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AUTOMATIC FIRE EXTINGUISHING SYSTEM

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Introduction/Background

- **Problem Statement:** The challenge of our Automatic Fire Extinguishing System is to automate early fire detection and rapid response in high-risk environments, improving safety, reducing damage, and addressing the shortcomings of traditional fire safety systems.

- **Project Scope:** The proposed system detects and responds early in cases of fire with high detection accuracy and is compatible with different environments for minimal potential damage, reliable operation, better fire safety, and efficiency.

- **Constraints:**
  - System must fit within spaces as small as 4 m^2 as prototype
  - Initial investment cannot exceed SR 6,000
  - Prototype must be completed within a 4-month timeframe

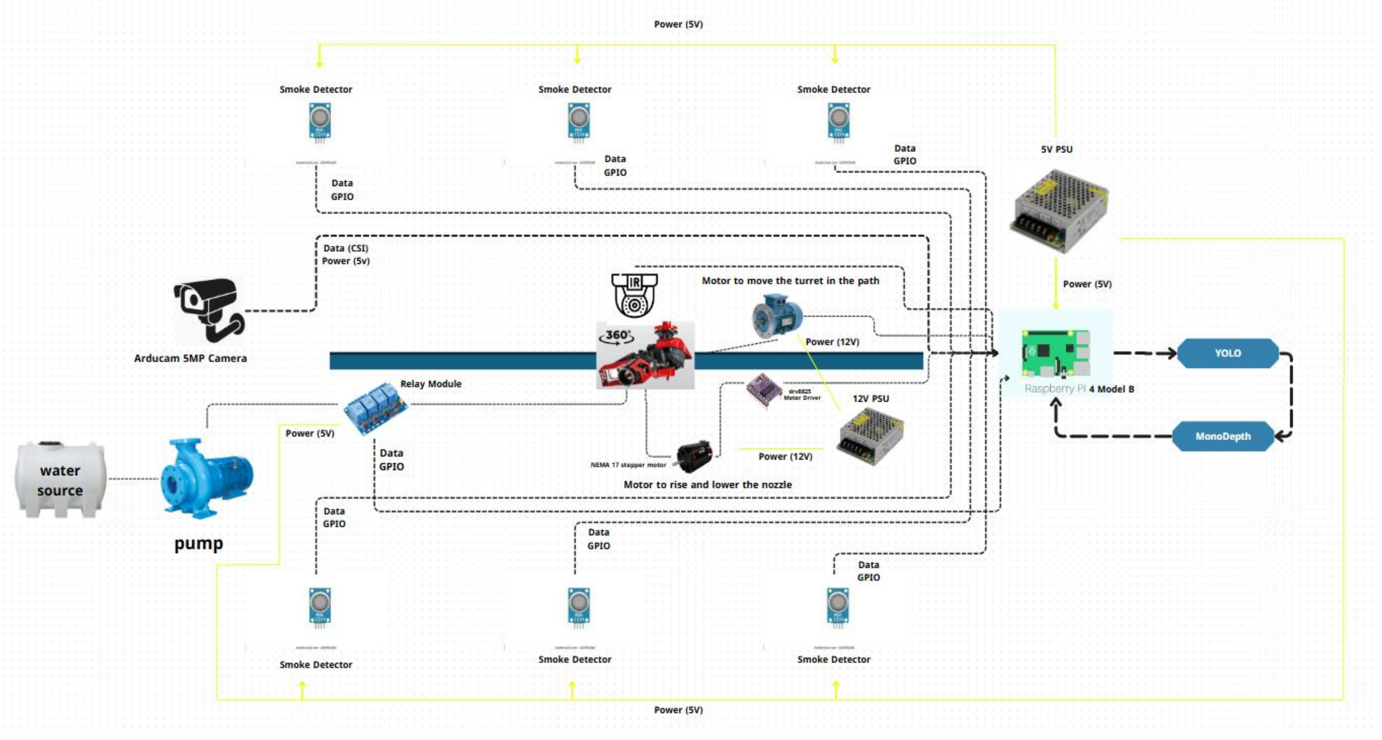
- **Specification:**
  - Fire detection accuracy of at least 90%
  - Fire detection time under 8 seconds
  - Weight less than 30kg
  - Power consumption less than 100watt

