Smart Incubation and Monitoring System for Olive Ridley Turtle

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Abstract— *Olive Ridley Turtles Hatchings face Predation from various predators such as birds, crabs, etc., and Coastal development, Pollution etc. The Smart Incubation and Monitoring System for Olive Ridley Turtles is a comprehensive solution designed to enhance the conservation efforts of these endangered species. Utilizing advanced technologies such as IoT sensors, the system monitors crucial parameters during the incubation process, ensuring optimal conditions for turtle eggs. Real-time data transmission allows researchers to remotely observe and analyze environmental factors, safeguarding against potential threats. Weight sensor will observe the weight of the egg, based on the egg weight gender will be displayed. This innovative system not only improves hatchling success rates but also contributes significantly to the overall conservation of Olive Ridley Turtles.*

Keywords— **Olive Ridley Turtles, Monitoring System, gender, IoT, Turtle eggs**

1.INTRODUCTION

Olive Ridley Turtles are an endangered species, and their conservation faces several obstacles such as habitat loss from pollution and coastal development, as well as predation[1].

The Olive Ridley turtle, scientifically known as Lepidochelys olivacea, is one of the five species of sea turtles globally recognized. The unique olive-green colouring of these turtles is well known. An Olive Ridley Turtle is seen in Figure 1. In the Indian setting, the Olive Ridley turtle is an important conservation problem, especially in coastal locations. These turtles are found throughout the Pacific and Indian Oceans, primarily in tropical and warm seas. Their distribution is circumtropical, extending from Arabia and India to Japan, Micronesia, southern Africa, Australia, and New Zealand[2]. When the turtles come ashore to lay their eggs, these nesting places are essential to their reproductive cycle.

Figure2 represents the nesting ground in and around India in which red circles are major nesting grounds and yellow circles are minor nesting beaches. Conservation efforts often focus on protecting these nesting grounds and implementing measures to safeguard the turtles during their nesting season. This includes minimizing disturbances, preventing poaching, and raising awareness among local communities about the importance of preserving these habitats for the survival of Olive Ridley turtles.

Fig 1:Olive Ridley Turtle

Olive ridley turtles display two distinct nesting behaviors: solitary nesting, which is more common, and the synchronized mass nesting known as arribadas, which they are famous for. During the nesting season, female olive ridleys return to the same beach where they were hatched to lay their eggs. They meticulously dig conical nests about 1.5 feet deep using their hind flippers. In the Indian Ocean, particularly in the Arabian Sea near Honavar, Karnataka, a significant number of olive ridleys nest in large groups near Gahirmatha in Odisha. This coastal region is one of the largest mass nesting sites for olive ridleys globally, along with similar sites in Mexico and Costa Rica. For instance, in 1991, an astonishing 600,000 turtles nested along the Odisha coast within a single week. While mass nesting is prominent in certain areas like Odisha, solitary nesting also occurs along the Coromandel Coast and Sri Lanka, although in scattered locations. Despite these notable nesting sites, olive ridleys are considered rare in many parts of the Indian Ocean, with some nesting populations existing in the islands of Bangladesh near Cox's Bazar.

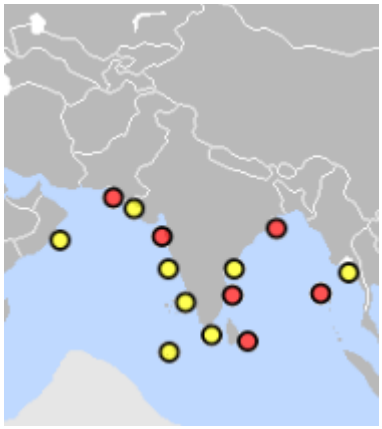

Fig 2:Red circles are major nesting grounds;

yellow circles are minor nesting beaches Nesting grounds

The Gahirmatha Marine Sanctuary in Odisha shown in Figure 3 is renowned as the world's largest rookery of sea turtles, serving as a critical breeding ground for olive ridleys and other turtle species. Conservation efforts in these areas focus on protecting nesting sites, minimizing human disturbances, and raising awareness about the importance of preserving these habitats for the survival of olive ridley turtles. Conservation efforts aimed at protecting Olive Ridley turtles encompass a range of strategies, including habitat preservation, nesting site management, and community engagement. Local communities living near nesting beaches are often involved in conservation initiatives, helping to monitor nesting activity, deter poaching, and promote responsible tourism practices. Overall, understanding the nesting behaviors of Olive Ridley turtles and implementing effective conservation measures are essential for ensuring the long-term survival of this iconic species. Through concerted efforts and continued research, we can work towards a future where these magnificent turtles thrive in their natural habitats.

