Project ReportOn

Linear Drive Greasing Automation

SIEMENS

Ingenuity for life

Guided by

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Siemens Scholarship Program

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Siemens Scholarship Program

CERTIFICATE

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Acknowledgement

We would like to express out special thanks of gratitude to our project guide and mentor, Deepak Kumar Khatri, Siemens Scholarship Program.

We wouldn't have gotten such a great opportunity to learn and research without you.

We would also like to thank our parents, friends and colleagues for their immense support and help for completing this project.

ABSTRACT

As the name Suggests, this Project is based on PLC or dispenser using sensor. Grease dispenser will Save our time which we spend during the manual Grease dispensing.

Currently there are many methods for Grease dispensing. Most of them are using the sensor motor. In this Project, we hope to achieve the Same basic goals to perfection before Moving or designing a Complicated platform.

To build this, we make use of ultra-Sonic sensor to detect the level of grease in the tank of Grease -dispenser. For now, we plan on buildings a Minimal version of this project.

work of this dispenser involves PLC response Controller; we use Conveyor belt for this we but shaft by and take outside the shaft size.

Their exit application of this project, it is highly educational in the sense that we get learn about theory of sensor conveyor length and shaft size.

In conclusion we believe this project can act as a primer for any future projects. we might make and act as a stepping stone and design more this type of structure.

INTRODUCTION

The first question that comes to mind on seeing the title of the project is what possible use could a project of this kind have?

Let's start off by saying that this project is a great learning resource because in order to develop a linear drive grease automation, the user needs to thoroughly understand concepts like sensor interfacing, servo mechanism and its interfacing and control systems.

When it comes to applications, a lot of examples come to mind, but in this section, we will only be discussing a few.
First of all, linear drive grease automation uses in continuous flow of grease for calculated time and on a projected place which can automate the greasing in industry on shaft. Build a dispenser on top of it and use limit switch to start and stop the flow of grease controlled by PLC and any digital screen.

The goal of this project is to build an Automatic Grease Dispenser that is responsive, stable and controllable at any point in theleast possible time. And it can be modified for further improvements.

We believe that projects like these that can work without human supervision contribute to the development of automation in industries.

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HARDWARE DEVELOPMENT

Block Diagram

In the hardware development part of this project, we need to make the body of the project, as well as assemble it. To understand exactly how the project was built, consider the following block diagram. The shaft is transferred from end position to the grease dispensing unit with the help of conveyor belt.

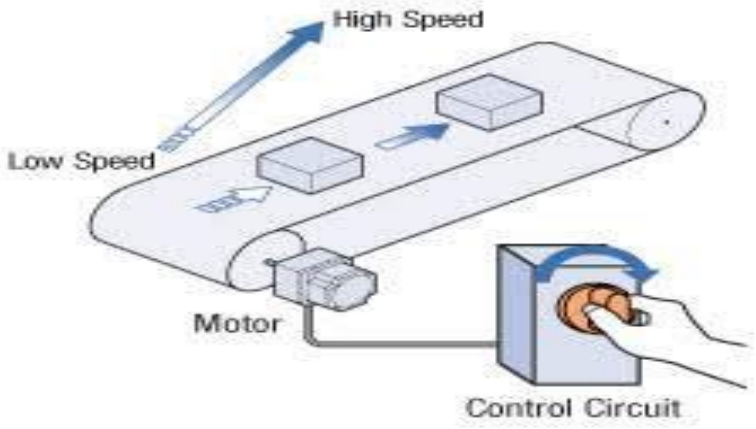


FIG 1. BLOCK DIAGRAM

The shaft is rotated with the help of servo motor.

