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CLAY CUTTING MACHINE

Sundar Ganesh C S[1],Roopika R[2], P.C Niveditha[3],Vaishnavi P[4]

[1] *Assistant Professor, Department of Robotics and Automation Engineering, PSG College of Technology, Coimbatore*

[2,3,4] *UG Student, Department of Robotics and Automation Engineering, PSG College of Technology, Coimbatore*

Abstract:- *The objective of the paper is to automate the process of clay cutting manufacturing of bricks used for construction purposes. Clay cutting happens in the latter stages of cutting the section into individual brick pieces. Problems such as low accuracy, long time consumption and heavy clay accumulation arise in manual clay cutting.For the above concerned problems, we proposed a cost-effective solution using Totally Integrated Automation and Solid Works. The process is facilitated by the use of a double acting pneumatic cylinder which is used to severe the clay at a preset required length. Also a roller type conveyor which is controlled by a 1 hp AC motor is used in transfer of the cut clay pieces to the next stage. The automation of the process is carried out with the use of proximity sensors. This enables us to reduce power consumption and wastage. It also improves and maintains the consistent quality of the bricks. Using Automation enables us to get continuous production of the bricks with proper maintenance.In this paper Siemens PLC S7 1200 along with Siemens Totally Integrated Automation portal is used. It also provides a SCADA based HMI interface for the easy usage of the operator. The project was carried out at Millennium Machine Works, Coimbatore.*

KeyWords:- *Clay Cutting machine, Industrial Automation, Solid works, Programmable Logic Controllers*

I. INTRODUCTION

The manufacture of bricks used for construction purpose is an age old process. It involves a huge set-up space and numerous labourers to do the tedious task of mixing the sand, moulding the bricks and drying them. The need for a fully automated plant for this process is inevitable in today's world of fast growing infrastructure. Hence, according to the needs demanded by the traditional brick manufacturing companies, a fully automated system has been suggested for the same. The fundamentals of brick manufacturing have not changed over time. However, technological advancements have made contemporary brick plants substantially more efficient and have improved the overall quality of the products.

A more complete knowledge of raw materials and their properties, better control of firing, improved kiln designs and more advanced mechanization have all contributed to advancing the brick industry. The quality of brick is important for a successful brick making program. Different aspects of the brick making process can be improved easily in order to increase the quality of brick.

Technical problems involved in brick making is that to identify the faulty brick or batch of bricks.in reality small scale brickmakers often face many problems such as fuel scarcity,time management etc. the moulding of bricking manually leads to less perfection so automation is required more in this field.An oval or circular trench, 6–9 meters wide, 2-2.5 meters deep, and 100–150 meters in circumference, is dug. A tall exhaust chimney is constructed in the centre. Half or more of the trench is filled with "green" (unfired) bricks which are stacked in an open lattice pattern to allow airflow. The lattice is capped with a roofing layer of finished brick.

In operation, new green bricks, along with roofing bricks, are stacked at one end of the brick pile. Cooled finished bricks are removed from the other end for transport. In the middle the brick workers create a firing zone by dropping fuel through access holes in the roof above the trench.The process of clay cutting has been manual in the traditional brick making. They are done with the help of certain mechanical setup which are operated by a labourer. The one time output of these machines is one to two bricks per cut. They also consume relatively more time and effort. Some samples of a manual clay cutting machines are shown in fig.1and fig.2

Fig. 1 Manual clay cutting machine

The clay mixture is fed into the cutter manually and a lever action is done to have the mould cut the clay mixture into individual brick parts. In addition to the increased consumption of time and labour, this also has low accuracy, as the accuracy depends on the amount of force exerted by the human, which is subjected to change.

Fig. 2 Block Brick making machine

Because clays shrink during both drying and firing, allowances are made in the forming process to achieve the desired size of the finished brick. Both drying shrinkage and firing shrinkage vary for different clays, usually falling within the following ranges:

• Drying shrinkage: 2 to 4 percent

• Firing shrinkage: 2.5 to 4 percent

Firing shrinkage increases with higher temperatures, which produce darker shades. When a wide range of colors is desired, some variation between the sizes of the dark and light units is inevitable. To obtain products of uniform size, manufacturers control factors contributing to shrinkage. Because of normal variations in raw materials and temperature variations within kilns, absolute uniformity is impossible. Consequently, specifications for brick allow size variations.

