Deliverable E

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1. Abstract

The proposed project is aimed at developing a dust sensor monitoring device for use on top of a silo. The device will be used to monitor the level of dust in the silo and relay the information back to the main monitor. The device will consist of a dust sensor, three level sensors, and a signal relay. The device will be designed using a detailed design approach, and a product/project cost spreadsheet will be used to manage the budget. The device will go through three prototyping phases to ensure its functionality and feasibility.

2. Introduction

The aim of this project is to design and develop a dust sensor monitoring device for use on top of a silo. The device will be used to monitor the level of dust in the silo and will consist of a dust sensor, three level sensors, and a signal relay to send information back to the main monitor. The device will be designed using a detailed design approach and will go through three prototyping phases to ensure its functionality and feasibility.

3. Related Work

Similar devices have been developed for monitoring the level of dust in industrial environments. These devices often use laser-based sensors to measure the concentration of dust in the air. However, these devices can be expensive and may not be suitable for use on top of a silo. Other devices use weight sensors to monitor the level of dust in the silo. While effective, these devices are often complex and can be difficult to install. Our proposed device aims to provide an affordable, easy-to-install solution for monitoring dust levels in a silo.

4. Table of B.O.M (Bill of Materials)

Item Name	Description	Unit of Measurement	Quantity	Unit Cost	Link
Dust Sensor	Nova PM Sensor SDS011	Unit	1	20$	https://www.amazon.com/SDS011-Quality-Detection-Conditioning-Monitor/dp/B07FSDMRR5
Level Sensors	Ultrasonic level sensor -	Unit	3	5$ (each)	https://www.sparkfun.com/products/155

	HC-SR04				69
Microcontroller	Arduino UNO R3	Unit	1	22$ (already have)	https://3dprintingcanada.com/products/arduino-uno-r3-with-usb-cable?variant=1410886900125 9&ab_version=A&gclid=Cj0KCQiArsefBhCbARIsAP98hXQNp54LJSfdRhHk-1SedoHpbtMhZG7lP1gbwJw14th-pXrbm3CTf_waAmotEALw_wcB
Relay Module	SainSmart 4-channel Relay Module	Unit	1	10$	https://www.amazon.ca/SainSmart-101-70-101-4-Channel-Relay-Module/dp/B0057OC5O8/ref=asc_df_B0057OC5O8/?tag=googleshopc0c-20&linkCode=df0&hvadid=292968375828&hvpos=&hvnetw=g&hvrand=2583717506987431787&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000690&hvtargid=pla-435415527109&psc=1
LCD Display	Elegoo	Unit	1	8$ (already	https://www.a

	16x2 LCD display module			have)	mazon.ca/Professional-HW-060A-Display-Adapter-Interface/dp/B086TY9XX8/ref=sr_1_3_sspa?qclid=Cj0KCQiArsefBhCbARIsAP98hXQqfoHTsFy2zlltAGMbolKG7qXoT9TfvDEvVzOB_tQhNWynA7A8KRYaAsCKEALw_wcB&hvadid=243376346574&hvdev=c&hvlocphy=9000690&hvnetw=g&hvqmt=b&hvrand=11806118606076251546&hvtargid=kwd-488105781752&hydadcr=23340_10308593&keywords=lcd+module+16x2&qid=1676848161&sr=8-3-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzSUtHTzBMS05LMjBFJmVuY3J5cHRlZElkPUEwMjA5MTA2WUxVUTNJTzVIQk0wJmVuY3J5cHRlZEFkSWQ9QTAzNDU5MjBGWVhMTThLVFBMMkM

					md2lkZ2V0TmFtZT1zcF9hdGYmYWN0aW9uPWNsaWNrUmVkaXJlY3QmZG9Ob3RMb2dDbGljaz10cnVl
Jumper Wires	40-Pin Female to Female Jumper Wires	Unit	1	7$ (already have)	https://tinkersphere.com/breadboard-perfboard-prototyping/908-40-pin-female-to-female-ribbon-jumper-cable-.html
Power Supply	DC Power Supply 9V 1A	Unit	1	8$	https://www.amazon.ca/Planet-Waves-9V-Power-Adapter/dp/B00191WVF6/ref=asc_df_B00191WVF6/?tag=googleshopc0c-20&linkCode=df0&hvadid=293011081342&hvpos=&hvnetw=g&hvrand=12743078527791959895989&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000690&hvtargid=pla-382920948679&psc=1
Total Cost	N/A	N/A	N/A	**43$**	N/A

