ROBOTIC SYSTEM FOR AUTOMATIC POURING OF MOLTEN METAL USING PLC

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Abstract - *Foundry industries in developing countries suffer from poor quality and productivity due to involvement of number of process parameter. Even in completely controlled process, defect in casting are observed and for this automatic pouring of molten metal robotic system was introduced. As a result of different analysis and calculations an appropriate design was developed. The robot follows a linear path and is being controlled using PLC. The study also includes PLC programming and Electrical connections for the same. Authors would like to give well analyzed conclusion for the proposed problems.*

Key Words: **PLC, Automatic, Mechatronics, Robots, Vehicle, Castings**

1. INTRODUCTION

Foundry industries in developing countries suffer from poor quality and productivity due to involvement of number of process parameter. Even in completely controlled process, defect in casting are observed and hence casting process is also known as process of uncertainty which challenges explanation about the cause of casting defects. In order to enhance the productivity and reduce the problems related to casting, the study is aimed in the research work. This study aims to introduce new trends in foundries and put forward various advantages of using robotics and automation in foundries by in-depth by analysis. In this paper an attempt has been made to list different types of advanced technologies used in foundries. This paper also aims to provide correct guideline to various industries to apply robotics and automation in their foundries.

2. PROBLEM DEFINATION

After visits to various foundries 'Bhavani industry, Kolhapur' was selected for designing and developing a prototypic solution. As per the survey the foundries faced the following hindering problems:

1. Workers safety and health are endangered due to use of traditional system
2. Manual process is less efficient and cumbersome for the workers.
3. Rejection rate is higher.
4. Installation of conveyor system is costlier and required more space.

3. CALCULATION

3.1 Total Weight:

Referring to the Catia Design Software total weight was found to be 64kg with molten metal it is considered to be 100kg (approx.).

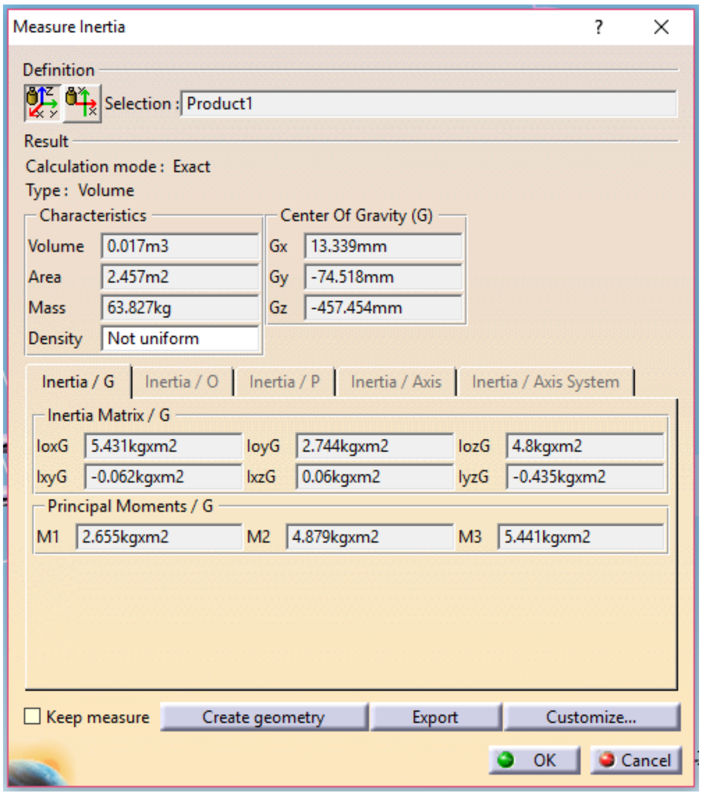

Fig 1. CATIA Measure Inertia dialog box.

3.2 Motor Calculation:

Total weight = 100kg

Supported by 4 wheels:

100/4= 25 kg

Considering maximum coefficient friction as e=1

Traction force = 25kg

Radius of wheel = 3 cm

Therefore, traction torque =75kg-cm

Required motors torque = 75kg-cm

Considering factor of safety = 1.2

We have selected motor with 92kg-cm torque considering factor of safety as 1.2

4. DESIGN

The CAD modelling software used for designing is CATIA V5.