II. DESIGN

The factors of cost efficiency and environment of the machinery has been taken into consideration for the design suggested. The design uses a double acting pneumatic cylinder, an AC motor, a gear system, a roller conveyor belt, proximity sensors and a back-up air cylinder. The system is controlled by a Programmable Logic Controller.A roller conveyor belt is set up at the end of the clay tube. As the clay strip comes out, it slides on the roller belt. Near the desired length of cut, two proximity sensors are placed. When the clay strip activates the proximity sensor, a signal is sent to the double acting pneumatic cylinder to move forward.The Cutting equipment attached to the cylinder cuts the clay strip. Immediately, the clay strip is accelerated to the next stage by the action of an AC motor attached to the latter portion of the conveyor belt. This way, the next clay strip continues the cycle by initiating the cut via reverse movement of the cylinder.Fig.3 shows the block diagram of the process.

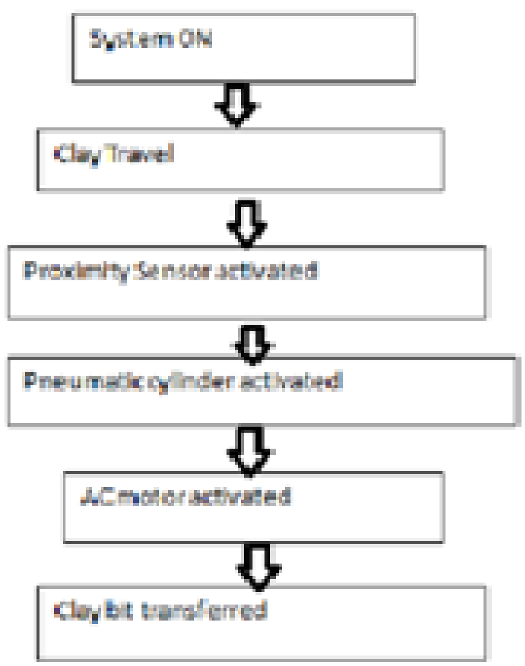

Fig. 3 Flow Diagram of the Process

The sequence of action taking place in the procedure is given below,

- The system is ON
- Clay strip travels on the roller belt due to its inertia
- Proximity sensor activated
- Signal sent, pneumatic cylinder moves forward and cuts
- AC motor is activated
- Clay bit is transferred to the next stage
- The cycle continues

  Thus the process is carried on to the subsequent stages of clay cutting.

III. Hardware

A. Shaded-pole motor

A common single-phase motor is the shaded-pole motor and is used in devices requiring low starting torque, such as electric fans, small pumps, or small household appliances. In this motor, small single-turn copper "shading coils" create the moving magnetic field. Part of each pole is encircled by a copper coil or strap; the induced current in the strap opposes the change of flux through the coil. This causes a time lag in the flux passing through the shading coil, so that the maximum field intensity moves across the pole face on each cycle. This produces a low level rotating magnetic field which is large enough to turn both the rotor and its attached load. As the rotor picks up speed the torque builds up to its full level as the principal magnetic field is rotating relative to the rotating rotor.

A reversible shaded-pole motor was made by Barber-Colman several decades ago. It had a single field coil, and two principal poles, each split halfway to create two pairs of poles. Each of these four "half-poles" carried a coil, and the coils of diagonally opposite half-poles were connected to a pair of terminals. One terminal of each pair was common, so only three terminals were needed in all.

The motor would not start with the terminals open; connecting the common to one other made the motor run one way, and connecting common to the other made it run the other way. These motors were used in industrial and scientific devices.

