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	1)Painam Surendrakumar
	    Address of Applicant :Dr. Painam Surendra kumar, Associate Professor, Department of Electronics and Communication Engineering, Bapatla Engineering College, Bapatla-522102, Andhra Pradesh, India. ----------- -----------

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Name of Applicant : NA
Address of Applicant : NA
(72)**Name of Inventor :**
  1)B. Chinna Subbanna
Address of Applicant :Asst. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India Bapatla ----------- -----------
  2)Kommalapati Rajesh
Address of Applicant :Asst. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India. Bapatla ----------- -----------
  3)Painam. Surendra Kumar
Address of Applicant :Assoc. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India Bapatla ----------- -----------
  4)M. Vamsi Krishna
Address of Applicant :Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India. Bapatla ----------- -----------
  5)Y. Kavya
Address of Applicant :Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India. Bapatla ----------- -----------
  6): K. Varshini
Address of Applicant :Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India. Bapatla ----------- -----------
  7)P. Ruthik
Address of Applicant :Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India. Bapatla ----------- -----------
  8)U. Srinivasa Rao
Address of Applicant :Assoc. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India. Bapatla ----------- -----------
  9)Miriyala Suneel
Address of Applicant :Asst. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India Bapatla ----------- -----------
  10)K. Kalpana
Address of Applicant :Asst. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India Bapatla ----------- -----------
  11)Mahesh Gatram
Address of Applicant :Asst. Professor, Department of Electronics and Communication Engineering Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India Bapatla ----------- -----------
  12)Bapatla Engineering College
Address of Applicant :Bapatla Engineering College, Bapatla, 522102, Andhra Pradesh, India Bapatla ----------- -----------

(57) Abstract :

Railway bridges, primarily constructed from steel, are susceptible to environmental variations such as temperature fluctuations, humidity, and moisture, as well as natural disasters including earthquakes and floods. These factors necessitate continuous monitoring of parameters such as bridge tilt and water levels to ensure structural integrity. Maintaining the structural stability of railway bridges is essential for the safety and efficiency of railway transportation. This study proposes an intelligent monitoring system that utilizes a Wireless Sensor Network (WSN) and the Internet of Things (IoT) to assess real-time structural and environmental conditions. The proposed system integrates various sensors, including load cells, tilt sensors, ultrasonic sensors, humidity and moisture sensors, and temperature sensors, to monitor critical parameters. Data collected from these sensors undergoes processing through the Random Forest Machine Learning algorithm, implemented using Python IDLE 3.8 (64-bit), for predictive analysis and anomaly detection. The CPU of the system is an Arduino UNO microcontroller, which facilitates data communication via Radio Frequency (RF) signals. In the event of structural anomalies, an alert mechanism comprising an LCD display, a buzzer, and emergency signal lights provides immediate warnings before a train enters the bridge. This system employs RF technology for wireless data transmission and operates within a relative range of 15 meters, with potential for extended coverage through frequency band modifications. The operational frequency range of 2.4 GHz to 2.5 GHz aligns with standard wireless communication protocols, including Wi-Fi modules. By enabling real-time remote monitoring, the proposed system enhances railway bridge safety, reduces maintenance costs, and improves early failure detection.

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