5. Functionality of our Device

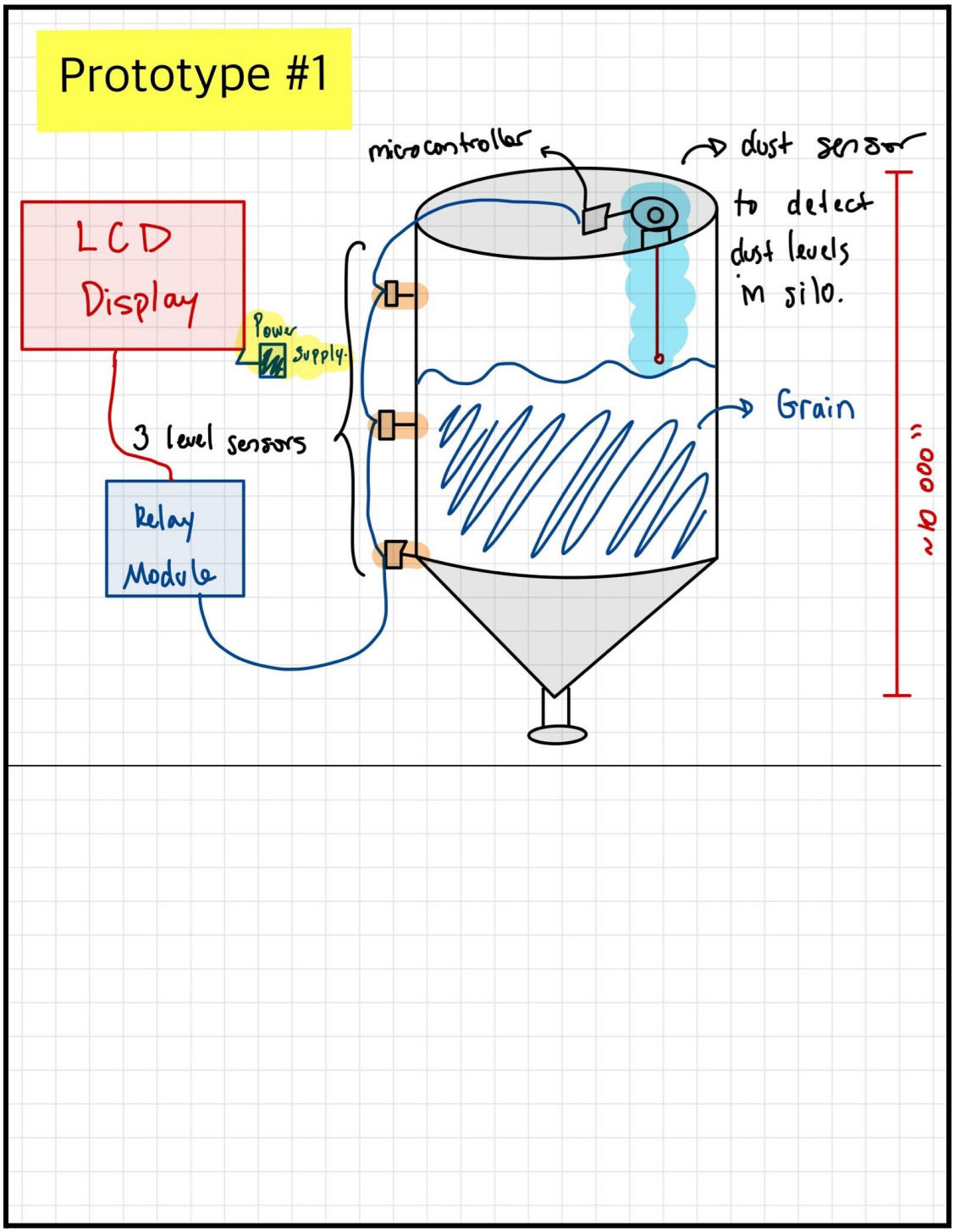
1. **Dust Sensor:** The dust sensor measures the concentration of dust particles in the air. It uses laser scattering to detect the number and size of particles in the air.
2. **Level Sensors:** The 3 level sensors are used to measure the level of dust in the silo. These sensors use ultrasonic waves to measure the distance from the sensor to the top of the dust layer. By taking readings from the 3 sensors at different locations, the device can calculate the average level of dust in the silo.
3. **Microcontroller:** The microcontroller receives the data from the sensors and processes it. It has the ability to communicate with the sensors, read the data, and store it in memory. The microcontroller is also responsible for controlling the relay module that sends the data to the main monitor.
4. **Relay Module:** The relay module is connected to the microcontroller and serves as a signal to relay the information to the main monitor. It is used to send data from the microcontroller to the main monitor wirelessly or via a wired connection.
5. **LCD Display:** The LCD display shows the current level of dust in the silo, as well as other relevant information, such as the time and date. It is connected to the microcontroller and is used to display the information that is processed by the microcontroller.
6. **Power Supply:** The device is powered by a DC power supply. It provides the necessary power to run the microcontroller, sensors, and LCD display.

