

# A Wireless Sensor Network Based Habitat Monitoring for Protection of Endangered Species

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**ABSTRACT:** Wildlife conservation has become an increasingly important practice due to various negative aspects like global warming, deforestation, poaching, forest fires, and other unwanted direct or indirect human interferences. Wireless sensor networks play an important role in protection of endangered species through constant habitat monitoring and thus providing information so that necessary actions could be taken at the earliest. The proposed system employed wireless sensor networks to perform real-time monitoring of an area under observation. The system enabled human intrusion detection in the restricted area to prevent various illegal activities like poaching and deforestation, forest fire detection, elephant birth detection or other herd behavior on the roads through the protected areas of the forest as well as drought detection. The system also included a provision for water supply to the drought affected water source in the area under observation. The system enabled remote real-time monitoring through live video streaming which could be accessed from anywhere around in the world. The contribution of the system lies in providing real time data and for including necessary monitoring activities that help to protect the endangered species in their natural habitat.

**KEYWORDS:** WSN, Wildlife conservation, Habitat monitoring, Real-time monitoring.

## I. INTRODUCTION

Conservation is the practice of protecting wild species and their natural habitats. Wildlife conservation is important to ensure that nature will be protected and to realize the importance of forest and natural resources in the life of human population. Wildlife conservation has become an increasingly important practice due to the negative effects of human activity. An endangered species is defined as a population of a living species that is at the verge of extinction. The human interference into the wildlife has seriously affected the existence of a large number of species. Practices like deforestation (deliberate forest fires and cutting of trees) and poaching have led to massive extinction. The present situation of wildlife monitoring is manual i.e., forest range officers take rounds in the forests for monitoring. This current way has helped to find dead animals and remains of cut trees and cleared land. The existing methods do not ensure any protection measures other than monitoring at the outskirts of the forests. Manual monitoring is nearly impossible in dense forests because of predators. The traditional method depends on rainfall measurements to assess droughts and does not give any support for survival of species. When conditions of emergencies are encountered, like endangered species wounded or if the habitat is at an environmental threat like forest fires and floods, the animals are moved to a man made facility like zoo which is not a persistent solution and does not give any assurance for species continuity. Range offices are sometimes or never occupied with wireless communicating devices which is not sufficient for acquiring that degree of protection which protects the forests and its inhabitants from extinction. Other practices for

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monitoring depend on satellites and such monitoring is performed for monitoring forest fires. But the reporting time is almost two hours which is a question to time criticality. Hence there is an urgent need for habitat monitoring [1] that is implemented efficiently with the aim to protect the plant and animal species in their natural habitats and also ensuring less human animal interaction.

WSN plays an important role in habitat monitoring as the sensors sense parameters that are impossible manually. The WSN reduces human intervention into the wildlife thus providing an undisturbed environment. The monitoring using WSN requires least time interventions to set up the system and to check the conditions of the system. The WSN enables keen observation of the environment sensing all the possible details. The monitored parameters made available to the remote user can help to evaluate the habitat based on the sensed information and take necessary actions.

The objective of the paper is to ensure protection to the endangered species through habitat monitoring employing the possibilities of various applications of Wireless Sensor Network. The proposed system finds that the species are best protected in their natural habitats and aims at monitoring the shelters of the endangered species. The system aims to provide protection from poachers and deforestation due to cutting of trees. The monitoring of animal movement on roads in the forests forms a part of the system which reduces the human animal encounters. The proposed system establishes a drought handling mechanism to ensure water supply to where water scarcity is a concern. The proposed system thus aims at a reduced human intervention in the wildlife and hence conservation of biodiversity.

The organization of the paper is as follows. Section II Discusses the literature survey of the related works in the field. The methodology and block diagram description of the proposed system is explained in Section III. Section IV discusses the results obtained after experimenting each working section of the system. Section V concludes the paper and also mentions future scope of the proposed system.

## II. LITERATURE SURVEY

The study of existing approaches and background researches give necessary information and ideas to implement the proposed system. The importance of the existing theories relate to the fact as to which parameter should be made the subject of study. This section gives a review of the various research studies conducted in the area of interest.