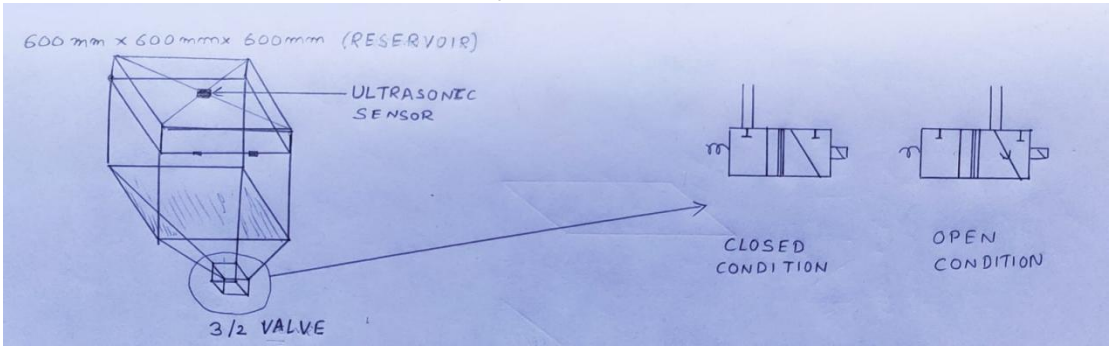


FIG 2. BLOCK DIAGRAM

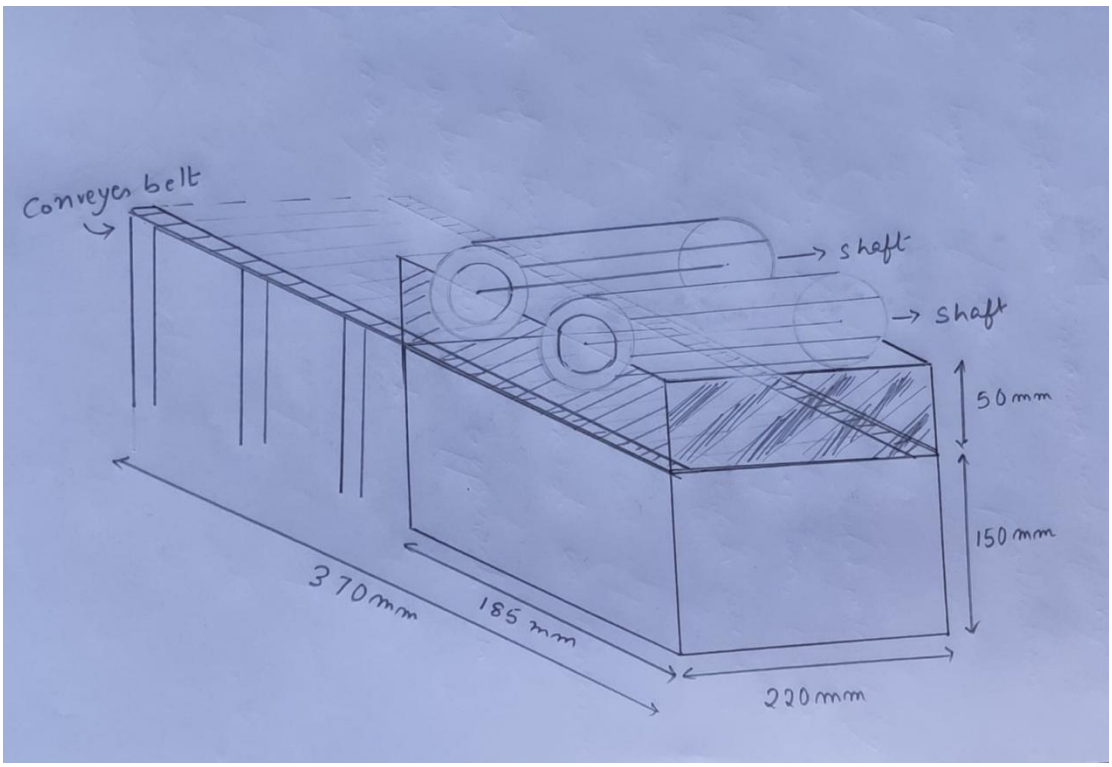


FIG 3. BLOCK DIAGRAM

Thickness of gear required for proper greasing,

Gq=0.114*D*T;

T=Thickness in inch, D=diameter in inch, Gq=amount in ounce;

Gq=0.144*3.54331*0.393701.

Gq=0.1590unce. And Gq=4.7021ml.

So, approximately we take 5 ml of grease for a gear, since there is 2 gear 10ml of grease is taken in one period of greasing. And shaft is rotated for Sec.

The project can be divided into three sections- The dispenser, an actuator,a sensor and a control system.

The sensor and actuator, which are servo motor Ultrasonic sensor and PLC respectively, will be interfaced with the controller using Ladder Logic, whereas the Control System will be software based.

When the shaft is placed on the conveyor and the dispenser is turned on, the ultrasonic sensor will detect the amount of the grease. This value will be present in analog form. The microcontroller will read this value and convert it to digital format using the inbuilt ADC converter.

The digital equivalent of the distance of grease from sensor will give to the control system. The control system will operate on the distance, the expected distance, error, etc. and come up with a grease level.

The output value obtained from the controller will be given as input to the limit switch and servo motor under conveyor. This value will represent the time to flow grease on shaft and servo motor hasto rotate to start and stop conveyor.

This cycle of read, process, actuate will continue until the shaft moves and stop atexactly the given set point. After that, limit switch will allow grease to flow and the shaft is greased and the conveyor start and brings the shaft out from another side.

Technical Specifications of Components

I. Grease Dispenser

The main purpose for the project is to grease the gear and for greasing, an automated grease dispenser is installed. The timing for the greasing is control through a timer for the PLC.
In our project, we use the Raziol lube 502 Art. -Nr. 1077000502. (Series 200: light version).

Our product range includes lubricants for all areas of non-cutting metal forming and minimum lubricant technology. Lubricants, free of chlorinated additives and mineral oil-free, partially evaporating stamping oils, Fineblanking oils and drawing oils guarantee maximum environmental sustainability and a long service life of the tools. High-performance concentrates for water-miscible cooling lubricants, free from secondary amines and with high stability, complete the product range.

A large selection of roller lubricators from our product range for production processes involving stamping, Fineblanking, deep drawing, bending and profiling.

Factors such as the material being lubricated (material width, material thickness, ...), the rate of infeed and the respective stroke of your stamping machine are of utmost importance when it comes to selecting the correct roller lubricator (roller, roller placement, roller lubricator width).
The choice of the right lubricant also depends on the material to be lubricated (type) and the roller lubricator employed (roller diameter, type of application roller).