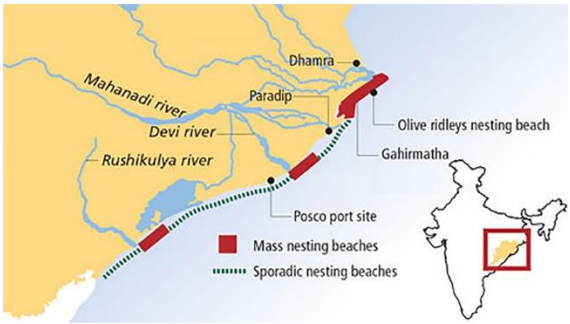

Fig 3 Odisha's Gahirmatha Marine Sanctuary

A.Threats

Hatchlings encounter many hungry predators when they emerge from their nests and make their way across the beach to the ocean. Vultures, frigate birds, crabs, raccoons, coyotes, iguanas, and snakes are some of these predators. After hatchlings are in the water, they continue to face risks from a variety of marine predators, including sharks, crocodiles, and oceanic fish.Olive Ridley turtles confront additional significant threats beyond predation. Mortality resulting from boat collisions poses a considerable risk, as do incidental captures in fishing operations. One of the most significant challenges Olive Ridley turtles face during mass nesting events, or arribadas, is the inadvertent destruction of previously laid nests. The sheer density of nesting females during these events often leads to nests being inadvertently dug up and destroyed by other females as they dig their own nests, resulting in substantial egg loss.

Natural disasters, coastal development, and the consequences of climate change continue to be threats to Olive Ridley turtle nesting areas.. These factors contribute to beach erosion, which can diminish available nesting habitat and exacerbate the challenges faced by nesting females during the critical nesting season. Efforts to mitigate these threats require a multifaceted approach that addresses both natural and human-induced factors impacting Olive Ridley turtles and their nesting habitats. Conservation initiatives aimed at protecting nesting sites, reducing human disturbance, implementing sustainable fishing practices, and addressing the broader issues of habitat degradation and climate change are essential for the long-term survival of this species. Additionally, raising awareness and fostering community involvement are vital components of effective conservation efforts aimed at safeguarding Olive Ridley turtles and their nesting grounds[1].

Here as a conservation initiative, we have proposed a Smart Incubation and Monitoring System for Olive Ridley Turtles. This all-inclusive system uses cutting-edge technologies, like Internet of Things sensors, to track vital indicators throughout the incubation of turtle eggs. Through the provision of real-time data transmission and optimal settings, the system enables researchers to remotely monitor and assess environmental elements, thereby efficiently mitigating potential dangers. Notably, the weight sensors allow the system to infer the gender of the hatchlings from the weight of the eggs, which improves our knowledge of population dynamics. With this novel approach, hatchling success rates have increased dramatically, which is a major advancement for Olive Ridley Turtle conservation and the preservation of their delicate environments.

2.Related Works

Remote sensing techniques, such as satellite imagery and aerial surveys, are widely used in wildlife monitoring and conservation[3]. Satellite technology can provide valuable information about nesting habitats, population dynamics, and threats to sea turtle populations, including habitat loss, pollution, and climate change[4]. Several projects focus on developing smart monitoring systems for various species of sea turtles, including Olive Ridleys[5]. These systems typically involve the use of sensors, cameras, and IoT technology to monitor nesting activities, environmental conditions, and threats to nesting sites. For example, the Sea Turtle Conservancy's "Tour de Turtles" project incorporates satellite tracking to monitor the migration patterns of sea turtles, providing valuable data for conservation efforts[6]. Data analytics and machine learning algorithms are increasingly being used to analyse Several initiatives have implemented automated nest monitoring systems for various sea turtle species. These systems often utilize sensors and cameras to monitor nesting activity and environmental conditions, providing valuable data for research and conservation.