Important Equations

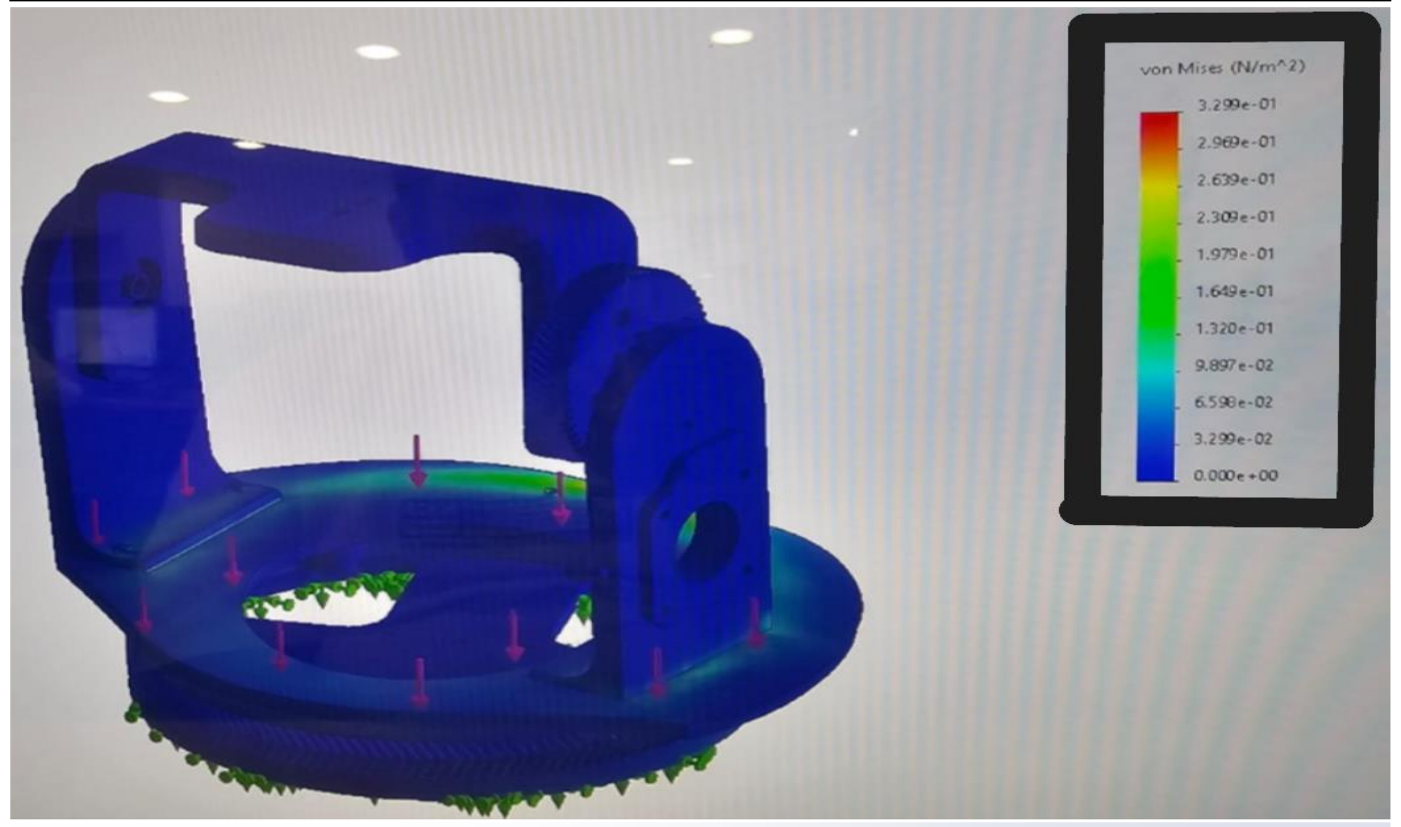
- **The Moving System**
- RPM = 50, w= $\frac{RPM * 2pi}{60}$
- D = 0.25m, V = w * r
- Time = D/V
- W = angular speed
- D = distance
- V = speed