Oil quantity Q: Indicates the quantitative run of the oil dispensing through the lubricating rollers on the customer`s material
Oil quantity Qneeded: The customer`s required oil quantity QNeeds results from the amount of oil, that needs to be applied evenly over the entire spread and feed length, regardless of the stroke rate of the forming machine onto the material

II. Ultrasonic Sensor

The detection for the presence of grease up to a certain amount on the reservoir is detected by the ultrasonic sensor.
For our project, the sensor US-100 is selected. The sensor has a range of 2cm to 5m.
Ultrasonic Sensor HC-SR04 is a sensor that can measure distance. It emits an ultrasound at 40 000 Hz (40kHz) which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance.

The configuration pin of HC-SR04 is VCC (1), TRIG (2), ECHO (3), and GND (4). The supply voltage of VCC is +5V and you can attach TRIG and ECHO pin to any Digital I/O in your Arduino Board.
The ultrasonic sensor can easily be interfaced to microcontrollers where the triggering and measurement can be done using two I/O pins. The sensor transmits an ultrasonic wave and produces an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width, the distance to the target can easily be calculated. This Ultrasonic Distance Sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects

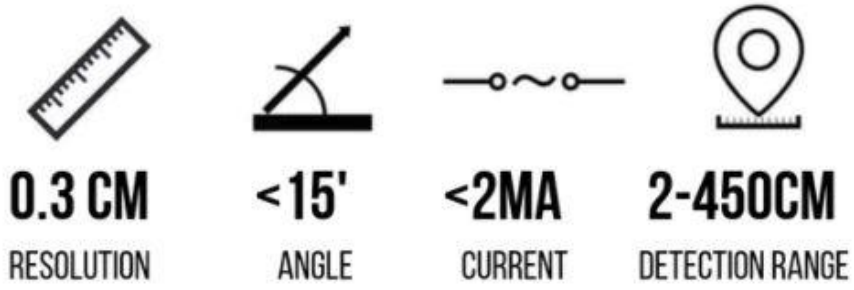


FIG 4. SPECIFICATIONS OF ULTRASONIC SENSOR

III. Servo Motor

As an actuator for tilting the platform, we decided to use a servo motor.
While there are a lot of different motors out in the market- like stepper motor, DC motor, geared DC motor, servo motor, etc. We decided to go with servo.
The main reason for this choice was control. From the control system we would be receiving a fixed value representing the angle of tilt. The motor we choose should be capable of taking this value and moving to the appropriate position without any hassle.
In case of a DC motor, or a geared DC motor, we would need to purchase an encoder for getting the current position of the motor. We would also need to design a control system for making the motor stop at the given angle. This leads to a lot of work on our part, work that can easily be avoided.
In case of stepper motor, the position control is very precise and fine. This motor can be used in the project. But a motor with the resolution required in this project is too costly.
So, it all comes down to servo motors. They have an in-built control system, there are affordable and easy to control.
We used the servo motors in two applications, first for the movement of the shaft through conveyor belt and the second for the rotation of shaft for greasing propose.

The model we use is PSM57HS2A54-2P. The motor speed of both purposes is controlled through the controller.

For the movement of shaft through conveyor belt, the speed is set between 600 rpm to 800 rpm.

For the shaft greasing, the speed is set at around 200 - 400 rpm.

IV. Limit Switch

For the detection of shaft and to check if the shaft is at the right position for greasing

For our project, we use OMRON 3D Printer Limit Switch ENDSTOP SS-5GL
OMRON 3D Printer Limit Switch ENDSTOP SS-5GL.

The Omron SS series are subminiature basic switches. These switches offer high reliability and security. A variety of models are available with an operating force ranging from low to high
1.Switching capacity of 3A at 250VAC, 5A at 125VAC, 0.1A at 30VDC.
2.Pin plunger, hinge, long hinge, simulated roller, hinge roller lever actuators available.
3.Solder, quick connect, PCB terminals available.
4.SPDT, SPST-NC, SPST-NO contact configuration.
5.Two split springs ensure high stability and durability.
6.Economical, subminiature snap action switch offers long service life (30 million operations minimum)
7.All models are free from overtravel restrictions, permit easy setting
8.Wide switching capacity range from micro voltage/current loads (1 mA at 5 VDC to high-capacity loads 10.1 A at 250VAC)
9.Standard operating force, low force or super-low force models available
10.RoHS Compliant

Component Pictures

FIG 4. Grease dispenser:
Raziol : Lube 502
Art. -Nr. 1077000502.

