International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 10 | Oct - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Machine Accident Analytics and Protection System (MAAPS): An IoT and Data Analytics Based Approach to Enhance Safety in Agricultural Machinery

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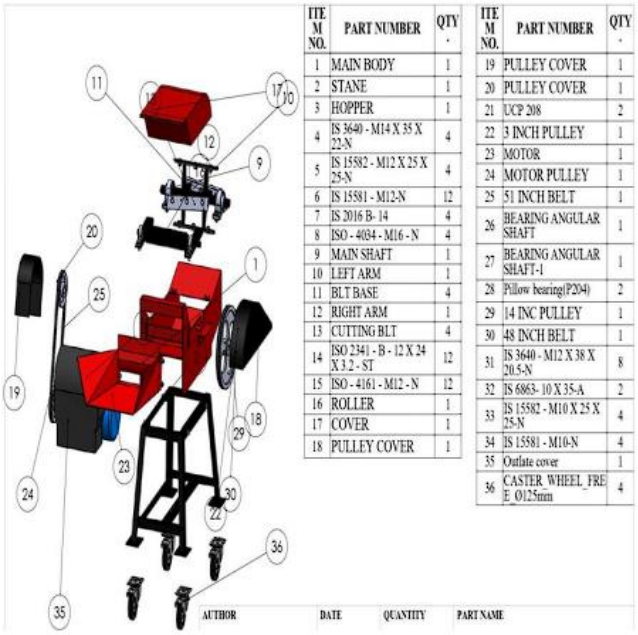
Abstract - The agricultural industry is often associated with significant risks, particularly concerning machine-related accidents. This paper presents the Machine Accident Analytics and Protection System (MAAPS), an Internet of Things (IoT) and data analytics-based system designed to enhance safety in the operation of chaff cutters. By integrating PIR sensors and RFID technology, MAAPS aims to prevent accidents through real-time monitoring and immediate machine shutdown when safety limits are breached. The findings reveal that a significant percentage of accidents occur during specific time frames, particularly between 3:00 PM and 6:00 PM, and are often associated with operator fatigue. This paper discusses the system's design, implementation, and implications for improving safety standards in agricultural machinery.

***Key Words*:** IoT, data analytics, safety, chaff cutter, machine accidents

1.INTRODUCTION

The use of agricultural machinery, particularly chaff cutters, has revolutionized farming practices, increasing efficiency and productivity. However, these machines pose significant risks, with accidents often resulting in severe injuries or fatalities. According to recent studies, many accidents occur due to operator fatigue and lack of real-time monitoring systems. This paper introduces the Machine Accident Analytics and Protection System (MAAPS), a novel solution designed to analyze accident trends and enhance safety protocols in the use of chaff cutters.



ITEM NO.	PART NUMBER	QTY
1	MAIN BODY	1
2	STANE	1
3	HOPPER	1
4	IS 3640 - M14 X 35 X 22-N	4
5	IS 15582 - M12 X 25 X 25-N	4
6	IS 15581 - M12-N	12
7	IS 2016 B- 14	4
8	ISO - 4034 - M16 - N	4
9	MAIN SHAFT	1
10	LEFT ARM	1
11	BLT BASE	4
12	RIGHT ARM	1
13	CUTTING BLT	4
14	ISO 2341 - B - 12 X 24 X 3.2 - ST	12
15	ISO - 4161 - M12 - N	12
16	ROLLER	1
17	COVER	1
18	PULLEY COVER	1

ITEM NO.	PART NUMBER	QTY
19	PULLEY COVER	1
20	PULLEY COVER	1
21	UCP 208	2
22	3 INCH PULLEY	1
23	MOTOR	1
24	MOTOR PULLEY	1
25	51 INCH BELT	1
26	BEARING ANGULAR SHAFT	1
27	BEARING ANGULAR SHAFT-1	1
28	Pillow bearing(P204)	2
29	14 INC PULLEY	1
30	48 INCH BELT	1
31	IS 3640 - M12 X 38 X 20.5-N	8
32	IS 6863- 10 X 35-A	2
33	IS 15582 - M10 X 25 X 25-N	4
34	IS 15581 - M10-N	4
35	Outlate cover	1
36	CASTER WHEEL_FREE_Ø125mm	4