Alan Mainwaring et al. [1] gives an in depth study related to the application of wireless sensor networks to real-world habitat monitoring based on the burrowing habit of the ducks on The Great Duck Island. The proposed system states design requirements which include the hardware design of the nodes, sensor network, and the capabilities for remote data access and management. System architecture is proposed to address these requirements for habitat monitoring.

Harminder Kaur et al. [2] discuss the need for efficient disaster detection and alerting system could effectively reduce the loss of life and properties in the event of a disaster. The paper highlights the efficiency of WSN in continuous monitoring platforms and becoming one of the enabling technologies for alert systems. The paper discusses several WSN architectures to alert flood, forest fires, drought, earthquake and Tsunamis.

Anton Herutomo et al. [3] defines the architecture of the system with the objective of developing a prototype for forest fire detection based on WSN which can communicate to OpenMTC M2M platform using the Internet and to test its reliability based on sensor accuracy and system response in detecting a forest fire.

Piero Zappi et al. [4] demonstrates how low-power, low-cost devices can provides useful information regarding the movements of people within observed environments. The paper evaluates the ability of PIR sensors to provide a reliable indication of people presence.

Mehdi Ahmedi et.al [5] presents a new real time video streaming system for remotely monitoring ultrasound exams. The proposed system calls for the need of video transmission of the ultrasound exams with best possible quality from a remote area to medical facilities where service of the expert could be available. The proposed system transmits the video via the Internet over long distances.

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## III. PROPOSED METHODOLOGY

Habitat monitoring is the major concern of the proposed system. The need for protection of endangered species in their natural habitats and prevention of wild animal and human conflict is the motivation behind the proposed system. The proposed system provides human intrusion alert, drought and forest fire indication. The system also has provision for monitoring of the water bodies around which a major population of animals in the forest depends for food and water. The proposed system includes a water pumping functionality for pumping water when the drought is severe and affects the water body in the forest. The movement of animals through roads in the protected forests are also monitored and informed to the officials in the forest range office. The proposed system also gives a live streaming of the events monitored. The proposed system employs a PIR based human detection. When the human presence is felt, the system detects and conveys the message over the Internet to the web page. The droughts in the extreme summer area major cause for the death of wild animals. A measure to monitor the droughts is provided by constantly keeping an account of the temperature. Forest fires are another major cause for the extinction of animals on a large scale. The temperature variation is analyzed for the higher increase in temperature and assessed for the forest fire or drought. Animals depend on common water source in the dense forest, depletion of which can seriously affect the food chain. The proposed system includes a water source monitoring facility to monitor the water level in the water source and involves a mechanism for supply of water at times of severe drought. Major reason for death of humans on roads through protected forests is the elephant stampede. So the proposed system enables animal detection on roads to indicate the presence of animals so that a diverted path could be taken. All the information sensed by the proposed system is communicated to the forest officials which could be viewed from anywhere in the world. The block diagram of the proposed system is shown in figure 1. The main processing function of the proposed system is carried out by the Raspberry Pi to which the various sensor blocks are interfaced. The human intrusion detection to detect the presence of poachers and people cutting down trees is implemented using a PIR sensor which senses human in its range. This sensor gives a digital output and hence it is directly interfaced to the Raspberry Pi. The sensor on sensing a human presence gives a message that human is detected and when no such detection activities occur, it gives a message conveying that human is not detected. The temperature measurement based on which the drought and forest fires are assessed is performed with the help of a temperature sensor; the sensor being used here is DHT11 which also provides a digital output. The sensor continuously measures the temperature and communicated the value to the processor. The animal detection on roads is made possible using a pressure sensor, FSR406. The change in resistance of the sensing element denotes the presence and absence of animal on the road. The sensed information is also communicated to the processor. The system consists of a drought management mechanism which consists of a water level sensor to monitor the water level. The water level sensor used in the system is a float sensor which detects when the water level goes beyond a critical level. The system includes a pumping mechanism that pumps water to the source in critical state which consists of a pump and a driver circuit to drive the motor. The system encloses a web camera for live video streaming. The information sensed by the various sensors is loaded to the web page designed for wildlife monitoring along with live video streaming.