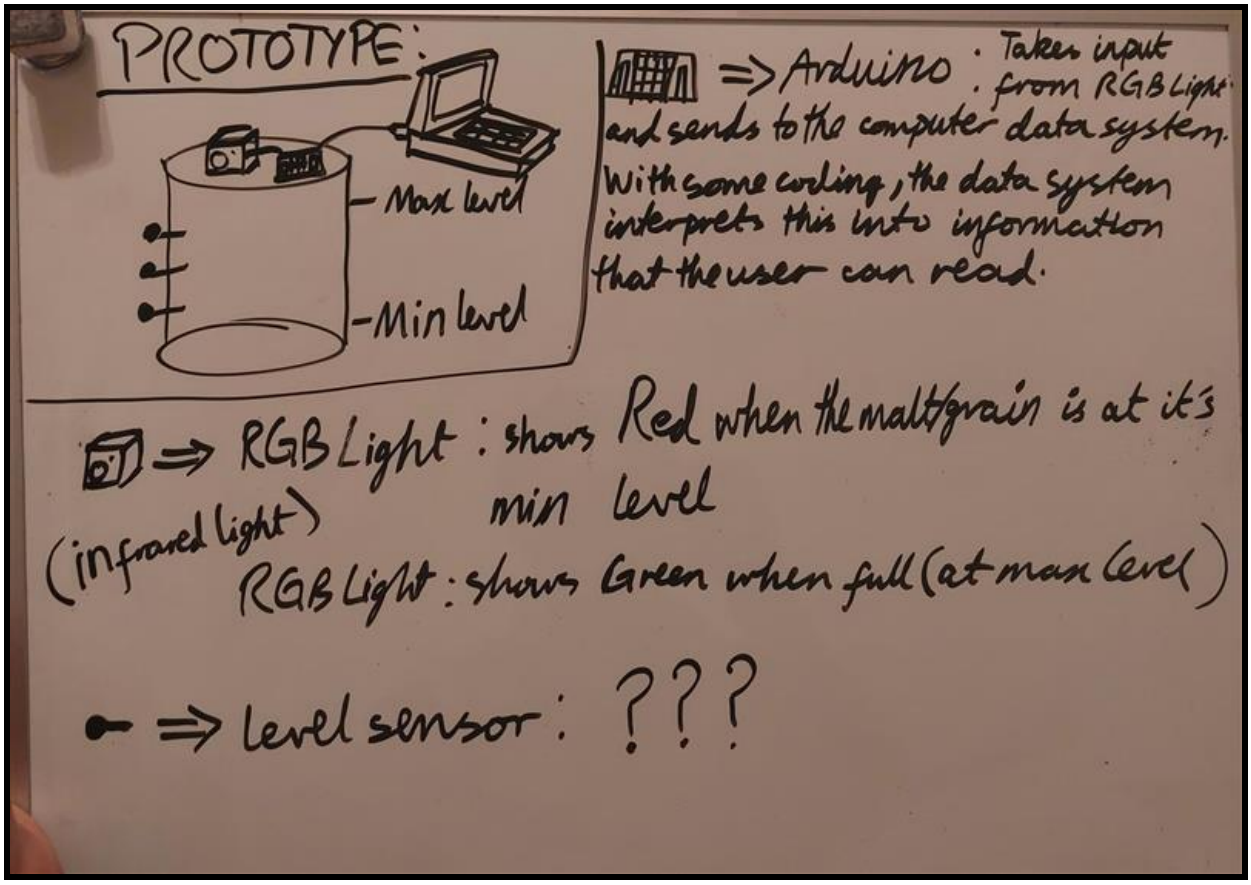
In summary, the dust sensor monitoring device on top of a silo functions by measuring the concentration of dust particles in the air and the level of dust in the silo. It then processes the data, sends it to the main monitor, and displays it on an LCD screen. This device helps to maintain a safe and healthy working environment by monitoring the dust levels and taking action when necessary.