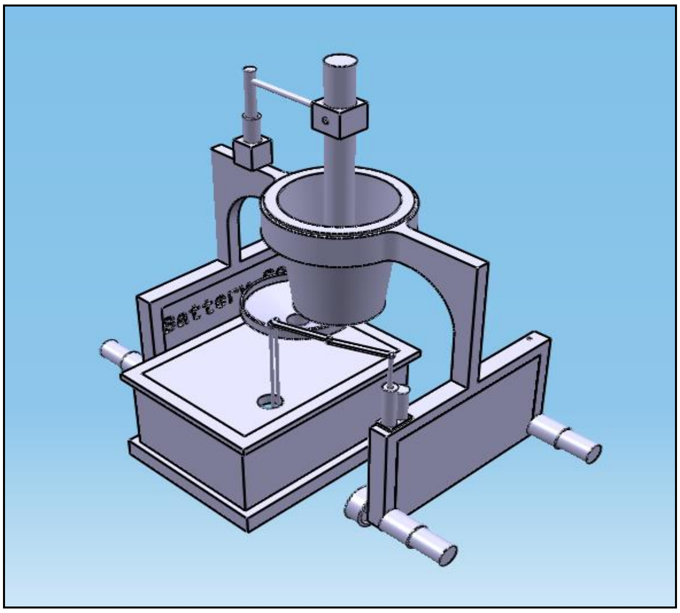

Fig 2. Isometric view of a setup.

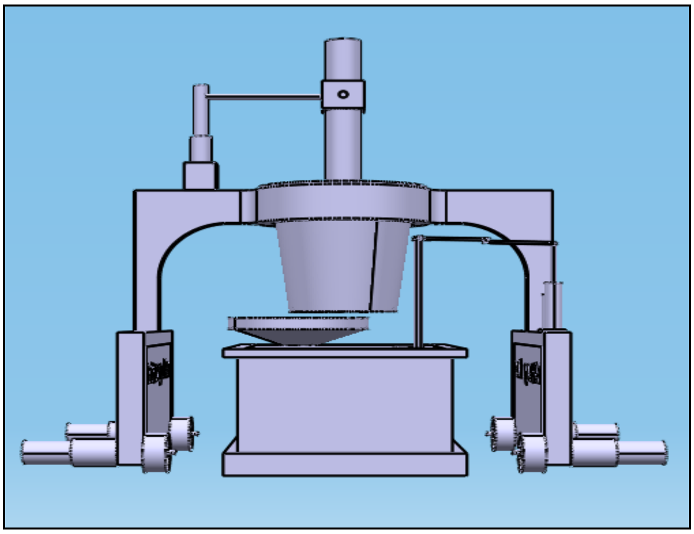

Fig 3. Front view of the setup.

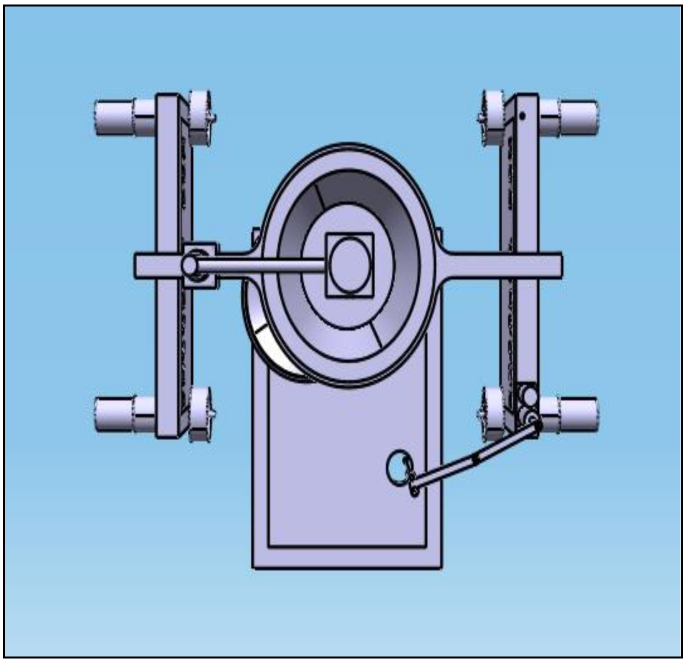

Fig 4. Top View of the setup.