AUTHOR DATE QUANTITY PART NAME

Fig 1: A typical drawing of a chaff cutter machine

2. Literature Review

Previous research has highlighted the need for improved safety measures in agricultural machinery. Studies have demonstrated that integrating IoT technology can enhance operational safety by providing real-time data and alerts. Existing systems have utilized various sensors to monitor operator behavior and machine performance. However, there is a gap in the development of comprehensive systems that not only analyze data but also implement immediate safety measures.

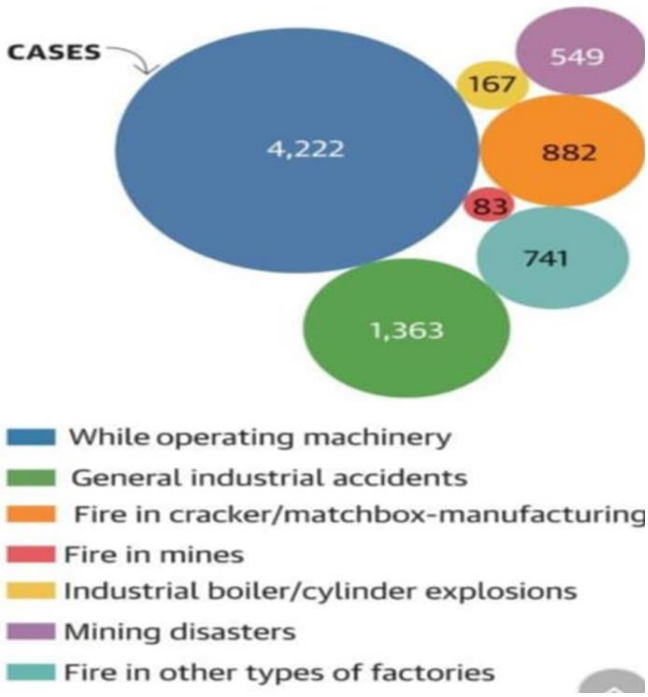


Fig.2: Cases in 2021

3. Methodology

The MAAPS system comprises several components:

Fig. Arduino

- Arduino Microcontroller: Serves as the central processing unit for the system.

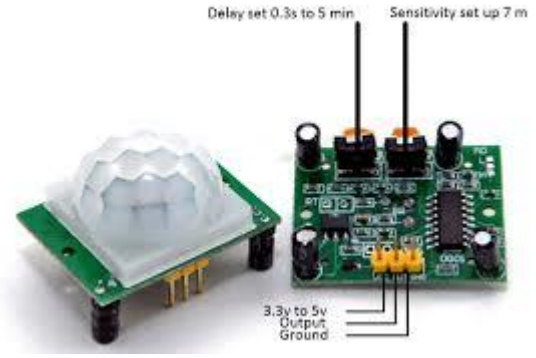


Fig. PIR Sensors

- PIR Sensors: Detect human hands crossing predetermined safety limits.

Fig. RFID Sensors

- RFID Sensors: Placed on gloves worn by operators, communicating with readers installed on the chaff cutter to track proximity and ensure safety.

Battery

- Battery: Powers the entire system.

When the PIR sensor detects a hand crossing the safety limit, the system immediately shuts down the machine and engages the brakes to stop the blades from rotating, preventing potential injuries.

4. Results

Data collected from testing the MAAPS system on a demo model indicated that chaff cutters were responsible for a significant number of incidents, particularly those requiring amputation. Key findings include:

- Timing of Incidents: Eighteen (45%) of the incidents occurred between 3:00 PM and 6:00 PM.

- Causes of Incidents: Twelve (30%) of the incidents were attributed to operator fatigue.

