Automated Customized Cow Shed Cleaning Machine

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Abstract— The paper work is about the project that we are proposing to automate the process of cleaning the dairy farm with the press of a button. The fundamental reason as to why the concept has been chosen is the cost of the labor that is required to maintain the hygiene and the cleanliness of the cow shed. Places which are deep inside the rural belt also face the acute problem of labor shortage. The proposed model consists of a pair of guide ways which is a primary load carrying member. The rack and pinion mechanism helps in the movement of machine apparatuses along the length of the scaled down frame. Here the electric DC motor is mounted with a gear on top which drives the machine along the rack. The movement along the length of the cow shed is considered as x axis. Similarly the height of the apparatus is considered as Y axis. There are two support guide ways mounted to the bottom of the main frame machine. The brush assembly is made to move along the two guide ways with the help of a screw rod and gear drive mechanism. The screw rod set up is coupled to a controllable DC motor, where the motion of the motor can be controlled by the output of the limit switch.

Key words: Rack and Pinion, DC motor, Limit Switch and Relay, Micro-Controller, IR Sensors

I. INTRODUCTION

The fundamental reason as to why the concept has been chosen is the cost of the labor that is required to maintain the hygiene and the cleanliness of the cow shed. Places which are deep inside the rural belt also face the acute problem of labor shortage. The sheds located in the village belt may face problem of the electricity shortage but can be overcome with the help of a solar power backup. Animal welfare refers to both the physical and mental state of an animal, and how it is coping with its situation. An animal is considered in a good state of welfare if it is able to express its innate behavior, comfortable, healthy, safe, well nourished, and is not suffering from negative states such as distress, fear and pain. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling, transport and eventually, humane slaughter. Hence proper and a clean shed are a necessity to the cattle. Dairy products manufactured under unsanitary or unsuitable conditions have an increased chance of containing bacteria. Proper sanitation practices help to reduce the rate of bacterial contamination, and pasteurization greatly decreases the amount of contaminated milk that reaches the consumer.

II. OBJECTIVE

The main objectives of the project are as follows:
- To reduce the time taken to clean the shed.
- To regulate the quantity of water in-flowed to the cleaning area.
- Cost of labour is eliminated.
- Safety feature using Infrared sensor is incorporated, that triggers the machine off when the cows or people are still inside the cleaning space.

III. EXPECTED SEQUENCE OF OPERATION

The following output is expected in the sequence mentioned below:
- The brush assembly comes down on the vertical slide.
- The 1st limit switch is activated and the forward movement starts with water flushing out from the nozzle.
- During the forward stroke the brush and the wiper assembly pushes the dung into the wide hollow path in the front.
- At this Stage the 2nd limit switch is activated and the brush assembly starts moving upwards and simultaneously the water is stopped.
- Now the 3rd limit switch is activated and the upward movements stopped and back moving program is activated.
- When the final 4th limit switch is activated the movement over the guide ways stop and the programs come to a halt.
- Finally water is flushed for another 3seconds to flush out the remaining dung.
- An IR sensor is fitted on the brush assembly that will sense an object linearly to about a distance of 1.5 feet and will immediately halt the movement of the brush both in the X as well as in Y direction.

IV. CAD DRAWINGS RELATED TO THE PROJECT

The concept of cleaning machine was made using CAD software. The following are the 2D draft models of the machine.
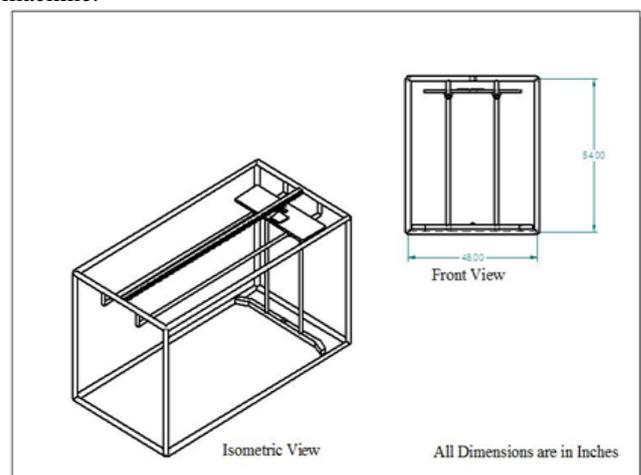