FIG 5.Aurdino HC-SR04 Ultrasonic Sensor
Range 2cm to 5m

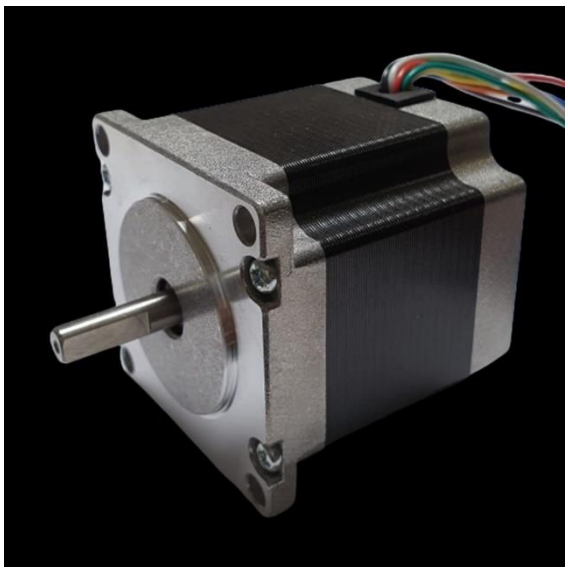


FIG 6. Servo Motor

Model : PSM57HS2A54-2P

FIG 7. OMRON 3D Printer Limit Switch ENDSTOP SS-5GL

