

## Hydra Smart Home

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### Abstract

In the context of accelerating urban growth and changing climatic conditions, modern housing systems are increasingly affected by challenges such as restricted land availability, frequent flooding, and environmental uncertainty. The **Hydra Smart Home** is proposed as a novel housing concept that combines intelligent automation with an amphibious structural design, enabling the dwelling to operate effectively on both land and water surfaces. The system employs tyres to support mobility and balance on land, while recycled plastic bottles and propeller mechanisms are used to maintain buoyancy and stability in water-based environments, enhancing overall safety and adaptability.

The smart home is equipped with IoT-enabled automation that allows centralized control of essential household components, including lighting, ventilation, doors, and curtains, through a microcontroller-based system. To strengthen security and monitoring capabilities, the design integrates RFID-based entry authorization along with GPS tracking, allowing continuous location monitoring and controlled access.

This project focuses on providing a practical solution to housing limitations in flood-affected and water-surrounded regions by offering a portable, eco-friendly, and resilient living structure. Experimental testing confirms that the developed prototype demonstrates stable performance on both land and water while successfully executing automated functions. Overall, the Hydra Smart Home contributes towards the development of adaptive, disaster-resistant, and sustainable housing solutions that prioritize comfort, security, and environmental responsibility.

**Keywords:** Smart home, Internet of Things, home automation, amphibious housing, RFID-based security, GPS monitoring, sustainable living.

### 1.Introduction

Having constantly improved technology is a source of pride for the entire planet. The primary goal of technology is to increase efficiency while reducing effort. The Internet of Things (IoT) is becoming increasingly important in today's environment. The internet of things (IOT) is the network of physical objects or "Things" embedded with electronics, software, sensors and network

connectivity, which enable these objects to collect and exchanging data. IOT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunity for more direct integration between the physical world and computer-based system, and resulting in improve efficiency, accuracy and economic benefits. [9]

The idea of Amphibious House gives experiences of living in both water and land. In engineering languages, it can be said as hybrid structure, in which the weight of a structure is partially supported by both land and water simultaneously. This house designed to be retrofitted to an existing house that is normal circumstances, but to rise with water and float on its surface when flooding occurs, then Settle back in to its original position as the water level decreases. Kerala state in India occasionally experience heavy seasonal rain that results in flooding. Flooding in Kerala is characterized by heavy rainfall, large discharge from dams& landslides. The state has largest in terms of population in India. Being an area that receives seasonal heavy rains, the state has been facing challenge when they experience heavy downpours as the rain water results in flooding which cause havoc in the areas. Flooding can be defined as the subversion of an area in to water. It can also be defined as the over flow of water beyond, it is confines to area that are considered to be dry areas. Building practices have a great inter depending with the extent of destruction by flood. So, this project focus on how the house where damaged by floods can rebuilt, so as to prevent the impact of the flood on these building in a cost-effective way. It also aimed to check the feasibility of adaption of amphibious house in Kerala climate.[4]

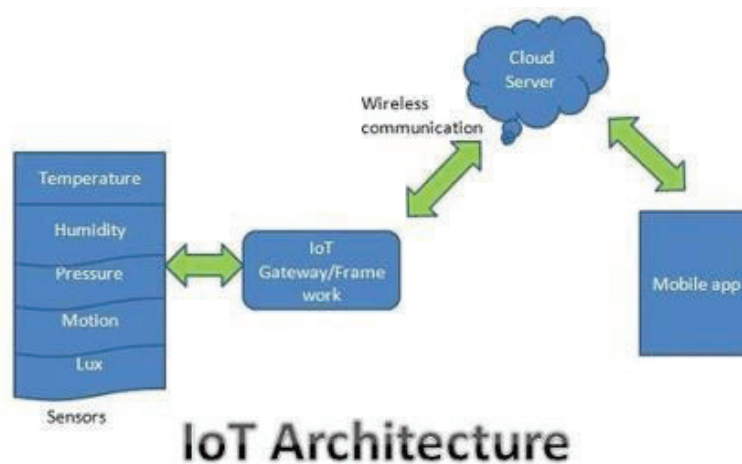


Fig 1: IoT Architecture [7]

### 1.1 Background Of Project

At the heart of this system lies the concept of connectivity. Through the deployment of IoT-enabled devices, such as sensors, actuators, and smart controllers, every aspect of a home can be seamlessly linked to the internet. This connectivity allows for real-time communication and control, empowering homeowners to remotely manage their living spaces from virtually anywhere in the world. A fundamental element in many digital home automation systems is the use of

microcontrollers like the Arduino UNO or connectivity modules such as the ESP8266 (ESP-01) Wi-Fi module. These components serve as the bridge between traditional appliances and the digital domain enabling them to become part of the larger IoT ecosystem.[3]

