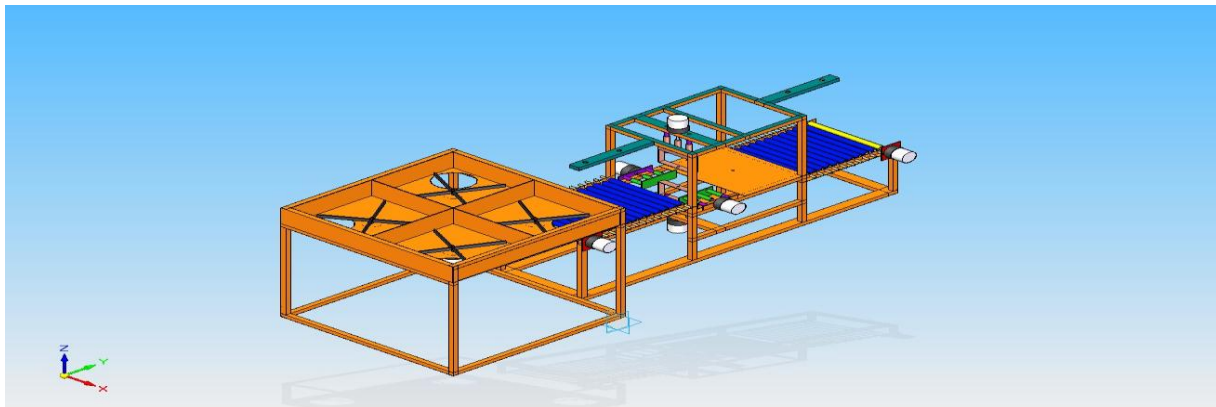


Fig.7: Virtual Complete Assembly Look

To understand the working principle let's consider the illustration of the proposed concept as given below.

AUTOMATIC UTENSIL WASHING MACHINE

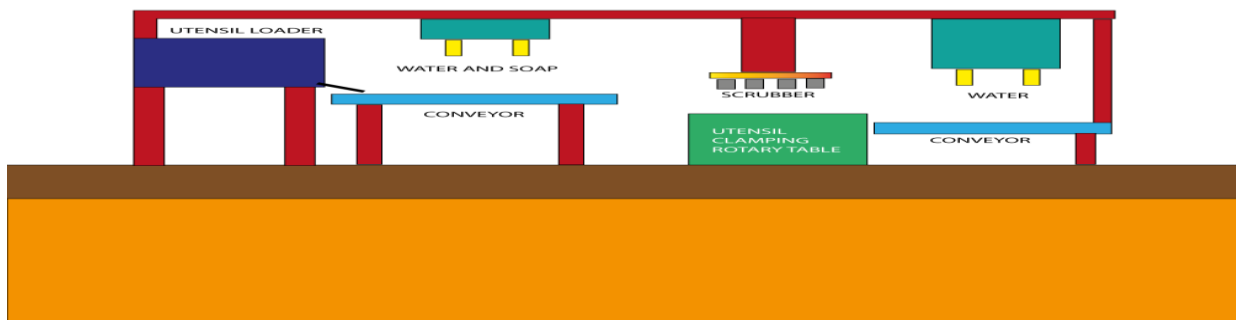
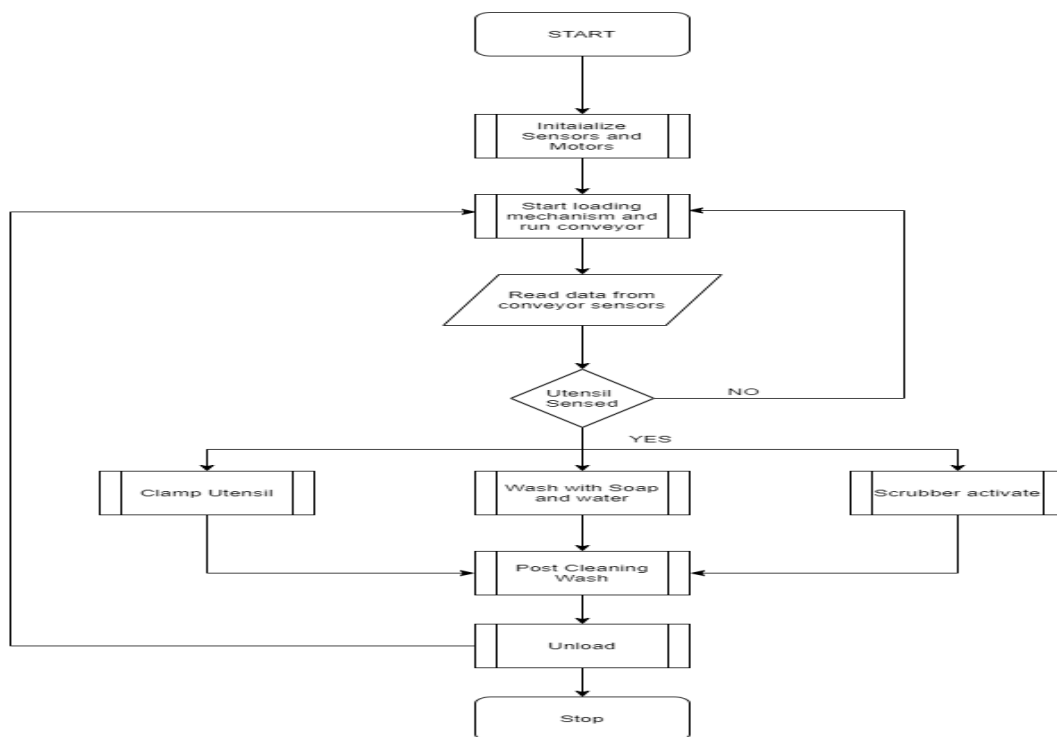


