Development of Advanced Weighing System for Self Loading Concrete Mixer

Shaniya Shaji C[1]
Select Dept, VIT University
Guided by: Prof Ramesh Babu N
Vellore, Tamil Nadu 632014

Abstract- **The Self Loading Mixer is a standalone machine. This machine self loads required quantity of Aggregates, Cement & Water into the drum. The pressure transducers are used for weighing solids and flow meter for liquids. Once the materials are weighed, the process of mixing starts in-line with transportation and discharges to the desired location. Hence the mixing time reduces.**

The newly developed prototype utilizes a load cell based Weighing technique for the solids which improves the accuracy of the system. This is achieved with the help of advanced intelligent weighing Modules called SIWAREX. The device is controlled and monitored by PLC and HMI.

Keywords:Self Loading Mixer, Load cell, SIWAREX, PLCand HMI.

1. INTRODUCTION

A.Overview

The Self Loading Mixer is a machine which is utilised in construction field for producing high quality concrete. It was invented in the early 1980s by Bruce D. Norlie, Robert N. Norlie. The commonly used method for weighing the materials is using pressure transducers. Here the weighing is done with the change in pressure with respect to the weight loaded into the lifting bucket. We couldn't able to achieve accuracy with this method because the pressure is not only proportional to the loaded material but also proportional to the engine RPM. Hence it is very difficult to achieve better accuracy. So in this paper some better methods are proposed to overcome the issues related to weighing. The paper also focuses in developing a completely automated system for weighing using Programmable Logic Controller.

B. Literature Review

A model has been proposed by Gilson and Wagner [1] which needs some arrangement to shovel the materials into the drum and further it is taken to the loading position. The main drawback of this method is that it needs some external assistance for shovelling the materials into the mixer drum.

Bolt and Wagner [2] has put forward many types of setup which have been mounted on tractors. The limitations of this kind of model are that it can be used for stationary purposes or for large scale production. There occurs the necessity of self-driven single operator based convenient tractors.

2. PROPOSED SYSTEM OVERVIEW

Fig 1. Self Loading Mixer

A. SIMATIC S7-1200

The S7-1200 is an optimal solution for monitoring and controlling many applications because of its hefty instruction set, precise design and versatile configuration [3]. The CPU was built with high end microprocessor. The Built-in Digital and Analog Inputs & Outputs with the PROFINET Communication ports enables the device so powerful. The application program logic was developed and programmed into the PLC to make it work for the desired application.
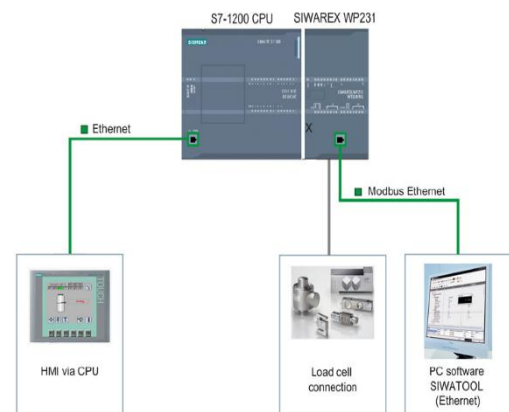

Fig 2. System Overview

The various logics involved in this program are Boolean Logic, Counters, Timers, Complex Math Logics etc. The CPU receives the input and the output is changed accordingly to the loaded program. The HMI acts as a medium to communicate between the PLC and Human.

B. SIWAREX module

SIWAREX is a multifaceted and open ended electronic weighing system. It incorporates all features of automation, supports diagnostic systems and integrated communication. The SIMATIC S7-1200 is compatible so that it can utilize all tools available in the TIA portal software. This is the appropriate equipment for acquiring and processing the signals which are obtained from force or weighing sensors [4]. The significant application areas of SIWAREX module are platform scales, measuring level of silos and hoppers and also as a non automatic weighing device. The main advantage of this system is that we can develop customer specific solutions by the usage of configuration package. With the help of HMI panel or PC, parameters can be assigned to the module. It has an accuracy of 0.05% and resolution of 1 million parts. The SIWAREX module can be calibrated automatically without the use of weights. The SIWATOOL program gives the feature for adjusting the scales. The replacement of module is possible without the recalibration of scales.