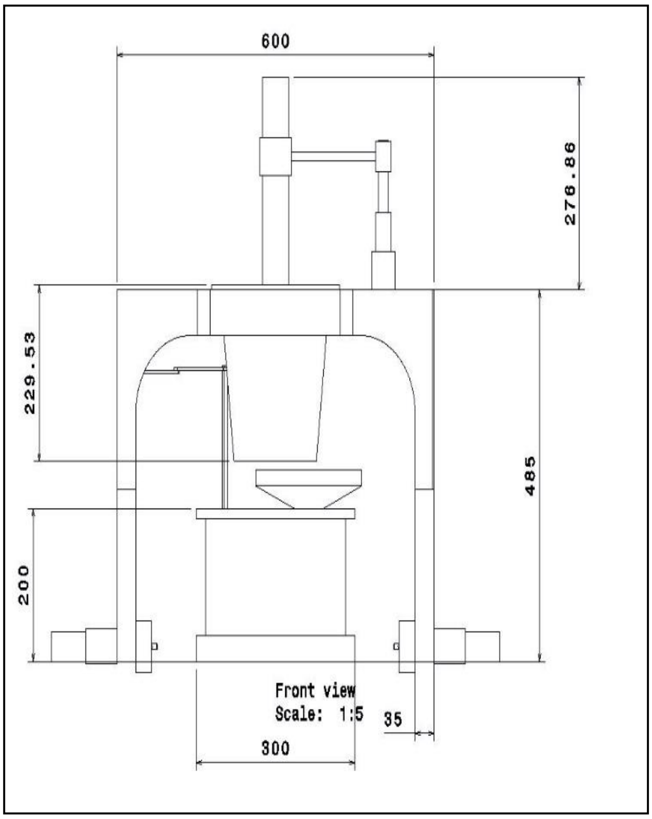

Fig 5. Front view of the setup with dimensions.

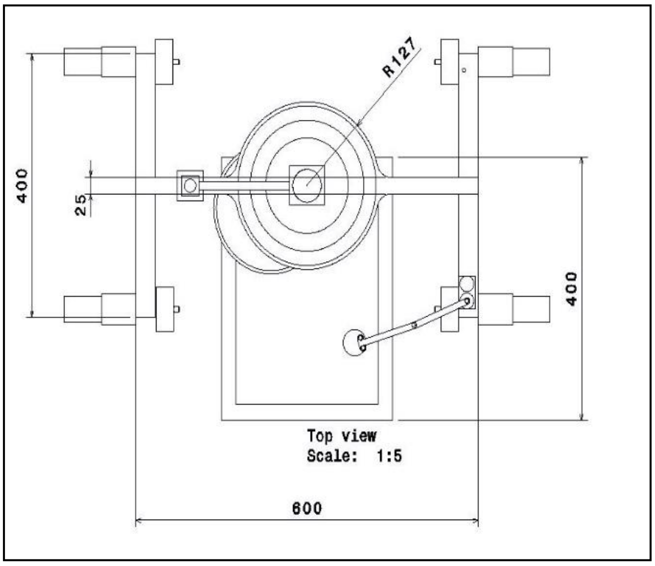

Fig 6. Front view of the setup with dimensions.

5. PROCESS DESCRIPTION.

1. When start button is pressed 4 wheel motors are switched on.
2. The robot moves over a mould and it is sensed by a sensor called as proximity sensor.
3. Upon sensing the mould all the 4 motors are turned off. Thus the robot stops.
4. Then an actuator relay is triggered called as cork uplift relay.
5. After this second actuator relay called as "riser down push relay" is turned ON.
6. There is pre-existing sensor called as riser sensor. When this sensor is turned ON two relays are triggered named as:-
   a. Riser uplift relay
   b. Cork down push relay.
7. Once this step is done, the robot moves ahead using the 4 wheel motors till the new mould is detected and the cycle repeats itself.
8. There is counter which counts the number of mould. After 10 count the counter is triggered and "4 wheel reverse relays" are turned ON which is stopped after a switch is pressed