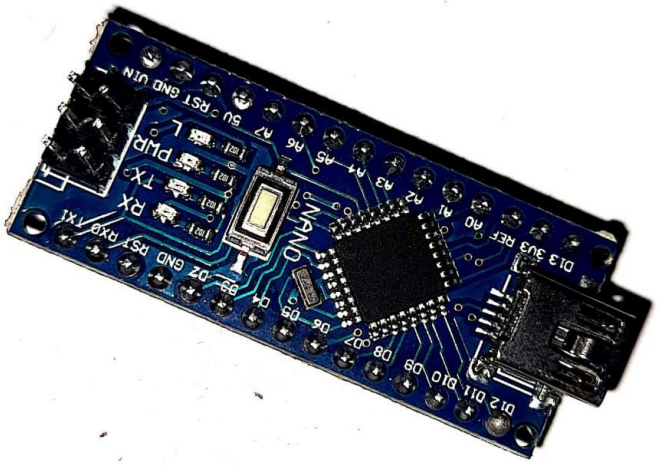


FIG 8. Arduino Nano

Circuit Diagram for Testing

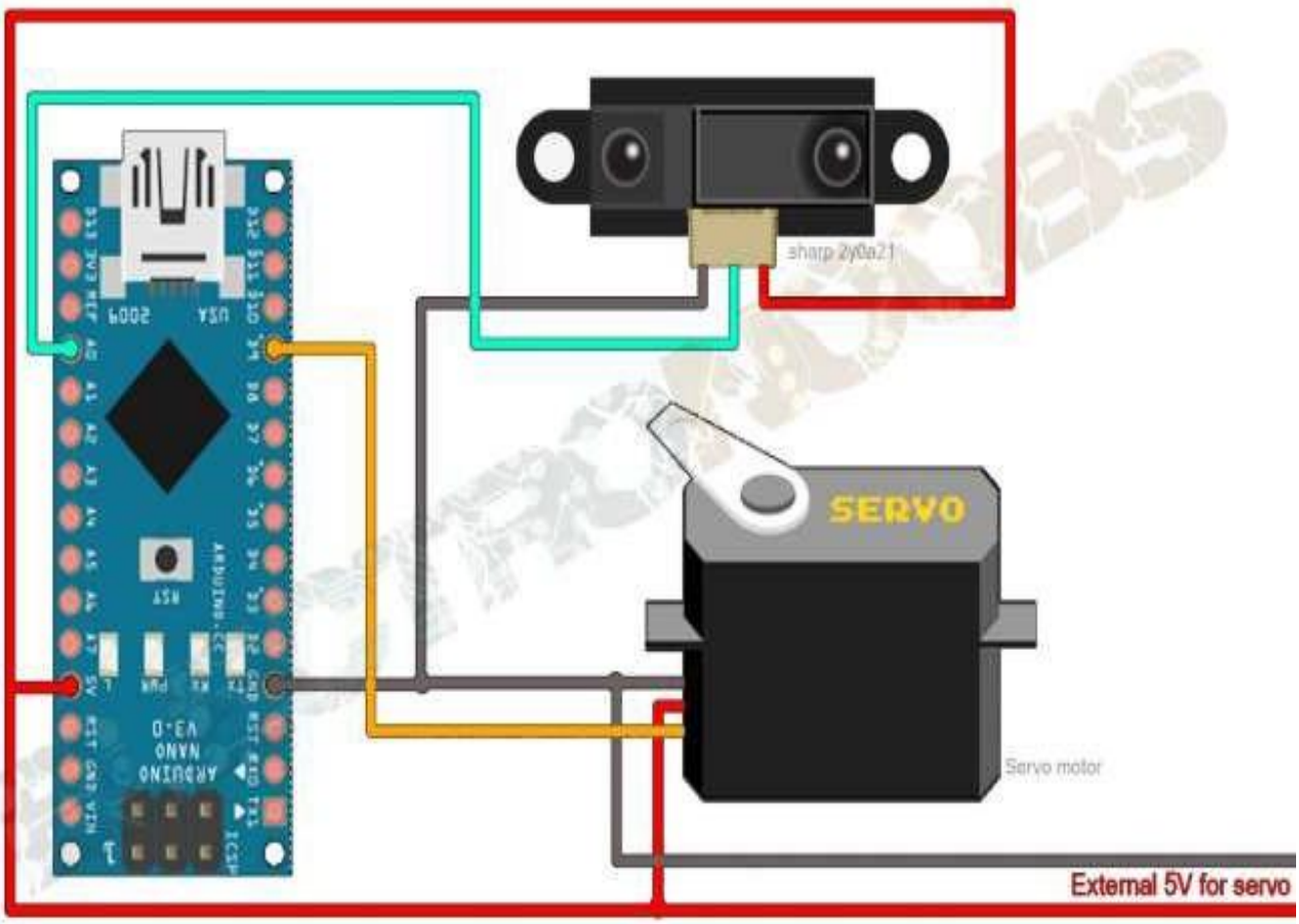
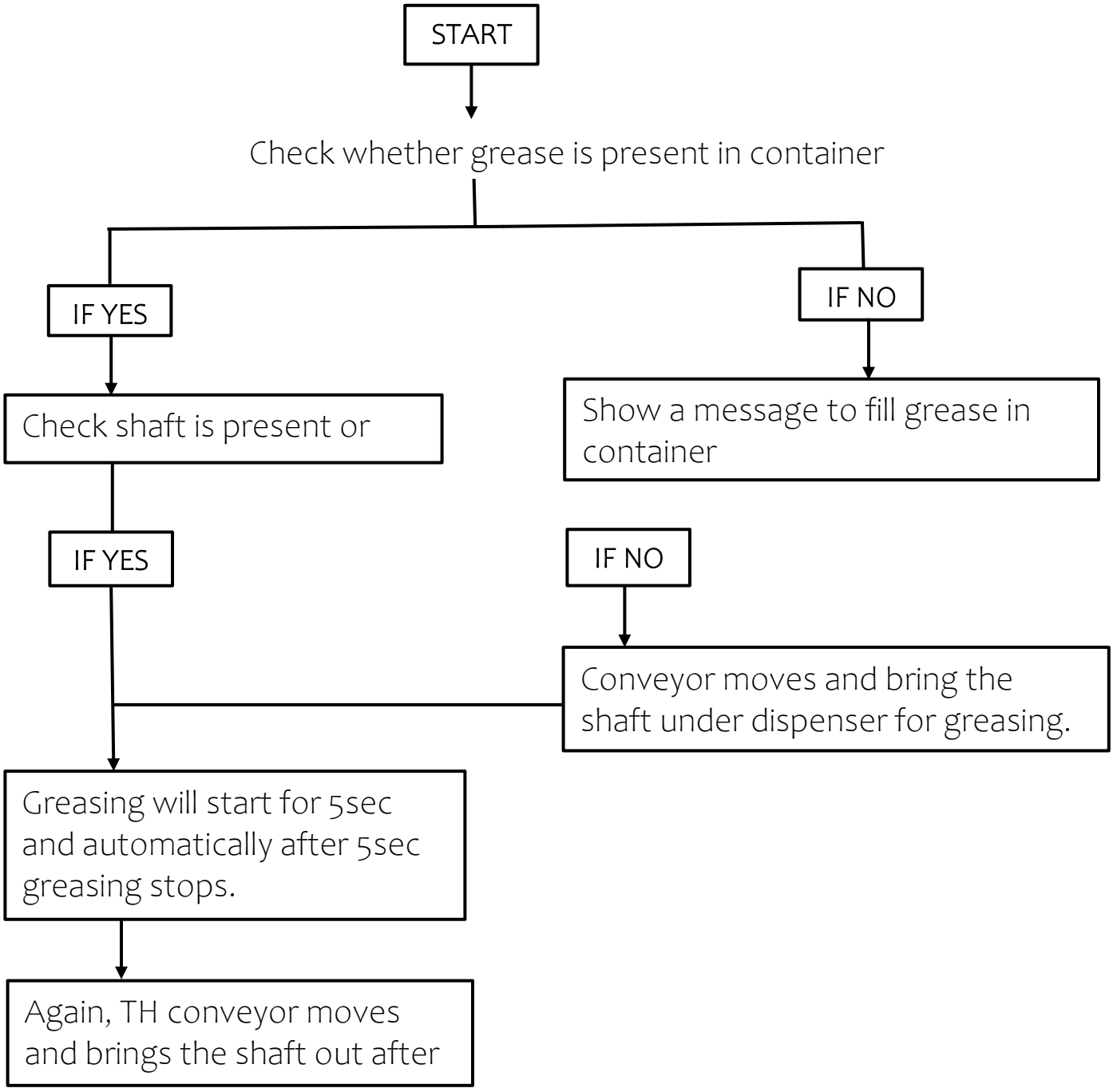