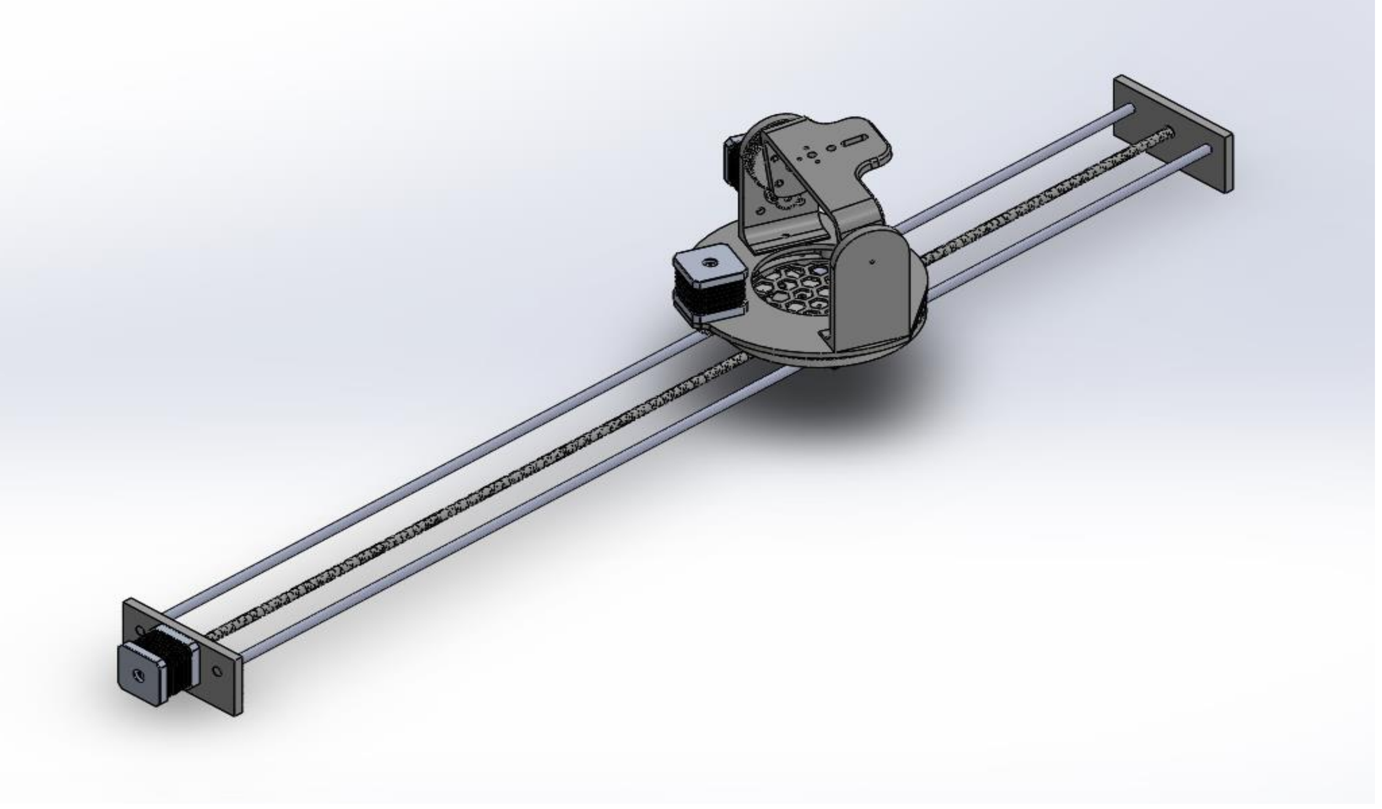
- **The Pan & Tilt System**
- Gear Ratio = N1/N2
- Force = m * g
- Needed Torque = Force * r
- Required Torque = needed T /Gear Ratio
- Torque provided by the motor = 0.6 Nm
- The motors are NEMA 17
- N1 = Teeth on the motor gear
- N2 = Teeth on the Larger gear base
- R = arm length
- Mass = 5kg

Connections



Prototype Design





Mathematical Model for designing the path

Objective Function

$$\text{Minimize} \quad \sum_{k=0}^{N_{\max}-1} b_k \cdot (|x_{k+1} - x_k| + |y_{k+1} - y_k|) + \sum_{k=0}^{N_{\max}-1} b_k$$

Constraints

$$|x_{k+1} - x_k| \le M \cdot z_k \cdot b_k \qquad \forall (x,y) \in \text{Roof}, \quad \exists (x_k, y_k) \quad \text{such that:}$$