6. LOGIC DIAGRAM

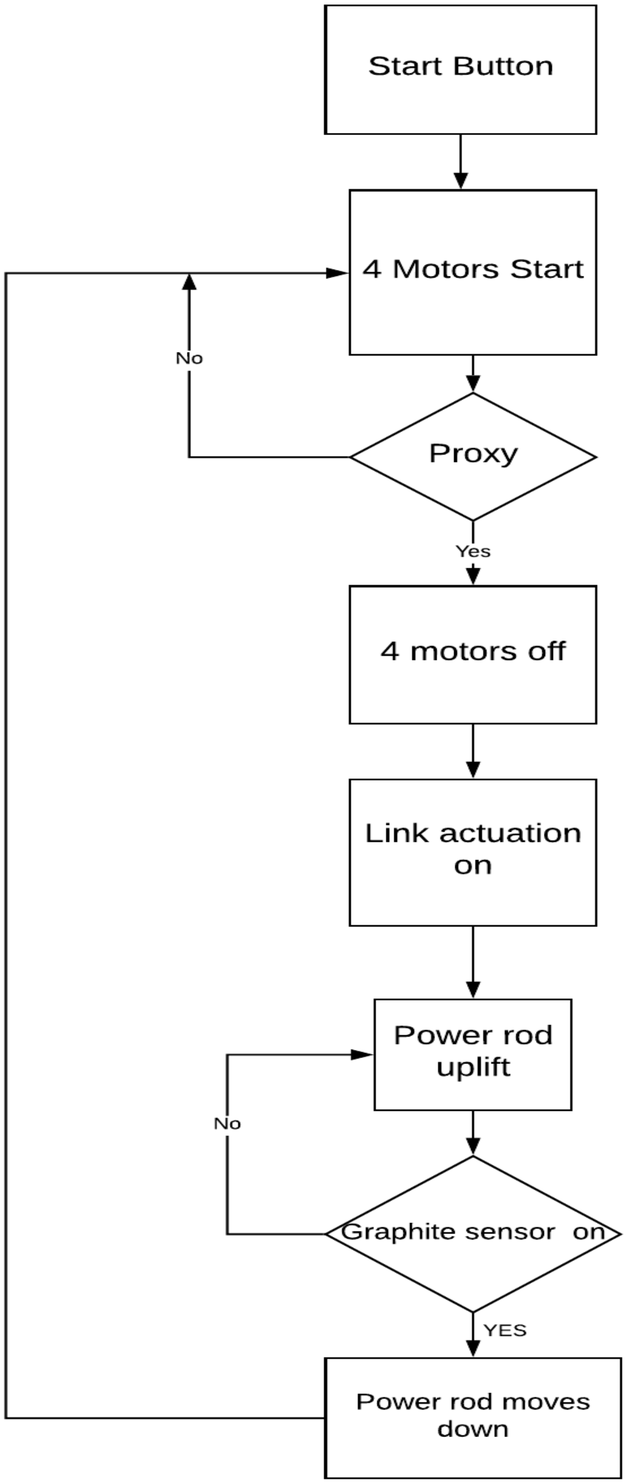

Fig 7. Logic Diagrams.