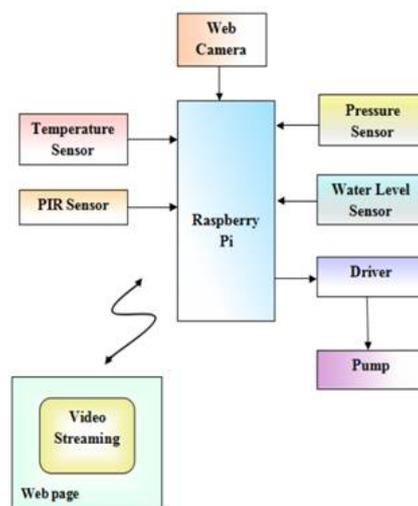


Fig 1. Block Diagram of the Proposed System

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The software implementation of the proposed system is done using Python IDLE. The webpage is created using HTML and loaded using Python.

## IV. EXPERIMENTAL RESULTS

The proposed system has 5 main working sections: Live Video Streaming, Human Intrusion Alert, Animal Detection on Roads, Drought and Fire Indication, Water Level Sensing and Pumping. The sensed parameters are displayed on the website designed for the purpose which could be viewed from anywhere using Internet. Figure 2 displays the parameters in the website when the system is initialized. The label “Temperature” displays the sensed temperature values from the temperature sensor, “PIR” indicates the detection of human presence (sensed by the PIR sensor), “Water Level” indicates the level of criticality of water in the water body under observation (sensed by the float sensor), and the label “Animal” indicates the presence of animals on the roads (sensed by the pressure sensor).

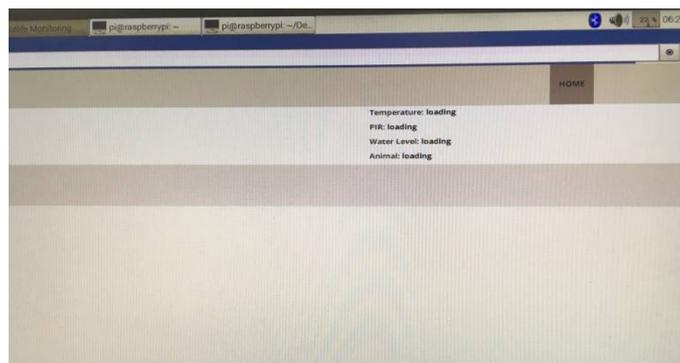
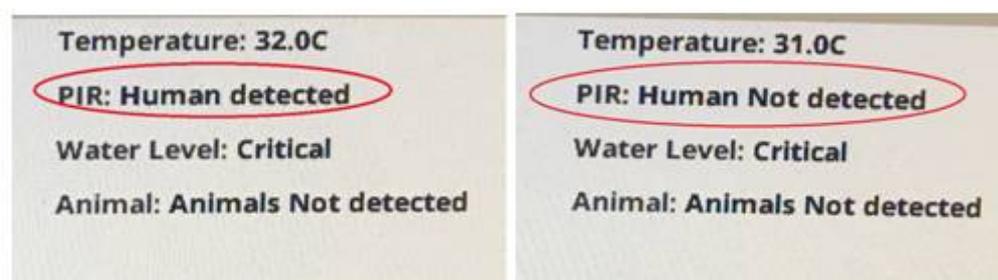


Fig1 Display of the webpage showing parameters during system initialization

Figure 3 (a), (b), (c), (d), shows the various results displayed when the sensor sensed different parameters for each condition.

Figure 3 (a) shows the parameter sensed by the PIR sensor. The label gives an output “Human detected” when the sensor senses the presence of human and displays “Human not detected” when the presence is not detected by the sensor. Figure 3 (b) shows the output of the pressure sensor displaying “Animals detected” when a pressure is applied on the sensor and displaying “Animals Not detected” when no pressure is applied. Figure 3 (c) shows the output of the temperature sensor giving a continuous reading of the measured temperature of the area under observation. Figure 3 (d) displays the output of the float sensor. The webpage displays water level being “OK” when the float is up and displays “Critical” when the float shifts down.