The basic function of a SIWAREX module is measuring and registration of the present weight value directly with PLC. The Ethernet is the mode of communication used for assignment of parameters from the PC to the module. The software used for assigning the parameters is called as SIWATOOL software.

Fig 3. SIWAREX WP231 Weighing Module

C. Load Cell Based Arrangement

We have used shear beam type load cells for measuring the weights. The load cell works on Wheatstone bridge concept. The deformation of the load cell is proportional to the load applied on it.

Fig 4. Double Shear Beam Load Cell

In heavy industrial applications double shear beam load cells are commonly preferred. It has better accuracy (0.15%, 0.25% and 0.5% combined error) and it withstand high payload conditions. It gives the maximum or wide range of performance. Its low profile engineering design makes it very user friendly. It is available in different capacities such as 7.5ton, 15ton and 25ton. It is a fully laser welded device with IP68 protection. The load cell is made of stainless steel which is corrosion free and it gives choices for mounting the arrangement. This has a good range of temperature compensation which varies from -10 to +400C. The operating temperature scope is within -30 to +70^{0}C.

D. Flow Measurement

The flow rate of conductive liquid can be measured on the magnetic inductive sensing principle. Here a magnetic field is produced inside the pipe through the current carrying coils. The ions are then diverted perpendicularly with respect to the magnetic field, when there is a flow of conductive medium through the particular pipe. Positive and negative charge moves in opposite directions. Electrodes are used for measuring the voltage induced. The voltage produced and the average velocity is directly proportional. It has special feature for empty pipe detection. The flow meter is made up of stainless steel and also it has a compact and robust design. It has a measuring range of 5-600 l/min.

Fig 5. SM 9000 Flow Sensor

E. Human Machine Interface

The HMI acts as a interface between human and machine hence called as HMI. It has multi color display with soft keys to perform various operations. Also it has built-in memory of 4MB for data storage and programming. It is IP65, NEMA standards protected. All weighing related parameters are displayed and the user inputs are fed to the PLC using HMI. This makes the device more users friendly.

Fig 6. HMI Panel

3. SOFTWARES REQUIRED

A. TIA Portal V13

Totally Integrated Automation is an integrated and standard solution provided by Siemens to bring more engineering efficiency. It is a platform which brings the Programmable Logic Controllers, HMI, motor control to a common environment. This makes automation more users friendly.

B. SIMATIC WinCC

This software is used for configuring HMI. This gives a better visualization about the whole function. It has a wide range of graphical representations and data handling system.

C. SIWATOOL V7

SIWATOOL is parameterization software used along with SIWAREX module. This gives information about the parameters which are already configured and it also displays errors related to SIWAREX. It gives options for creating backup files. If parameter settings are changed it can be restored with the help of backup file. This has options for taring and calibration of the SIWAREX module.

Program Flow
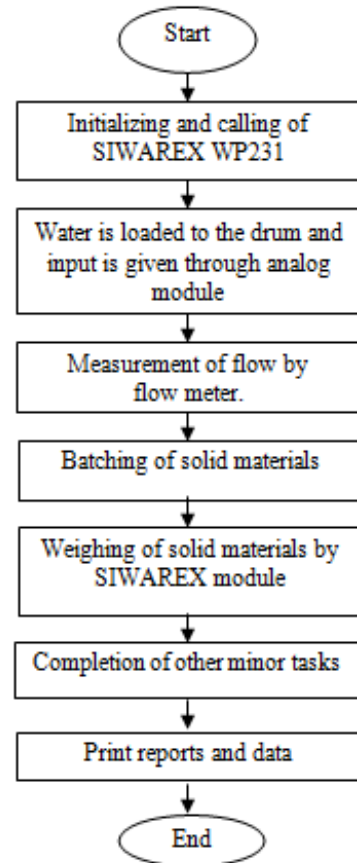
4. ADD ON FEATURES

### A. IR Mini Bullet Network Camera

Fig 8. IR Mini Bullet Network Camera

This enables the operator to have a better view about the process taking place in the backside of SLM..This is mostly used in image processing and supervisory system. This can seize images within the range of 20-30m. The device has an in-built IR cut filter for automatic day/night switching. It also has a good resolution and video capturing mode with high SNR. This camera has options for adjusting lighting and axis positions.