FIG. 9. CIRCUIT DIAGRAM FOR TESTING SERVO MOTOR AND SENSOR WITH ARDUINO



- There is no issue if grease is done twice.
- To check grease is present: -
    1. We will use level detector sensor.
    2. We will use 2/3 BOB to poor grease automatically.
    3. We limit switch to detect whether shaft is present or absent.

Software Development

PLC Ladder Logic

The first step to be performed after purchasing components is to perform hardware tests to check that all the components are functioning properly.

To do this, we wrote tests for the servo and the sensor to test their outputs.

In the test for the servo motor, we first interface the servo to the controller. Then we give it some angles to move to. To check that the servo is actually working, we check that the servo turns according to the angles give to it.

The program to perform the servo test has been attached below.

To test the sensor, we check its output.

First, we interface the sensor to the controller. Then start the serial monitor. In an infinite loop, we get the reading from the sensor and print its processed value on the serial monitor.

To check that the sensor is giving the correct results, we make use of a scale. We take a obstacle and move it along the scale and check that its position is at least approximately equal to the reading on the serial monitor.

The program to perform the sensor test has been attached below.

It was observed that both the sensor and the servo motor were working properly and gave the expected results.

With the components tested properly, we could then move on to the next stage

Arduino Code for Testing

Sensor Test

```
/*
* Created by ArduinoGetStarted,
https://arduinogetstarted.com
* Arduino - Ultrasonic Sensor HC-SR04
* Wiring: Ultrasonic Sensor -> Arduino:
* - VCC  -> 5VDC
* - TRIG -> Pin 9
* - ECHO -> Pin 8
* - GND  -> GND
* Tutorial is available here:
https://arduinogetstarted.com/tutorials/ardui
no-ultrasonic-sensor
*/
int trigPin = 9;    // TRIG pin
int echoPin = 8;    // ECHO pin
float duration_us, distance_cm;
 void setup() {
  // begin serial port
  Serial.begin (9600);
  // configure the trigger pin to output mode
```

```
  pinMode(trigPin, OUTPUT);
  // configure the echo pin to input mode
  pinMode(echoPin, INPUT);
}
 void loop() {
  // generate 10-microsecond pulse to TRIG pin
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // measure duration of pulse from ECHO pin
  duration_us = pulseIn(echoPin, HIGH);
  // calculate the distance
  distance_cm = 0.017 * duration_us;
  // print the value to Serial Monitor
  Serial.print("distance: ");
  Serial.print(distance_cm);
  Serial.println(" cm");
  delay(500);
}
```

Servo Test

```
// header file for Servo Interfacing
#include <Servo.h>

// create a servo object
Servo servo;
// pin where servo is connected
int servoPin = 9;
// default angle of servo
int startingAngle = 90;

void setup () {
   // attach this servo to the given pin
   servo.attach (servoPin);
   // move the servo to its default angle
   servo.write (startingAngle);
   // wait for some time
   delay (1000);
}
void loop () {
servo.write (0);
   delay (500);
   servo.write (90);
   delay (500);
   servo.write (180);
   delay (500);
}
```

Controller Design and Tuning

In the project, we have implemented the PLC Logic control for greasing the shaft on the controller.

PLC stands for Programmable Logic Control.

This control is by far the most widely used in industry and easy to implement and tune controller. It uses closed loop control feedback to keep the actual output froma process as close to the target or the setpoint output as possible.

A PLC controller takes the current measurement from the sensor and compares it with the desired measurement to compute the error. The desired measurement is also known as the set point.

The error that we get from the current measurement and the setpoint will be the base on which the proportional, integral and derivative terms are calculated.

The simplest of all the terms is the proportional term. It is basically the error multiplied with the proportionality constant. The proportionality constant is a number that has to be set when tuning the controller using trial and error.

Now after assembling all the parts in a desired way.

These are the steps our linear drive automatic grease dispenser works.

When main switch pressed on. Ultrasonic sensor will detect the height of grease present in the grease storage reservoir. If required amount of grease is not present in the reservoir. It displays on screen and alert technician to fill reservoir as it has insufficient amount of grease for complete greasing the shaft. As we are using digital display it also shows 3d animations on screen to open the reservoir and fill the grease in it. Once the grease is filled in it again it will detect the height and check grease level. If again sufficient amount of grease is not present it will repeat the step again till the desired amount of grease level it gets.

Now once the grease is filled at required level, Limit switch will detect the presence of shaft. We are using limit switch to detect the presence of shaft. If there is no shaft present then the motor start moving which results in moment of conveyor.

Once user place the shaft on conveyor. Now Conveyor runs till the shaft enters in the block and comes below the dispenser. Now limit switch will detect the shaft and once it detects the shaft conveyor stops and the grease dispenser will start dispensing grease by using 2/3 Bob fitted in the reservoir for the calculated amount of time.

After greasing shaft, the flow of grease will stop again by using 2/3 Bob. And again, the conveyor starts moving and brings the greased shaft out from another side of conveyor.

Once the shaft comes out from the block there will show message on digital screen that it has completed greasing of shaft and the count will increase by one. It stores all the data of shafts which are greased one the day and all the time it is working.

We can control all the operations on the PLC and on the digital screen also. All the above operation will be shown on digital display.

Now the same process will repeat all the time it works.

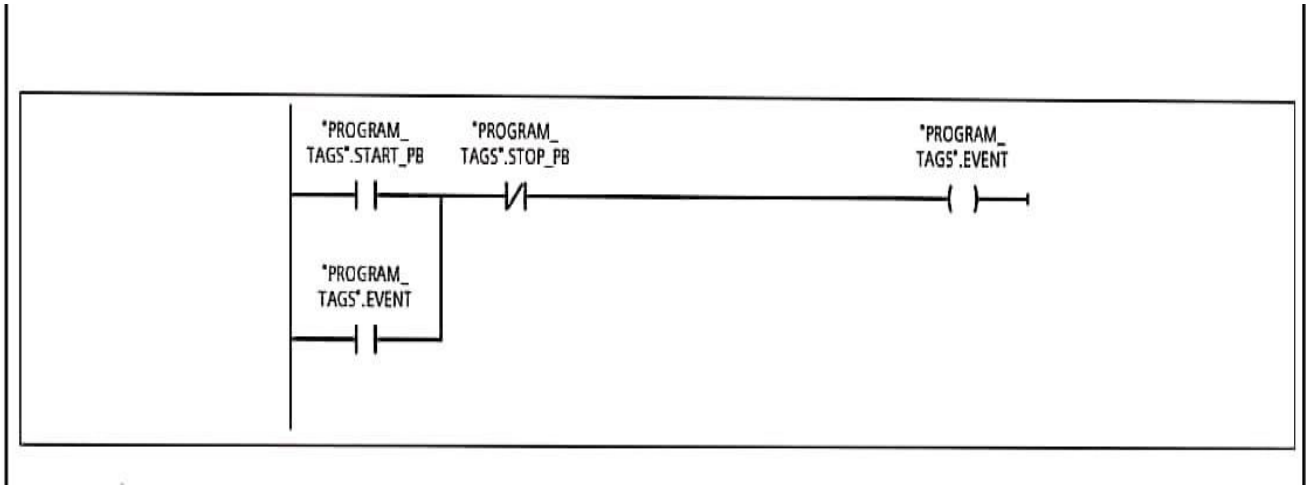
PLC Ladder Logic

MAIN_PROGRAM [OB1]