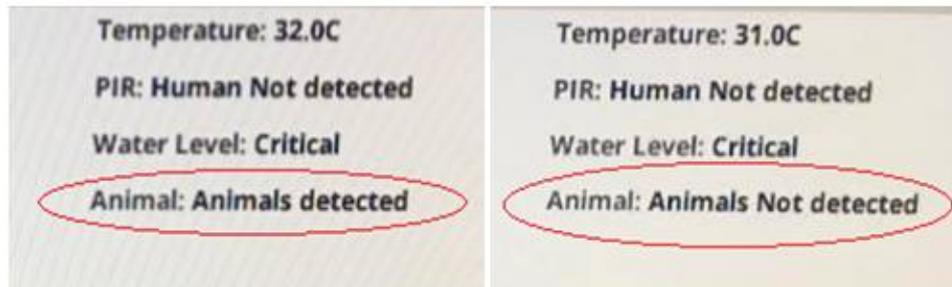
(a)

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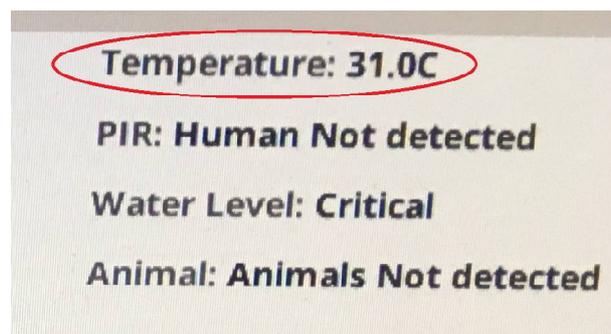
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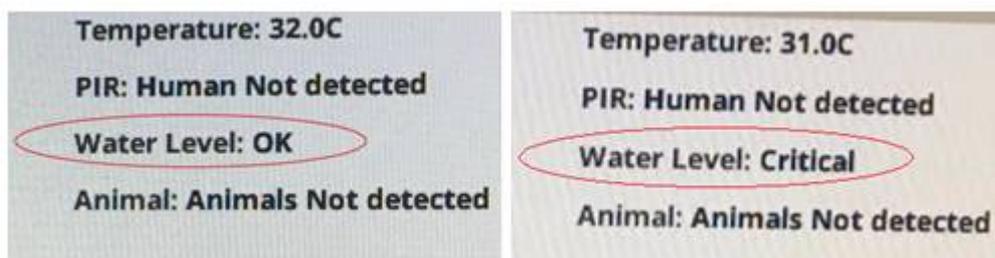
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(b)



(c)



(d)

Fig 3. Website display of results against the corresponding labels (a) Reading of the PIR Sensor when the human presence is detected and not detected. (b) Reading of the Pressure Sensor when the animal presence is felt and not felt. (c) Reading of the Temperature Sensor in degree Celsius (d) Reading of the Float Sensor when the water level is satisfactory and critical.

## V. CONCLUSION

The proposed system implemented various sensors to achieve monitoring of the natural habitat. Human intrusion system prevents endangered animal species from being hunted and trees from being cut. Sensors are deployed to monitor forest fire possibilities as well as to detect drought. The system also focuses on water supply to the drought affected area so that animals need not move out from their habitat. This measure prevents the incidents of predator attack in residential areas. Human safety on roads through protected forests is achieved by monitoring herd behavior and providing information regarding an alternate path. Moreover live video streaming of the events along with the monitored parameters could be viewed from anywhere using a website. Habitat monitoring is a breakthrough measure

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to prevent extinction as species are protected in their natural habitats. Other factors like quality of the water resources in the forests can also be included in the monitoring. The water level sensing could be modified well enough to act as a flood alert system. The sensed parameters could be communicated to the concerned personnel with the help of GSM so that the time criticality of the monitored factors like forest fires and human intrusion could be instantly notified and necessary measures could be taken at the earliest. The night monitoring through video streaming could be improved with the help of night vision cameras. Fire fighting systems could be incorporated so that the forest fires are degraded at the very onset. Thus the proposed system could be expanded to various levels of habitat monitoring and protective measures ensuring continuity of species of flora and fauna thus maintaining biodiversity.

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