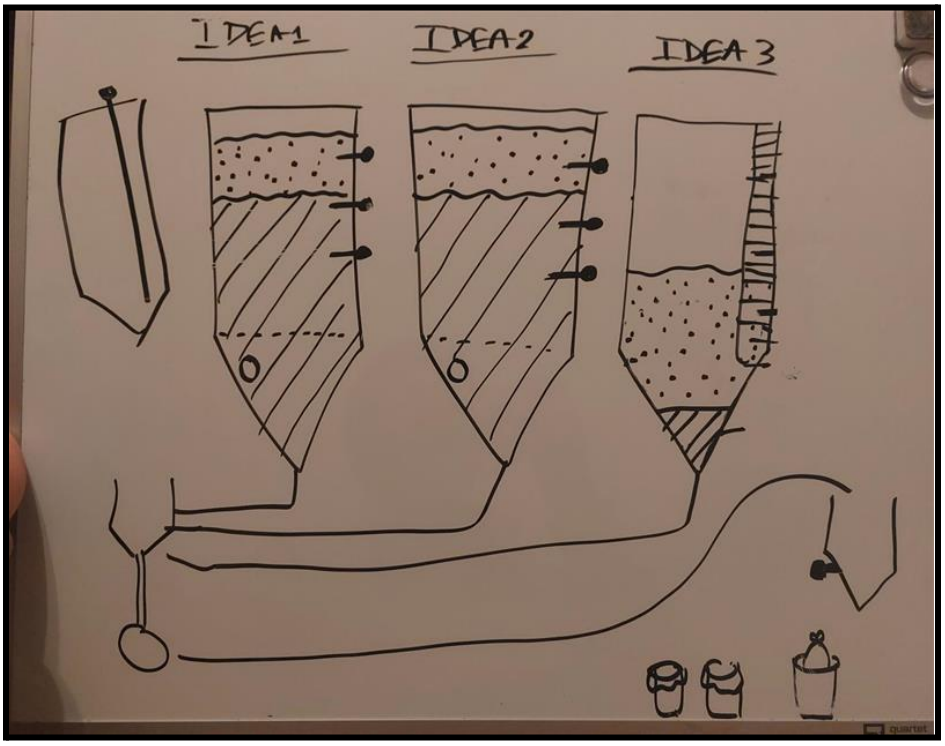
6. Building the Device

1. **Gather the materials:** Gather all the materials needed for building the device, including the dust sensor, level sensors, microcontroller, relay module, LCD display, power supply, and jumper wires.
2. **Connect the sensors to the microcontroller:** Connect the dust sensor and 3 level sensors to the microcontroller using the jumper wires. Make sure to follow the wiring diagram provided by the manufacturer.
3. **Program the microcontroller:** Program the microcontroller to read the data from the sensors, process it, and display the information on the LCD display. You can use Arduino IDE to write the code for the microcontroller.
4. **Test the device:** Test the device by turning it on and making sure that all the sensors are working correctly. Check if the data is being displayed on the LCD screen and if the relay module is transmitting the data to the main monitor.
5. **Install the device:** Install the device on top of the silo, making sure that it is securely mounted and protected from the elements. Connect the power supply and make sure the device is powered on.
6. **Monitor the dust levels:** Once the device is installed and working, it is important to monitor the dust levels and take action when necessary. Set up the main monitor to receive the data from the device and use it to monitor the dust levels in real-time.