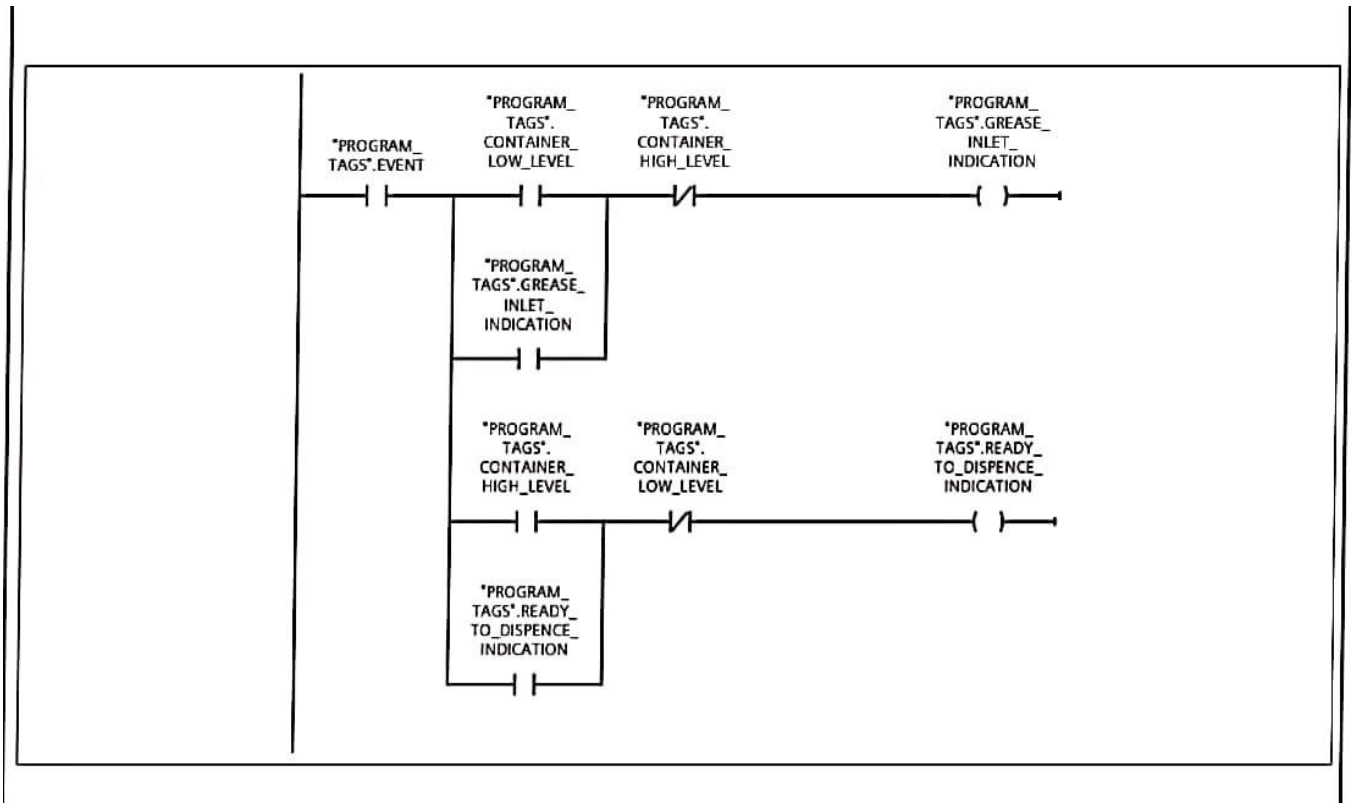
MAIN_PROGRAM Properties					
General					
Name	MAIN_PROGRAM	**Number**	1	**Type**	OB
Language	LAD	**Numbering**	Automatic		
Information					
Title	"Main Program Sweep (Cycle)"	**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

Name	Data type	Default value	Comment
Input			
Initial_Call	Bool		Initial call of this OB
Remanence	Bool		=True, if remanent data are available
Temp			
Constant			