While not tailored specifically for Olive Ridley turtles, these technologies share similarities with the Smart Incubation and Monitoring System in terms of remote monitoring and data collection. large datasets collected from wildlife monitoring efforts. These techniques can help identify patterns, trends, and anomalies in sea turtle nesting behaviour and environmental conditions, enabling more effective conservation strategies and interventions. In the realm of wildlife conservation, there are numerous projects leveraging IoT technologies for monitoring and protecting endangered species. These systems may employ sensor networks, satellite tracking, and data analytics to track animal movements, habitat

usage, and environmental factors. While not focused solely on sea turtles, these initiatives demonstrate the potential of IoT-based solutions for wildlife conservation, which could be adapted for Olive Ridley turtle conservation efforts. Remote sensing technologies, including satellite imagery and aerial surveys, are commonly used in marine conservation to monitor habitat changes, detect nesting sites, and assess population trends. Satellite-based monitoring can provide valuable insights into sea turtle distribution and habitat use, complementing on-the-ground efforts such as the Smart Incubation and Monitoring System. Robotics and autonomous systems are increasingly being deployed in conservation efforts to monitor and protect wildlife. For example, drones equipped with cameras and sensors can survey remote areas, monitor nesting sites, and detect threats such as poaching or habitat destruction. While still emerging, these technologies hold promise for enhancing the efficiency and effectiveness of sea turtle conservation initiatives.

These related works and technologies highlight the diverse approaches to wildlife monitoring and conservation, many of which share common goals and principles with the Smart Incubation and Monitoring System for Olive Ridley turtles. By building upon existing research and technological advancements, conservationists can continue to develop innovative solutions to safeguard endangered species and their habitats.

3. Proposed System

At its core, our system is equipped with state-of-the-art sensors and IoT (Internet of Things) connectivity, enabling real-time monitoring of crucial environmental variables within the nesting site. These variables include temperature, humidity, and sand moisture levels, all of which are critical factors affecting the success of turtle egg incubation. By continuously collecting and analyzing this data, our system can detect even subtle deviations from optimal conditions. One of the key advantages of our Smart Incubation and Monitoring System is its ability to provide real-time insights and alerts. If any environmental parameters fall outside the ideal range for Olive Ridley turtle egg incubation, the system can immediately trigger alerts to conservationists or researchers. This allows for timely intervention, such as adjusting environmental conditions or relocating at-risk nests, to ensure the best possible outcomes for the developing eggs.

Moreover, our system goes beyond mere environmental monitoring by incorporating advanced surveillance capabilities. Through strategically placed cameras and sensors, it offers remote monitoring of nesting activities, providing valuable insights into turtle behavior and nesting patterns. Additionally, this surveillance functionality serves as a deterrent to potential threats such as poaching or predation, helping to safeguard both nesting turtles and their eggs. By combining comprehensive environmental monitoring with proactive intervention and surveillance, our Smart Incubation and Monitoring System significantly enhances the success rate of Olive Ridley hatchings. Not only does it improve the chances of successful egg incubation, but it also contributes to broader conservation efforts aimed at protecting this endangered species. Ultimately, our system represents a vital tool in the ongoing battle to preserve the biodiversity of our oceans and ensure a brighter future for Olive Ridley sea turtles. Furthermore, our system offers a user-friendly interface that allows conservationists and researchers to access and analyze the collected data conveniently. With customizable dashboards and reporting tools, users can gain valuable insights into long-term trends and patterns, helping to inform conservation strategies and management decisions.

A more all-encompassing approach to Olive Ridley sea turtle conservation is fostered by the capacity to remotely access data and adjust system settings, which also makes it easier for stakeholders—including local communities, governmental bodies, and nonprofit organizations—to collaborate. By empowering stakeholders with actionable information and facilitating collaborative efforts, our Smart Incubation and Monitoring System strengthens the overall resilience of conservation initiatives, ensuring a sustainable future for these iconic marine species.

A.Temperature-Dependent Sex Determination (TSD)

Olive Ridley turtles have a fascinating reproductive strategy known as temperature-dependent sex determination[7]. This indicates that the temperature at which their eggs are incubated affects the sex of the hatchlings. In general, female hatchlings develop at warmer temperatures, while male hatchlings develop at cooler temperatures. Concerningly, though, are the effects of climate change on this temperature-dependent sex determination mechanism. As global temperatures rise due to climate change, it could potentially alter the temperature regimes experienced by Olive Ridley turtle eggs during incubation. This change in temperature could skew the sex ratios of hatching turtles[8], ultimately impacting the overall population dynamics of the species. If warmer temperatures become more prevalent in nesting areas, there could be an overabundance of female hatchlings compared to males[9].