7. PLC PROGRAM

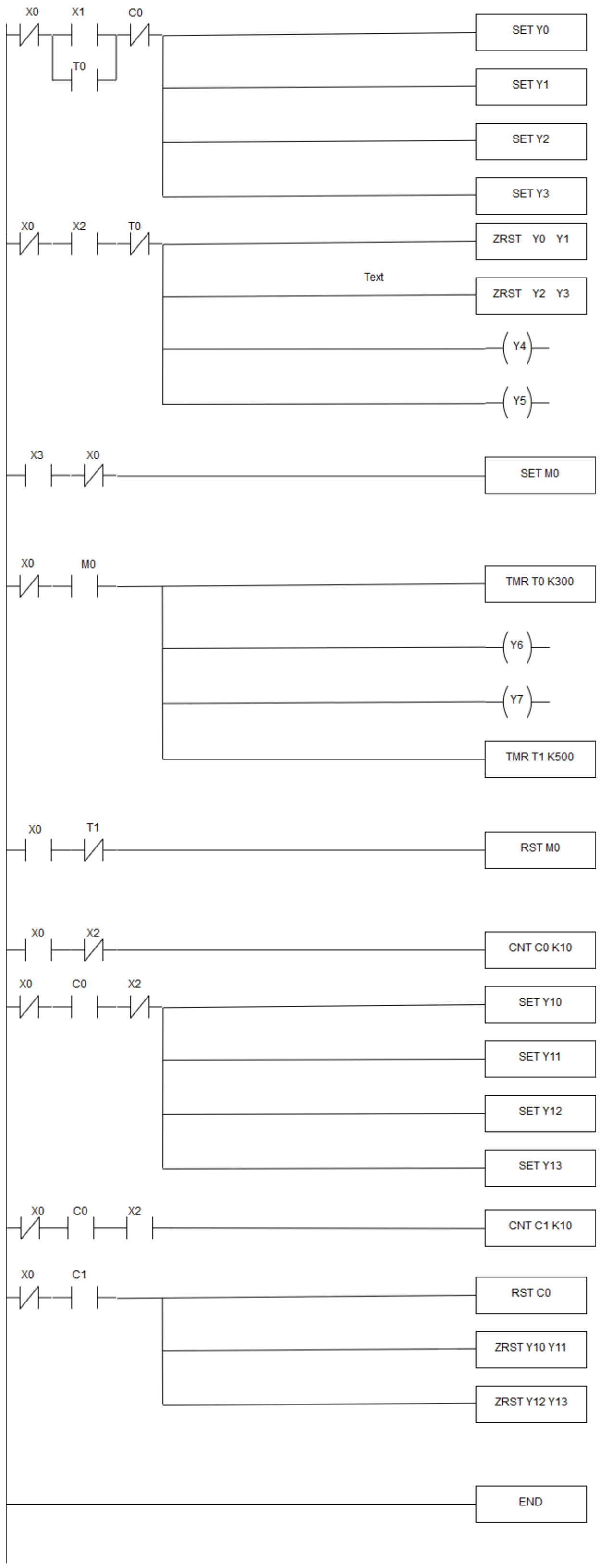

Fig 8. PLC program.

8. ELECTRICAL CONNECTION DIAGRAM.

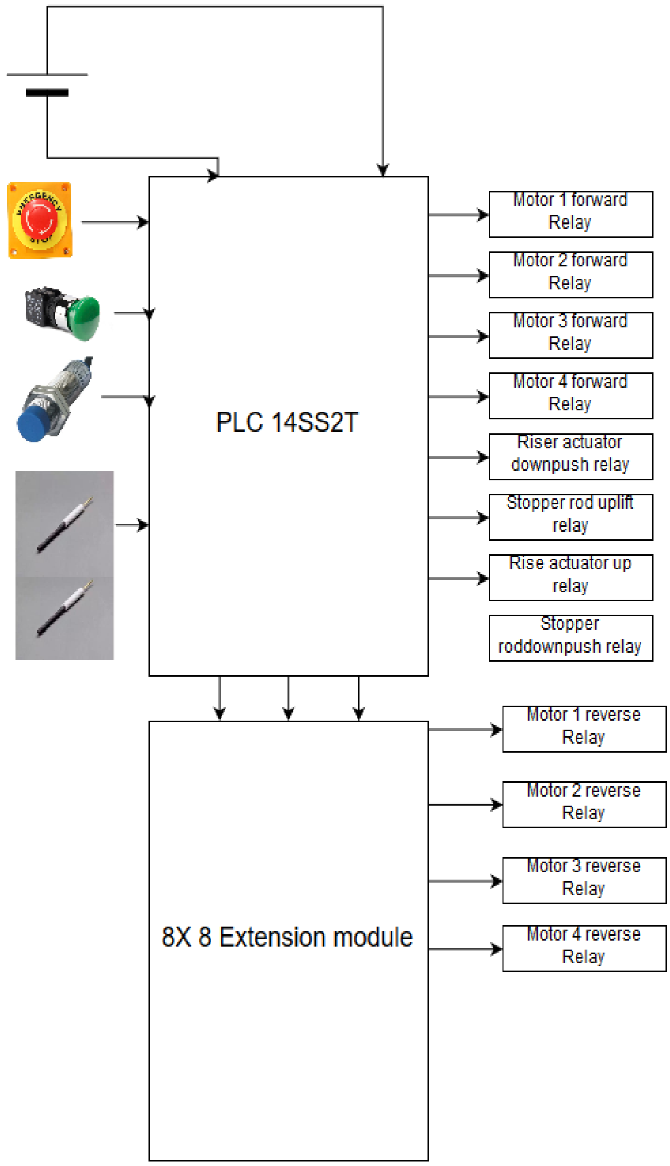

Fig 9. Electrical connection diagram.

9. ADVANTAGES

After a successful research following advantages were noted of the resulting prototype:

1. User friendly system
2. Less rejection rate of castings.
3. No over pouring of molten metal.
4. Less wastage.
5. Less initial cost as compared to the conveyor system.
6. Improved human safety and working condition.

10. CONCLUSIONS

Authors have carried out a research on foundry automation with an aim to understand the latest developments around the world. Researchers have designed a low cost, and efficient small robot to automate the foundry activities for small scale industries n Kolhapur district.

This paper concludes that the foundry automation is partially successful in structured and controlled environments and lot of research is in progress to full foundry automation activities and some significant progress is also achieved. Instead of using one sophisticated and high cost machinery, it is recommend using a fleet of small scale, special purpose robots in collaborative approach.

This paper has set out a vision of how production of castings should be automated. Although existing manned operations can be efficient over large areas there is a potential for reducing the scale of treatments with autonomous machines that may result in even higher efficiencies. The development process may be incremental but the overall concept requires a paradigm shift in the way we think about mechanization for cast component production that is based more on material properties and novel ways of meeting them rather than modifying existing techniques.

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