An unusual, adjustable-speed, low-torque shaded-pole motor could be found in traffic-light and advertising-lighting controllers. The pole faces were parallel and relatively close to each other, with the disc centred between them, something like the disc in a watthour meter. Each pole face was split, and had a shading coil on one part; the shading coils were on the parts that faced each other. Both shading coils were probably closer to the main coil; they could have both been farther away, without affecting the operating principle, just the direction of rotation.

Applying AC to the coil created a field that progressed in the gap between the poles. The plane of the stator core was approximately tangential to an imaginary circle on the disc, so the travelling magnetic field dragged the disc and made it rotate.The stator was mounted on a pivot so it could be positioned for the desired speed and then clamped in position. Keeping in mind that the effective speed of the travelling magnetic field in the gap was constant, placing the poles nearer to the centre of the disc made it run relatively faster, and toward the edge, slower.

B. Pneumatic Double Acting Cylinder

Pneumatic systems used extensively in industry are commonly powered by compressed air or compressed inert gases. A centrally located and electrically powered compressor powers cylinders, air motors, and other pneumatic devices. A pneumatic system controlled through manual or automatic solenoid valves is selected when it provides a lower cost, more flexible, or safer alternative to electric motors and actuators. Pneumatics also has applications in dentistry, construction, mining, and other areas.

Pneumatic cylinder(s) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion.Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved.Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage.

Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. For example, in the mechanical puppets of the Disney Tiki Room, pneumatics are used to prevent fluid from dripping onto people below the puppets.

Due to the forces acting on the cylinder, the piston rod is the most stressed component and has to be designed to withstand high amounts of bending, tensile and compressive forces. Depending on how long the piston rod is, stresses can be calculated differently. If the rods length is less than 10 times the diameter, then it may be treated as a rigid body which has compressive or tensile forces acting on it.

However, if the length of the rod exceeds the 10 times the value of the diameter, then the rod needs to be treated as a column and buckling needs to be calculated as well as discussed in fig. 4

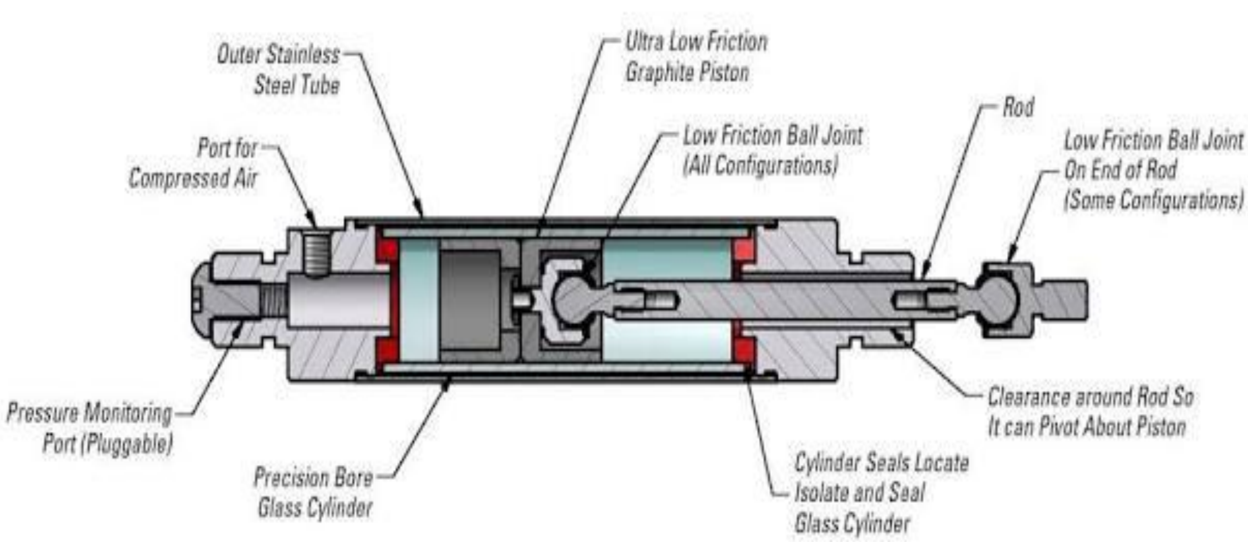

Fig. 4Cross Sectional View of a Pneumatic Cylinder

Although the diameter of the piston and the force exerted by a cylinder are related, they are not directly proportional to one another. Additionally, the typical mathematical relationship between the two assumes that the air supply does not become saturated. Due to the effective cross sectional area reduced by the area of the piston rod, the instroke force is less than the outstroke force when both are powered pneumatically and by same supply of compressed gas.