This imbalance in sex ratios could have significant consequences for the reproductive success of Olive Ridley turtles, as it may lead to reduced genetic diversity and reproductive opportunities[10]. Temperature is the main concern that determines the gender of the Olive Ridley Eggs. This system consist of Arduino UNO, Temperature sensor, relay, bulb, fan, weight sensor, and LCD display. Firstly, the olive ridley eggs are placed in the system which is connected to the Arduino UNO. The temperature surrounding the eggs is determined using the temperature sensor as mentioned in Table I.. For the egg to be male, the temperature should be less than or equal to 28℃ and for female, it is should above 31.5℃. Based on the desired gender, the temperature is lower using fan. For increasing the temperature, bulb is used. By using this mechanism of the proposed system shown in Figure 4, the desired temperature is varied.

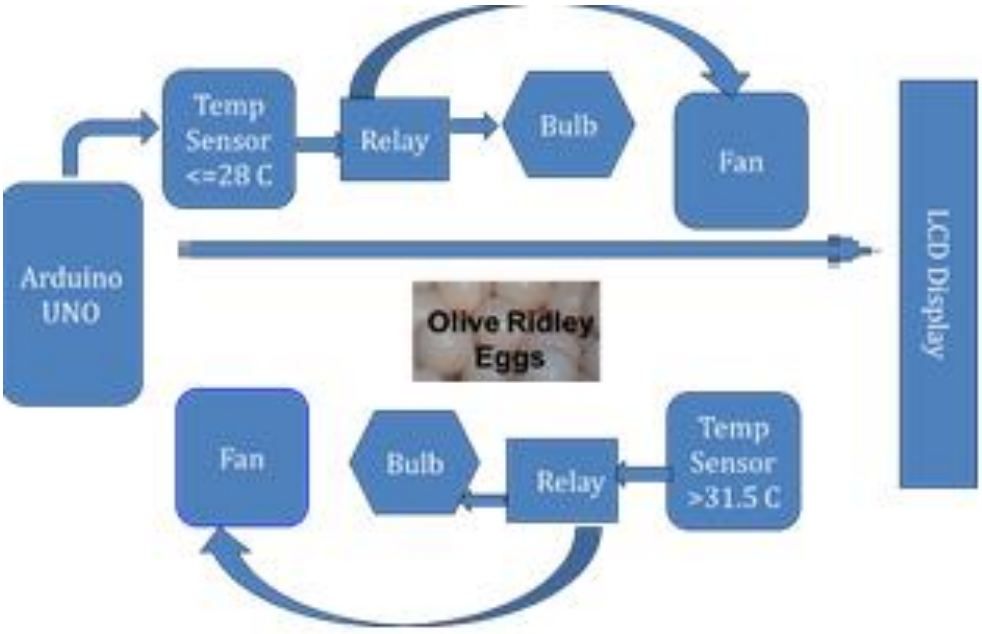

Fig 4: Our Proposed system

Parameters	Male	Female
Temperature Range	Less than or equal to 28 C	Above 31.5 C

Table 1:Parameteric Condition for the Proposed System

4.SOFTWARE DESCRIPTION

Methodology used	Description
Arduino IDE	The car has an ACC system installed in order to facilitate smooth mobility; the system determines what needs to be done based on the distance between vehicles. The Arduino microprocessor is used to implement the adaptive cruise control algorithm in the planned and constructed automobile.
Visual Studio Code	We developed a software programme to construct an Internet of Things platform using Microsoft Visual Studio, an integrated development environment (IDE) from Microsoft.
Embedded C	Programming language Embedded C is used in the software industry to create electronic devices. Every electronic system processor has an embedded software feature. Embedded C programming is essential to the processor's ability to carry out specific operations.

5.RESULTS

The below depicted pictures are the step-by-step implementation of the proposed system that includes Arduino UNO, Temperature sensor, relay, bulb, fan, weight sensor, and LCD display as shown in Figure 5 and Figure 6.

Fig 5: Implementation for two layer Oliver Ridley egg incubation.