Fig.8: Block Diagram Of Machine

The figure above shows the illustration of the automated utensil washing machine. As shown in the illustrative diagram, the utensils are loaded in the loader. The loader consists of mechanisms which will load the utensils one by one on the conveyor and then pass over the first conveyor to wash the same with water and soap water. The utensils are then passed over a scrubbing table which will clean the vessels with brushes. Once the scrubbing action is complete the utensils come over to second conveyor which will wash the utensils completely clean. The entire process happens Automatically using sensor based system to sense everything from time to time.

The Figure below shows the flow chart of the working of the proposed concept which will depict the step by step operation of the same.

Flow Chart Of Sequence Of Process Done In Machine



VIII. RESULT AND DISCUSSION

This chapter details about the comparison of the project with the commercial models as well as performance analysis of the project. The result analysis of different parameters is given below and is drawn based on the tests carried out on the project:



Sl. No	Parameter	Manual	Mach Conveyor Industrial Dishwasher	Automatic utensil washer
1	Time	35	32	55
2	Man Power Required	Yes	No	No
3	Price	NA	9,50,000	50,000
4	Automatic Loader	NA	Rack Type	Single Type
5	Cleaning Pass	Multiple	Single	Multiple
6	Power Consumption	NA	13.74 KW	300-700 Watt
7	Availability	NA	Import	Local
8	Type of Utensils	All	Dishes	Dishes and Utensils

Table.1: Comparison

From the above comparison table we can conclude that the only downside of the automatic utensil washing machine is the cleaning time. Rest it is far more advantageous than other industrial grade machines and manual.

The proposed concept deals with the topic of automatic utensil washing machine. The proposed concept was fabricated and testing was carried out on the machine for the manual vs. mechanized comparison. The results of the same are discussed in this section.

- 1) The machine will automatically load the utensils one by one onto the conveyor, this reduces the labour required to manually load the utensils into the conveyor saving the labor cost.
- 2) Cost wise the machine can automatically wash utensils with a fractional cost as that compared to the labor, making it a cost saving equipment.
- 3) The machine uses multiple passes of water and soap thereby ensuring that the cleansing is thorough, comparatively, manual washing is prone to errors
- 4) If we consider time factor the time required to wash the utensils using machine is slightly higher than that done manually
- 5) The machine can operate continuously, which on the other manual counterpart is subject to fatigue

Thus the machine is beneficial than the manual approach of cleaning from cost and cleanliness point of view. The machine is slight slow or equivalent to the manual cleaning in terms of time, but the same can be overcome by making the machine operate 24 x 7

IX. CONCLUSION

The proposed concept deals with the development of automatic utensil cleaning machine. The proposed concept will automatically wash the utensils by loading them one by one onto the conveyor and washing the same. Thus the proposed concept can provide a solution to labor problem by proposing an automatic utensil washing machine as well as save the cost on multiple labors making it an efficient solution for commercial utensil cleaning.

The project has only downside of the cleaning time. The Cleaning time can be further improved in future by designing multiple cleaning mechanisms at the same time thereby reducing the cleaning time of the machine.



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