B. Thermal Printers

This printer is based on a thermal printing technology. An electric current activates the heating parts such as thermal head on a printer. Due to the heat produced there is a change in the colour in the thermo sensitive paper where the thermal heads imprints. Thermal printers are similar to dot matrix printer due to the matrix type closely spaced dot arrangement. Thermal printers are faster than dot matrix printers. They are very reliable because of its light weight, portable and compact nature.

5. RESULTS & DISCUSSIONS
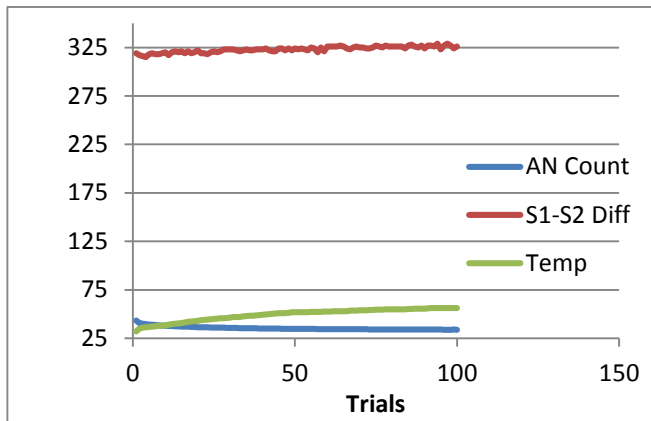
The result from the graph indicates that the main problem with the dual pressure based sensor is the accuracy issues. The pressure of the system is getting varied so it is not able to deliver accurate weight of material. The graph indicates that temperature is almost constant. But there is a gradual increase in the pressure values. The change in pressure can be due to leakage in the hydraulic cylinder. So there comes the necessity of a new arrangement in which pressure will not affect the weighing of materials. The load cell based arrangement has no effect with pressure change. Strain gauge load cells work on the principle that the strain gauge (a planar resistor) deforms/stretches/contracts when the material of the load cells deforms appropriately.The main advantage of this system is it has nothing to do with pressure changes so the weight can be measure accurately with 10% tolerance.

6. CONCLUSION

The weighing accuracy and repeatability of weighment is not always accurate in the pressure transducer based system. This is due to various factors including the Engine RPM, Oil Temperature and Viscosity. So the system is more dependent on the operator who operates it. The operator has to reproduce the same acceleration and weighing procedure all the time to get a repeatability. This leads to human errors and difficult to maintain the RPM. This also leads to excess fuel consumption.

The load cell based system is independent of the machine parameters like RPM & Oil Pressure. Also the system is not dependent on the operator who operates it. This system produces an accurate and repeated results all the time. Because the weighing is done through load cells and the external factors affecting the accuracy are very minimal. The only constraint in selecting the load cell is that, it should withstand the shock loads of the machine while travelling and during material loading. Hence we have selected a load cell at the higher end to withstand the sudden shock loads.

7. REFERENCES

[1] Self-loading concrete mixing and distributing mechanism Patent No.US 1554383 A.
[2] Tractor mounted self-loading concrete mixing apparatus Patent No.US 4268175 A
[3] Data sheet of S7-1200 Programmable Logic Controller.
[4] Data Sheet of Electronic weighing system SIWAREX WP231.
[5] Data sheet of KP-400 comfort panel Of Siemens.
[6] Operation manual of Self Loading Mixer 4000.
[7] "Control Technology for Ready-mix Truck Drum Cleaning" (PDF). U.S. Department of Health and Human Services. 31 May 2001. Retrieved21 October 2013.
[8] Portland Cement Association: History of Ready Mixed Concrete industry site.
[9] Casey, Jon M. "Parmer Metered Concrete offers precision and quality". Hard Hat News. Retrieved 24 November 2014.