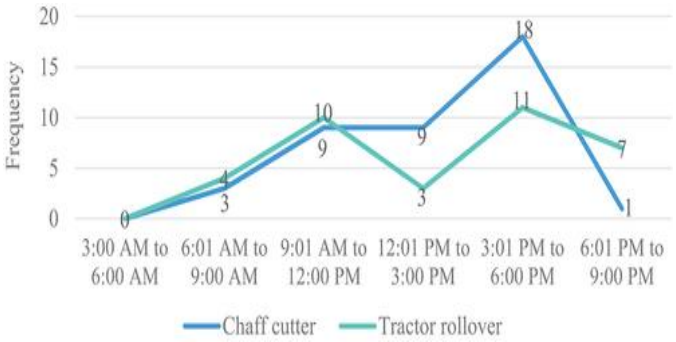


Fig.3: Severity of Agricultural Injuries and Its Economic Consequences in Border Belt of Gurdaspur District of Punjab, India

Visual representations of the data were created using bar charts and pie charts, illustrating the rates and trends of accidents associated with chaff cutters.

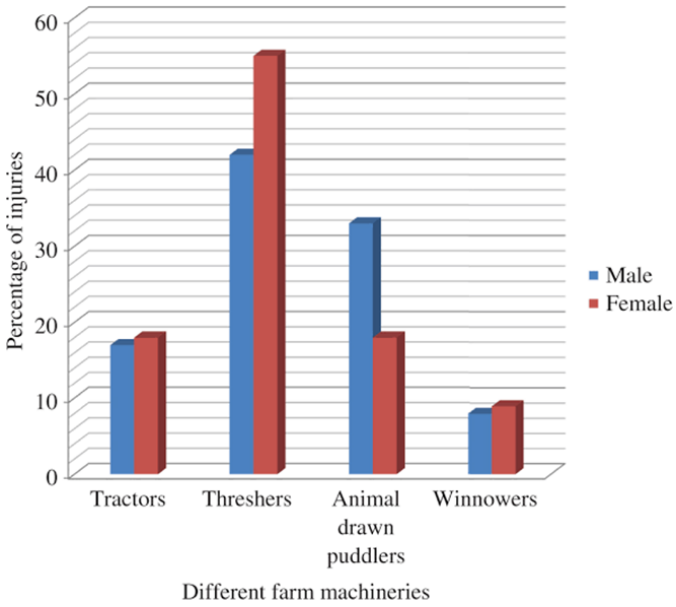


Fig.4: Male Female ratio with respect to injuries

5. Discussion

The results of the study demonstrate the potential of the MAAPS system to significantly reduce accidents in the use of chaff cutters. By analyzing the timing and causes of incidents, the system can implement targeted safety measures, such as scheduled breaks during high-risk periods. The integration of IoT technology allows for continuous monitoring, providing a proactive approach to safety in agricultural machinery.

Despite the promising results, limitations exist, including the need for real-world testing to validate the system's effectiveness fully. Future research should focus on collaborating with farms and manufacturers for extensive field testing and further refinement of the system.

6. Future Scope

There are several areas where MAPS can be expanded and improved:

- Scalability:
  The system can be adapted to different types of industrial machines by modifying sensor placement and integration.
- Advanced Analytics:
  By incorporating machine learning algorithms, the system could predict potential accidents based on operator behavior and machine usage patterns.
- Integration with Existing Safety Systems:
  MAPS can be integrated with other safety protocols, such as emergency shut-off systems, to create a comprehensive safety solution.

7. Conclusion

The Machine Accident Analytics and Protection System (MAAPS) represents a significant advancement in agricultural safety technology. By utilizing IoT and data analytics, MAAPS addresses critical safety concerns associated with chaff cutters, potentially reducing the incidence of accidents and improving operator safety. Future developments should focus on real-world implementation and continuous improvement of safety protocols in the agricultural sector.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to all those who contributed to the successful completion of the Machine Accident Analytics and Protection System (MAAPS) project.

First and foremost, I would like to thank my supervisor, **Prof. Imran Tamboli** sir, for their invaluable guidance and support throughout this research. Their expertise and encouragement were instrumental in shaping my understanding of IoT and data analytics in the context of agricultural safety.

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