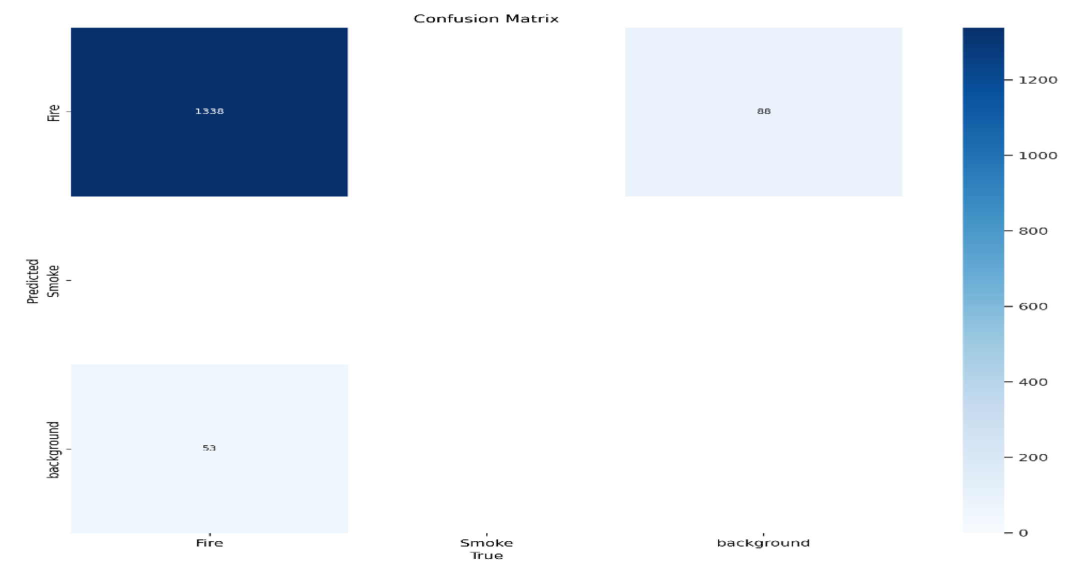
$$|y_{k+1} - y_k| \le M \cdot (1 - z_k) \cdot b_k \qquad \sqrt{(x - x_k)^2 + (y - y_k)^2} \le r$$

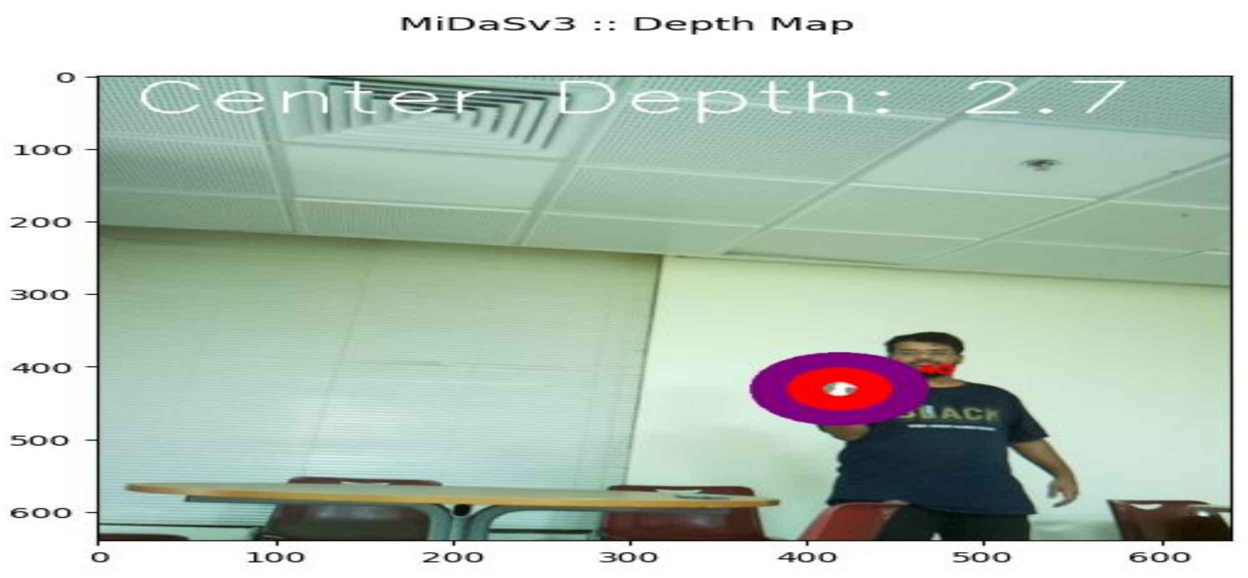
$$|x_{k+1} - x_k| \le M \cdot z_k \cdot b_k$$

$$|y_{k+1} - y_k| \le M \cdot (1 - z_k) \cdot b_k \qquad b_{k+1} \le b_k \quad \forall k \qquad x_k, y_k, L \ge 0$$

Testing/Validation

We tested our AI model with 1,479 Images and found that 141 images detected wrong, so our YOLO model has 90.47% accuracy.





Conclusion

The Automatic Fire Extinguishing System successfully meets the most important demands of early detection and rapid response in high-risk environments. The system shows its potential to improve safety, reduce damage, and overcome traditional fire safety systems' limitations by meeting stringent constraints and specifications such as high detection accuracy, fast response time, and reliable operation within compact spaces. This innovative solution opens new frontiers for enhanced fire management in a wide range of applications.