7. Overall Design Image/Process




PROTOTYPE:
Max level
Min level
⇒ Arduino : Takes input from RGB Light and sends to the computer data system. With some coding, the data system interprets this into information that the user can read.
⇒ RGB Light : shows Red when the malt grain is at it's min level
(infrared light)
RGB Light : shows Green when full (at max level)
⇒ level sensor : ???


IDEA 1
IDEA 2
IDEA 3

The dust sensor monitoring device prototype is a compact, portable device that can be easily mounted on the silo. The device has a dust sensor that uses laser scattering to detect the concentration of dust particles in the air. The device also has 3 ultrasonic level sensors that measure the level of dust in the silo by calculating the distance from the sensor to the top of the dust layer.

The prototype features a microcontroller that receives data from the sensors and processes it. It has the ability to communicate with the sensors, read the data, and store it in memory. The microcontroller also controls a relay module that sends the data to the main monitor. The device is powered by a DC power supply that provides the necessary power to run the microcontroller, sensors, and LCD display.

The prototype has a compact LCD display that shows the current level of dust in the silo, as well as other relevant information, such as the time and date. The device is designed to be durable and weather-resistant, with a sturdy casing to protect the sensitive components from damage. The device can be easily configured to communicate with the main monitoring system, either wirelessly or via a wired connection.

Overall, the prototype is designed to be a reliable, cost-effective solution for monitoring the level of dust in silos, and to help ensure the safety of workers and the surrounding environment.

8. Project Risks

1. **Sensor malfunction:** There is a risk that the dust sensor may malfunction and give incorrect readings. To mitigate this risk, we will regularly calibrate the sensor and keep a spare sensor on hand for immediate replacement if necessary.
2. **Wireless communication failure:** The device relies on wireless communication to send data to the main monitor. There is a risk that the communication system may fail. To mitigate this risk, we will test the communication system thoroughly and provide backup communication options such as wired connections.
3. **Power supply failure:** If the device loses power, it will not be able to operate or send data to the main monitor. To mitigate this risk, we will ensure that the power supply is reliable and we will include a backup power supply such as a battery or generator.
4. **Damage to sensors during installation:** There is a risk that the sensors may be damaged during installation. To mitigate this risk, we will handle the sensors with care and follow installation instructions carefully. We will also have spare sensors available in case of damage.
5. **Inaccurate readings due to sensor placement:** The placement of the sensors may affect the accuracy of the readings. To mitigate this risk, we will ensure that the sensors are placed in optimal positions and we will test the readings to confirm accuracy. We will also include a mechanism for adjusting sensor placement if necessary.

6. **Data processing errors:** The microcontroller processes the data from the sensors and sends it to the main monitor. There is a risk that data processing errors may occur. To mitigate this risk, we will test the microcontroller thoroughly and include error-checking mechanisms to ensure that the data sent is accurate.
7. **LCD display failure:** The LCD display is used to show the current level of dust in the silo, as well as other relevant information. There is a risk that the display may malfunction. To mitigate this risk, we will ensure that the display is reliable and include a backup display if necessary.

9. Conclusion

In conclusion, the dust sensor monitoring device is an innovative solution that can help industrial businesses track the dust concentration levels in their silos. The device utilizes a dust sensor, three level sensors, a microcontroller, relay module, and an LCD display. By combining these components, the device can provide real-time data on the dust concentration levels, helping to ensure worker safety and prevent equipment failure. Additionally, with a solid list of project risks and contingency plans in place, the device can be developed with confidence and the risks associated with the project can be minimized. Overall, the dust sensor monitoring device is an essential tool for any industrial business that wants to ensure a safe and efficient working environment.