C.Proximity Sensor

A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Some sensors can also have an impact on what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer.

Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as microsensors using MEMS technology. In most cases, a microsensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches as shown in fig.5

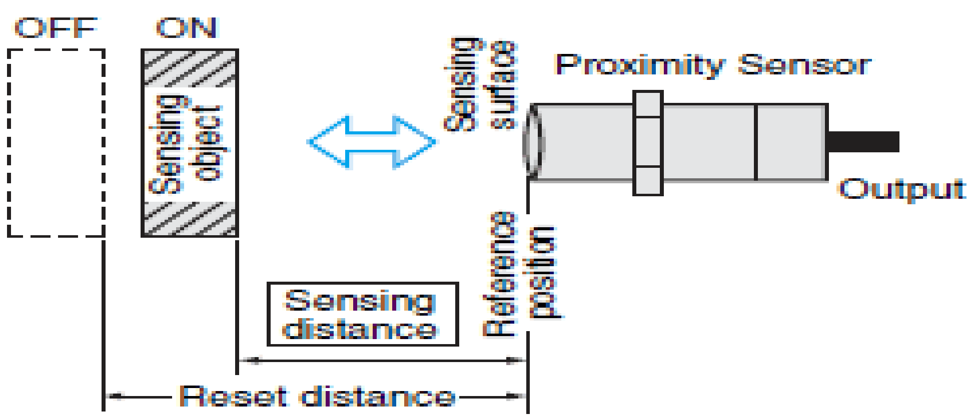

Fig. 5 Working of a Proximity Sensor

A **proximity sensor** is a sensor able to detect the presence of nearby objects without any physical contact.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.

The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance.Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

Proximity sensors are commonly used on smartphones to detect (and skip) accidental touchscreen taps when held to the ear during a call. They are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors, and motors that use sleeve-type bearings as shown in fig. 6

Fig. 6 Proximity Sensor

IV . CONTROLLER

The system used to electrically control the entire process is a controller. Here, the controller used is a Programmable Logic controller (PLC). The chosen brand of controller is SIEMENS. The SIEMENS PLC meekly gives out electrical signals for the pneumatic cylinder’s control using an electric solenoid valve. It controls the timing of the subsequent steps in the process. Also an alarm is given out in case of a mal function or emergency. The controller makes it easier for the worker to control the process.

A. SIEMENS PLC DESCRIPTION

Automation solutions must be compact, scalable and flexible. S7-1200 CPUs are available as standard and failsafe versions. They are scalable in terms of their performance and are equipped with integrated IOs, inte-grated PROFINET interface for programming, HMI connections, distributed IOs and distri-buted drive architectures. The S7-1200 can be optimally adapted to your individual requirements by means of pluggable signal modules and communication modules

Inputs/outputs:

- 14 digital inputs (12 V DC)
- 10 digital outputs (12 V DC, 400 mA)

- 4 analog inputs, 11 bit, 20 ms, (±10 V, 0 – 10 V, ±20 mA, 0/4 – 20 mA), 1 Pt100 input
- 2 analog outputs, (±10 V, 0 – 10 V, ±20 mA, 0/4 – 20 mA)

B. PROGRAMMING

The programming for FESTO PLC is given in the form of ladder logic. Then it is interfaced with the Human Machine Interface (HMI). The screen shots of the program is shown below in Fig. 7 and Fig. 8