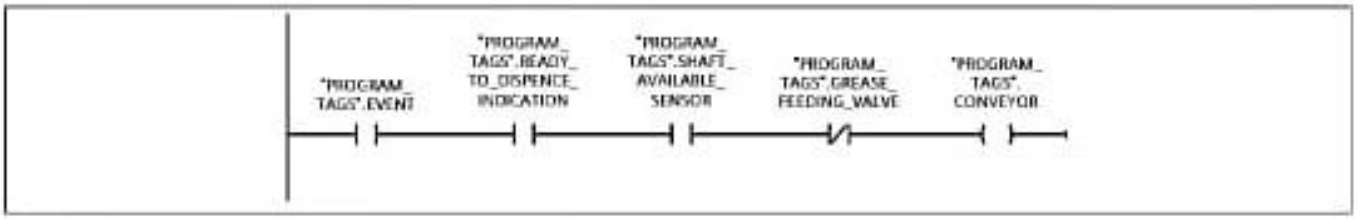
Network 1: START_STOP_CYCLE



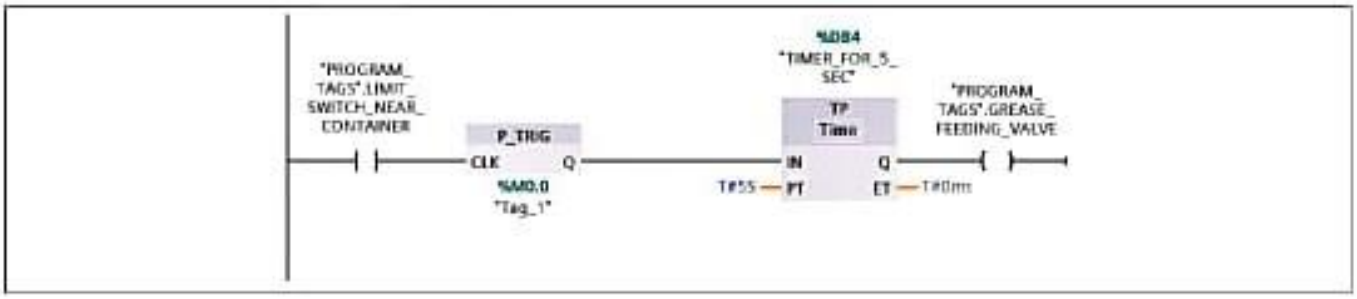
Network 2: GREASE_CONTAINER_HIGH_LOW_LEVEL_INDICATION


"PROGRAM_ TAGS".EVENT
"PROGRAM_ TAGS". CONTAINER_ LOW_LEVEL
"PROGRAM_ TAGS". CONTAINER_ HIGH_LEVEL
"PROGRAM_ TAGS".GREASE_ INLET_ INDICATION
"PROGRAM_ TAGS".GREASE_ INLET_ INDICATION
"PROGRAM_ TAGS". CONTAINER_ HIGH_LEVEL
"PROGRAM_ TAGS". CONTAINER_ LOW_LEVEL
"PROGRAM_ TAGS".READY_ TO_DISPENCE_ INDICATION
"PROGRAM_ TAGS".READY_ TO_DISPENCE_ INDICATION

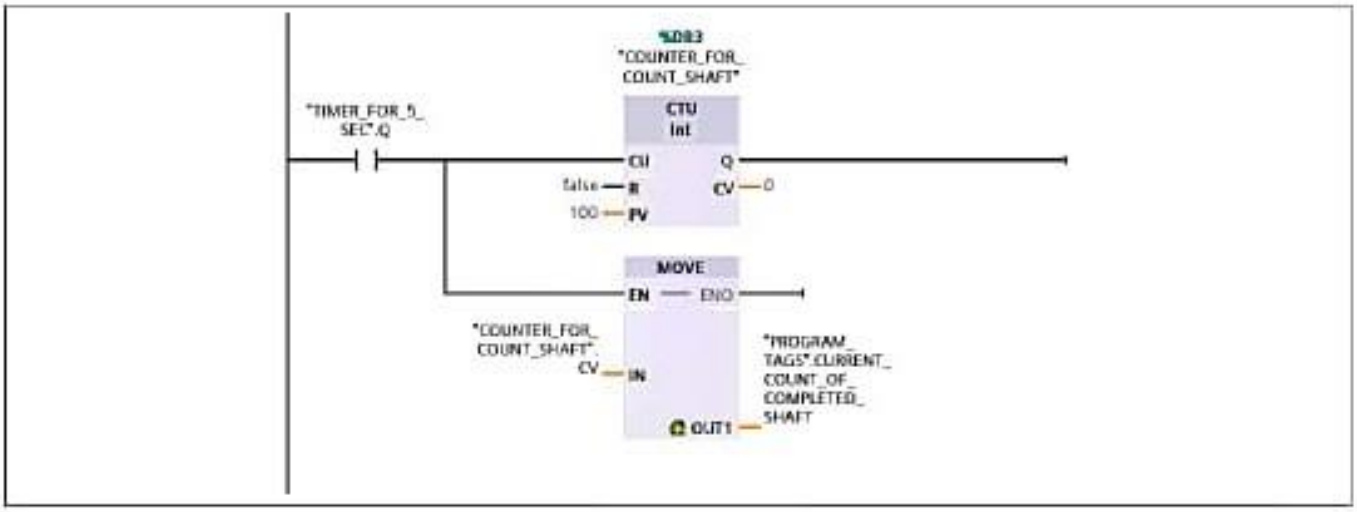
Network 3: CONVEYOR_ON_OFF_PROCESS



Network 4: GRESE_FEEDING_PROCESS



Network 5: SHAFT_COUNTING_PROCESS



Observation and Conclusion

Observation

Conclusion

APPENDIX

List of Figures

Expenses

Arduino Nano	349
Grease dispenser	₹10,000
Ultrasonic sensor	₹343
servo motor	₹1490
Limit switch	₹69

References