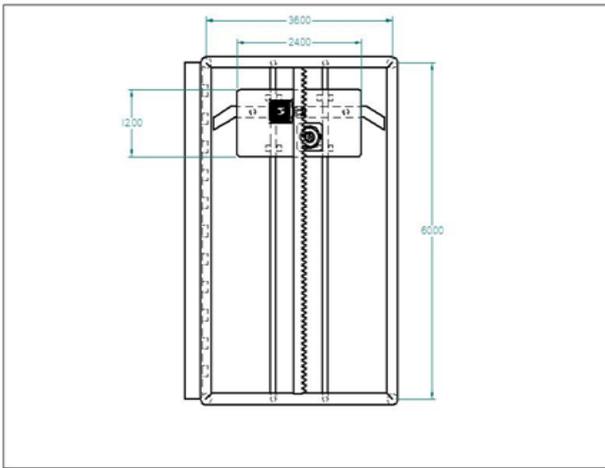Fig. 1: Isometric view and front view
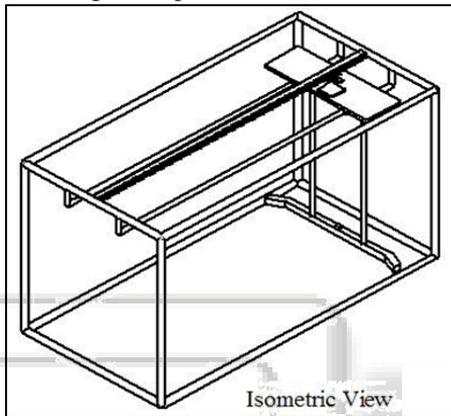
Fig. 2: Top view of the Model

Fig. 3: Isometric view

V. SPECIFICATION OF COMPONENTS USED

– Technical Specification of motor:-
Weight of motor: 1kg
Operating power required: 12v 1 amp
Operating voltage: 12v
Operating current: 1 amps
Motor speed: 80 rpm
Technical specification Of Rack:-
Material: cast iron
Module: 1.5mm
Cross-section: 75×25mm
Teeth on the rack is adjusted for 113mm
– Technical Specification Of Pinion:-
Young's Modulus $E_1 = E_2 = 1 \times 10^{11}$ N/ m^2
Circular Pitch = 4.7mm
Addendum = m =1.5 mm
Minimum dedendum = $1.157 \times m$
           = 1.7355 mm
Whole depth = $2.157 \times m$
         = 3.2355 mm
Clearance = $0.157 \times m$
         =.2355 mm
      Outside diameter = 75mm
– Technical Specification of Spur gears :-
Young's Modulus = 1×10^{11}N/m^2
Module = 1.5 mm
Outer Diameter of Gear = 132 mm
Outer Diameter of Pinion= 52 mm
Circular pitch = 4.7 mm

– Technical Specification of Screw Rod:-
Pitch diameter = 32mm
Thread density= 5/cm
Coefficient of friction= .15
For load =20 kg= 196.2 N
Torque (Raise) = .535 Nm
Torque (Lower) = -.410Nm
– Microcontroller used:- ATMEL AT89S522
Relay:- CUP V 001A605
Limit Switch: -Arcade Game Illuminated Push Button w Micro Switch.

VI. FABRICATION OF WORK

A. Brush Assembly

This sub part is called the brush assembly and here there are a pair of guide ways, and a screw rod along which the brush assembly is mounted. Also here there are two sets of brushes one is a cleaning brush and other is a wiping brush mechanism. Also here there is an MS square cross section steel pipe which is welded at one end with a water nozzle and other end is sealed. Bottom of it is drilled to allow water at a higher pressure.

Fig. 4: Brush Assembly

B. Rack and Pinion For X Axis Movement

Here this mechanism is helpful in carrying the brush assembly in the forward and backward direction. This is a mechanism that makes the brush assembly to move throughout the length of the shed. A set of 4rollers are provided in order to make the movement also hassle free.

Fig. 5: Rack and Pinion For X Axis Movement

C. Pair of Sur Gears for Upward Movement

These are a pair of spur gears that are used to control the screw rod that makes the up and down movement of the brush assembly. With a velocity reduction ratio of almost 2.53:1, the velocity is reduced and transmitted to the smaller gear that drives the screw rod.

Fig. 6: Pair of Sur Gears for Upward Movement

D. Carriage Assembly for Brushes

This carriage assembly is a prime member that acts as link between driving rack and pinion assembly and the brush assembly. This assembly is basically mounted on a pair of guide ways and is innately attached to the forward driving rack and pinion mechanism. To the Bottom of this carriage assembly the brush assembly is attached.

Fig. 7: Carriage Assembly for Brushes

E. Micro-Controller and Its Assemblies

This is the heart of the system. Along with the limit switches it acts as central brain that co-ordinates with the other organs for the perfect coordination of the system. Here there are limit switches that provide the positional output to the micro-controller assembly. The controller through the relays actuated the required motors at right intervals and also ensures that the switching action of the pump is also in a right sequence. Also IR sensors are placed that will pause the entire operation if there is an obstacle detected.

Fig. 8: Micro-Controller and Its Assemblies

F. Limit Switch

A mechanical limit switch interlocks a mechanical motion or position with an electrical circuit. A good starting point for limit-switch selection is contact arrangement. The most common limit switch is the single-pole contact block with one NO and one NC set of contacts; however, limit switches are available with up to four poles. Limit switches also are available with time-delayed contact transfer. Other limit switch contact arrangements include neutral-position and two-step.

G. Rack And Pinion

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.

For example, in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and forces a train up a steep slope. For every pair of conjugate involute profile, there is a basic rack. This basic rack is the profile of the conjugate gear of infinite pitch radius (i.e. a toothed straight edge).

H. IR Sensor

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.