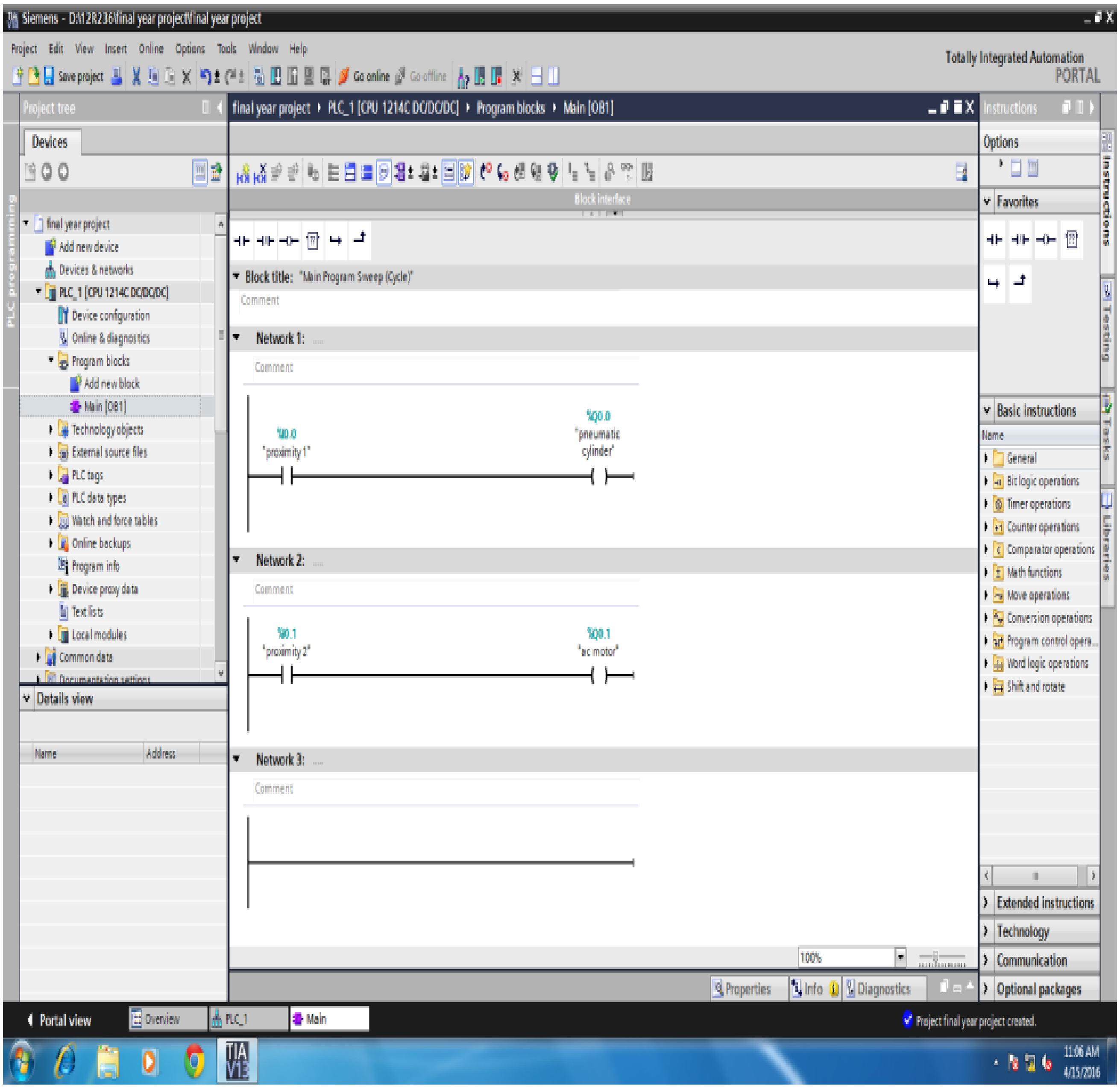

Fig. 7 Ladder Logic of the problem

The human machine interface is useful for even the uneducated workers as it contains the pictorial representation of the components found in the process.