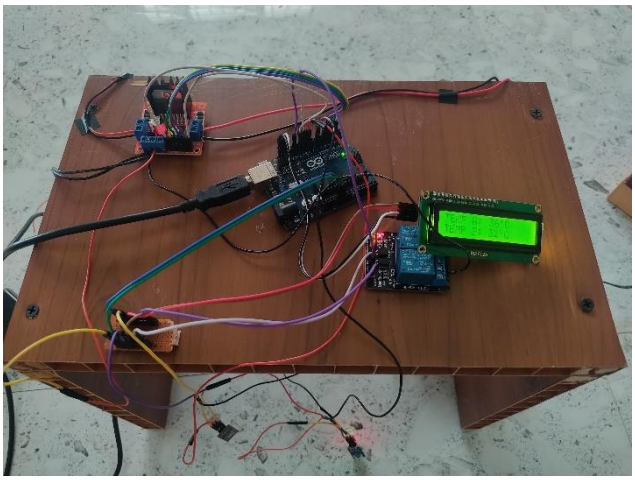

Fig 6: Top view of the proposed system

6.CONCLUSION

In this proposed system, the development and implementation of a Smart Incubation and Monitoring System for Olive Ridley Turtles represent a significant step forward in sea turtle conservation efforts. By leveraging technology such as temperature sensors, data loggers, and remote monitoring capabilities, this system offers a comprehensive approach to addressing the challenges faced by these endangered species during the critical nesting and incubation stages. Through precise temperature control and monitoring, the system helps ensure optimal conditions for the development of Olive Ridley turtle eggs, mitigating the risk of temperature-dependent sex ratio imbalances caused by climate change. Additionally, real-time monitoring allows for timely intervention in cases of nest disturbance, predation, or other threats, helping to safeguard both eggs and nesting females. Furthermore, the Smart Incubation and Monitoring System facilitates data collection and analysis, providing valuable insights into Olive Ridley turtle nesting behavior, population dynamics, and the impact of environmental factors on reproductive success. This information is essential for informing evidence-based conservation strategies and guiding efforts to protect nesting beaches and mitigate human-induced threats. Overall, the

implementation of such innovative technologies underscores a commitment to the conservation of Olive Ridley turtles and their fragile habitats. By combining scientific expertise with technological advancements, we can enhance our ability to monitor, protect, and ultimately ensure the survival of these iconic marine species for generations to come.

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REFERENCES

[1] Lepidochelys, R., Historical, T.A., Alfaro-n, A.: Threats and Vulnerabilities for the Globally Distributed Olive. (2022).

[2] NOAA: Olive Ridley Turtle (Lepidochelys olivacea). 1 (2014).

[3] Hennig, J.D., Schoenecker, K.A., Terwilliger, M.L.N., Holm, G.W., Laake, J.L.: Comparison of aerial thermal infrared imagery and helicopter surveys of bison (Bison bison) in grand canyon national park, USA. Sensors. 21, (2021). https://doi.org/10.3390/s21155087.

[4] Huang, T., Zhou, L., Zhou, M.: Key Technologies and Applications of Wild Animal Satellite Tracking. J. Phys. Conf. Ser. 1757, (2021). https://doi.org/10.1088/1742-6596/1757/1/012180.

[5] Hendrix, H., Pérez-Espona, S.: A Systematic Review of Population Monitoring Studies of Sea Turtles and Its Application to Conservation. Diversity. 16, 177 (2024). https://doi.org/10.3390/d16030177.

[6] Conservancy, T.S.T.: Sea Turtle Tracking: Tour de Turtles: A Sea Turtle Migration Marathon. (2023).

[7] Castheloge, V.D., Dos Santos, M.R. de D., de Castilhos, J.C., Filho, P.R. de J., Gomes, L. de C., Clemente-Carvalho, R.B.G., Ferreira, P.D.: Pivotal temperature and hatchling sex ratio of olive ridley sea turtles lepidochelys olivaceafrom the south Atlantic Coast of Brazil. Herpetol. Conserv. Biol. 13, 488–496 (2018).

[8] Fuentes, M.M.P.B., Santos, A.J.B., Al, A.-G. et: Adaptation of sea turtles to climate warming: Will phenological responses be sufficient to counteract changes in reproductive output? Glob. Chang. Biol. 30, (2024). https://doi.org/10.1111/gcb.16991.

[9] Stokes, H.J., Esteban, N., Hays, G.C.: Nest site selection in sea turtles shows consistencies across the globe in the face of climate change. Anim. Behav. 208, 59–68 (2024). https://doi.org/10.1016/j.anbehav.2023.12.001.

[10] Mérida, A.M., Helier, A., Cortés-gómez, A.A., Girondot, M.: Hatching success rather than temperature-dependent sex determination as the main driver of olive ridley (Lepidochelys olivacea) nesting activity in the pacific coast of central america. Animals. 11, (2021). https://doi.org/10.3390/ani11113168.