All objects which have a temperature greater than absolute zero (0 Kelvin) possess thermal energy and are sources of infrared radiation as a result. Sources of infrared radiation include blackbody radiators, tungsten lamps and silicon carbide. Infrared sensors typically use infrared lasers and LEDs with specific infrared wavelengths as sources.

A transmission medium is required for infrared transmission, which can be comprised of either a vacuum, the atmosphere or an optical fibre. Optical components, such as optical lenses made from quartz, CaF2, Ge and Si, polyethylene Fresnel lenses and Al or Au mirrors, are used to converge or focus the infrared radiation. In order to limit spectral response, bandpass filters can be used.

Next, infrared detectors are used in order to detect the radiation which has been focused. The output from the detector is usually very small and hence preamplifiers coupled with circuitry are required to further process the received signals.

I. Micro Controller

A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. In modern terminology, it is a system on a chip or SoC. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM.

Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical

devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.

Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. Some microcontrollers may use four-bit words and operate at frequencies as low as 4 kHz, for low power consumption (single-digit mill watts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just Nano watts, making many of them well suited for long lasting battery applications.
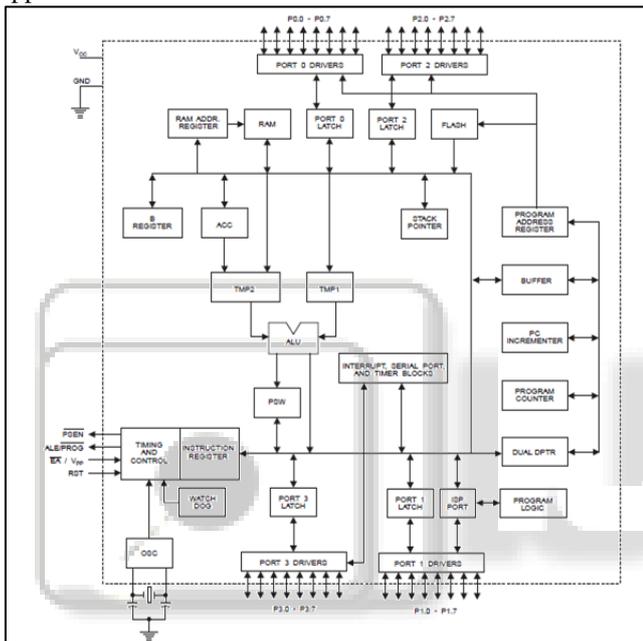

Fig. 9: Micro controller

J. DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. 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. Small DC motors are used in tools, toys, and appliances.

The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills.

K. RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other

operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two contacts in the relay pictured).

The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. The armature is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

L. Power Supply Unit

A power supply is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.
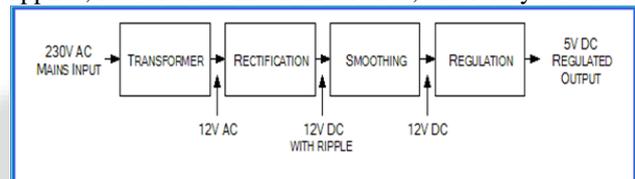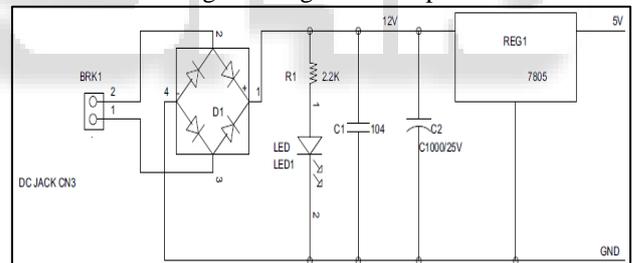

Fig. 10: Regulated Output

Fig. 11: Regulator circuit

VII. CONCLUSION

The design gives comfort and easy cleaning for the farmers of their cattle shed. As compared to the present day design this design has many more advantages as it helps in lifting the cow dung. It is a quick process consuming less time. And there is no consumption of fuel.

This design is made by keeping view of cheaper cost for fabrication and maintenance and Environmental Friendly. Providing easy and quick cleaning for the farmers is an important criterion.

As designing is a pre-process in every work this model is done in Solid edge v20 and this model overcomes many disadvantages of presently available model.

This cleaning machine is cost effective equipment. Since electric motor is used for cleaning no cost for fuel consumption. Design and safety has been given utmost importance keeping view of the comfort of the user and also the use of the motor is eco-friendly. Design shows that even

the adjustability can be achieved without loss in features. Each component was thoroughly tested in order to provide results for the best product possible at most reasonable price.

VIII. FUTURE SCOPE

- Since the process consists of pure mechanical linkages efficiency is less. A lot of work can be done in this regard.
- A lot of other motion transmitting and load carrying technologies such as Hydraulics, Pneumatics, Servomotors can be used for precision and efficient cleaning.
- Routing the electrical systems through PLC systems and Sensorics can greatly improve the efficiency and quality of the electrical systems.
- The wastes that are given out after the cleaning process can be routed to a biogas plant.
- Stationary nozzles can be a better choice, and work can be done on this

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