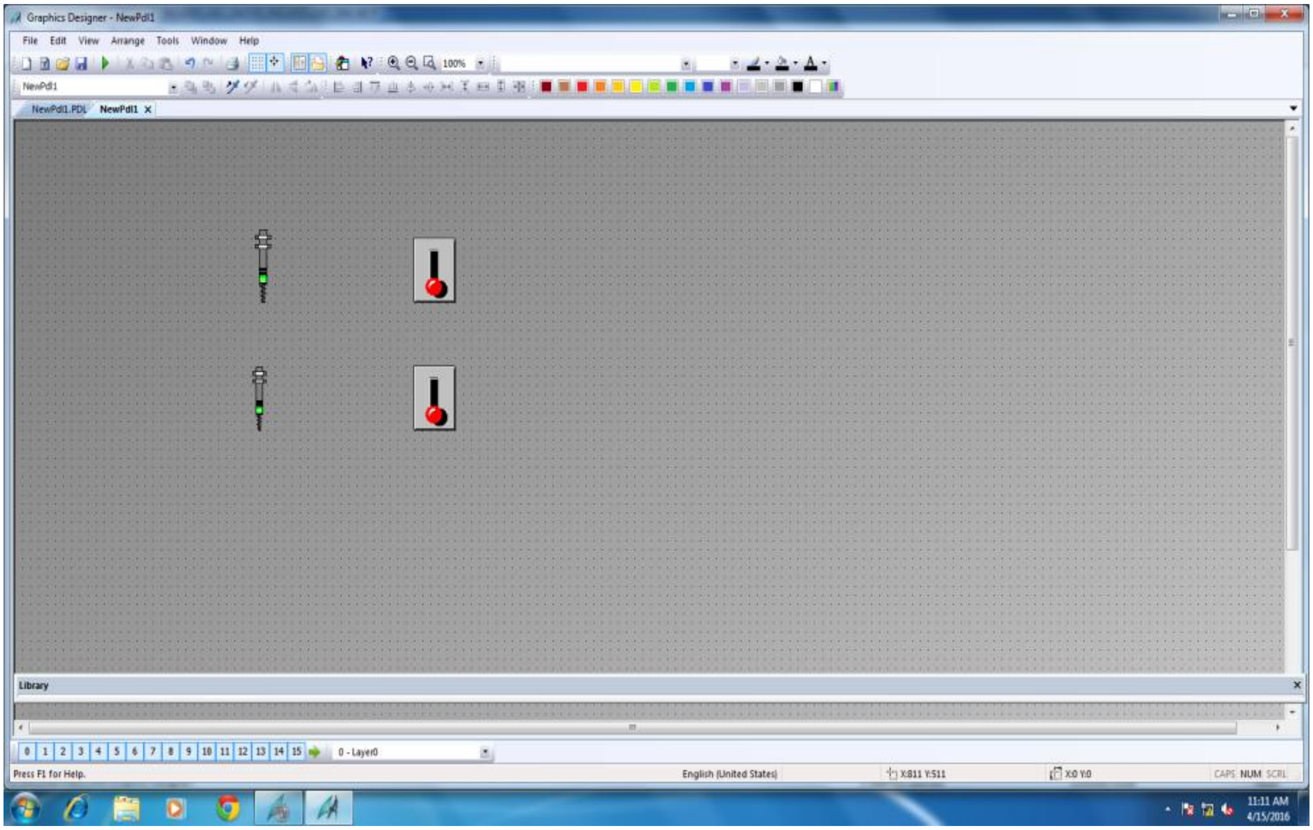

Fig. 8 Human Machine Interface screen

V. RESULTS

The first stage of clay cutting has been designed and simulated in 3-D using Solid works software.

SolidWorks (stylized as SOLIDWORKS) is a solid modeling computer-aided design (CAD) and computer-aided engineering(CAE) software program that runs on Microsoft Windows. SolidWorks is a solid modeler, and utilizes a parametric feature-based approach to create models and assemblies. The software is written on Parasolid-kernel.Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allows them to capture design intent.

SolidWorks also includes additional advanced mating features such as gear and cam follower mates, which allow modeled gear assemblies to accurately reproduce the rotational movement of an actual gear train.

Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed. The drawing module includes most paper sizes and standards.

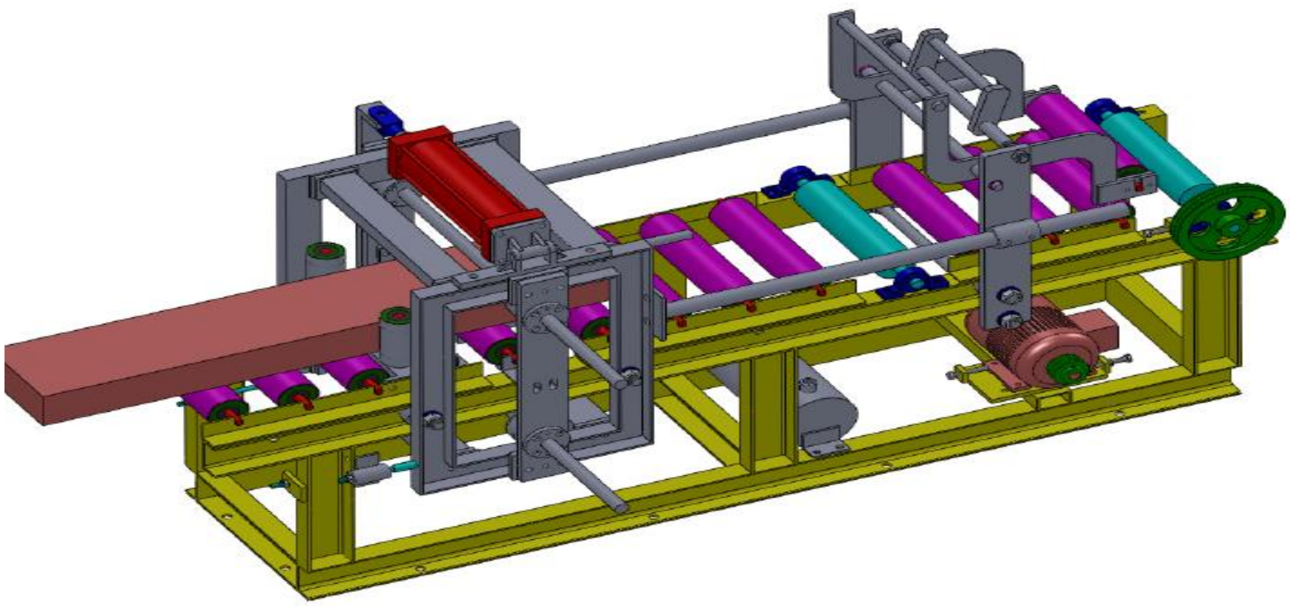

Fig. 9 Clay Cutting Simulated image - Stage 1

VI. CONCLUSION

The need of automation even in small scale industries is becoming increasingly instrumental in these days of labour scarcity and growing demands. The method used to form a brick has a major impact on its texture.Sand-finished surfaces are typical with molded brick. A variety of textures can be achieved with extruded brick. Brick manufacturers address sustainability by locating manufacturing facilities near clay sources to reduce transportation, by recycling of process waste, by reclaiming land where mining has occurred, and by taking measures to reduce plant emissions. Most brick are used within 500 miles of a brick manufacturing facility. The project of the 1st stage of clay cutting has been successfully simulated. This process, its logic, program, design and working can be incorporated in the fully automated brick manufacturing process.The brick industry recognizes that the stewardship of our planet lies in the hands of our generation. The goal is to continually seek out innovative, environmentally friendly opportunities in the manufacturing process and for the end use of clay brick products. As demonstrated over time, we are committed to manufacturing products that provide exceptional energy efficiency, durability, recyclability, and low maintenance with minimal impact on the environment from which they originate. We will ensure that our facilities meet or exceed state and federal environmental regulations, and we will continue to partner with building professionals to help them in using our products to create environmentally responsible living and working spaces for today’s and future generations.

VII. REFERENCES

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