## 1.2 Problem Statement

Increasing population has resulted in increased housing needs, but currently the available land for housing is decreasing. In addition, climate change has resulted in rising sea levels. With these three problems, it is necessary to develop a place to live with limited land and utilize the potential of Indonesian waters. The efforts that have been made by the current government by building settlements vertically but have not been able to meet the needs of the residence. One type of house that can be developed by utilizing the potential of the waters is floating houses. A floating house is a residential building that is built on water by applying floating structures, materials, and shapes to suit the construction site. The floating house will function properly with proper planning, especially in the selection of technology at the bottom, floats, and the stability of the building above the water. Besides technology, other things that need to be taken into consideration are the selection of materials and the selection of the type of structure that will be applied. This technological innovation is expected to be able to meet the needs of residences that can utilize territorial waters. [2]

## 1.3 Need and Importance of The Project

By the emergence of smart home systems in our life and its quick spreading in different places in the world, the users of smart home systems were increased because of its many advantages, such as:

- Helping users by saving money, time, and saving energy to achieve low power consumption.
- The smart home provides services, which are safe, comfortable, and as friendly living, such as climate control in the home and power administration
- Helping people who have chronic diseases and disabled people in using home applications.[10]

The suggested automatic security system uses extremely little power and money. The suggested solution is effective and ready for real-time applications thanks to the utilization of IoT. The accuracy is superb and merits recommendation [11]

## 2. Literature Review

Our main arguments are rooted in a migration theory in the field of population geography ([Barcus and Halfacree, 2018](#)). The movement of people from land-based to water-based settlements can be seen as a form of migration, which is a part of nature, society, individual, and life course expressions. It adds to the legacy of classic “push” and “pull” factors at the origin and destination respectively. Tidal flooding, SLR, and the slow on-set risks they present in a particular location are push factors that may create pressures on inhabitants to move from the existing location,

particularly when the risk is no longer tolerable. The potential benefits offered by living on top of water are pull factors for adopting this strategy.

People's migration decision is influenced by cognitive mechanisms that are related to (i) place utility, (ii) satisfier, (iii) people-place attachment, and (iv) stress (Barcus and Halfacree, 2018). The first concept highlights that individuals choose to live in places that give them higher overall utility. However, the meaning of utility is highly subjective based on individual perception. This leads to the second mechanism, which emphasizes the potential irrationality of migration because people may decide to migrate for satisfaction rather than optimality. The notion of people-place attachment focuses on the locational ties, which are shaped by sustained experience in a particular location and social relationships. The mechanism of stress suggests that the individual has a certain level of threshold to tolerate discomfort at their current location. Environmental change in people's neighborhoods is one source of stress that either leads to an increase in the threshold level – psychologically adapting to the changed environment - or migrating.[5]

## 2.1 Limitations Of Existing Smart Homes

There are a lot of difficulties and challenges facing smart home system, which are:

- The problem is how to manage and control so many applications
- The smart home is a complex system because it consists of various appliances and systems that are connected to a joint system
- Every time the needs of users are changed, the configuration of the smart home must be changed
- Spending more time, effort, and money to teach users how to use this technology.[6]

## 2.2 Scope Of Hydra Smart Home

The scope of the Hydra Smart Home project encompasses the design, development, and implementation of a smart, amphibious housing system capable of autonomous operation and environmental adaptability.

This project focuses on the following aspects:

- Designing a dual-terrain structure that ensures stability and functionality both on land and on water.
- Developing a microcontroller-based automation system to control lights, fans, doors, and curtains using IoT integration.
- Implementing RFID-based security access to enhance safety and prevent unauthorized entry.
- Incorporating GPS tracking for real-time monitoring and location identification of the home, especially during water-based operations.
- Addressing land scarcity by creating a portable and relocatable housing unit that does not depend solely on permanent land space.

- Enhancing accessibility for people in flood-prone and geographically limited regions by providing an adaptable and resilient housing option.

### 3. Methodology

The Hydra Smart Home is designed as an intelligent and adaptive system capable of operating on both land and water, automating household tasks, and providing enhanced security. The system begins with the ESP32 microcontroller initializing all connected sensors and modules, including RFID, GPS, motion, light, gas, and moisture sensors. These sensors continuously collect environmental and user data, which the ESP32 processes to make decisions such as unlocking doors via RFID or facial recognition, switching lights and fans automatically, and activating wheels or flotation mechanisms. Processed data is sent to an IoT platform, allowing users to remotely monitor and control appliances through a mobile app or dashboard. Actuators such as relays, motors, and servos execute commands to operate lights, fans, doors, curtains, and mobility systems, ensuring real-time automation and adaptability. Security is maintained through RFID verification, facial recognition, and GPS tracking, with alerts sent to the user in case of unauthorized access or hazardous conditions. Finally, the system displays its status on the IoT dashboard and saves the last configuration for automatic resumption after power off, creating a seamless, intelligent, and user-friendly smart home environment.

#### 3.1 Architecture Diagram

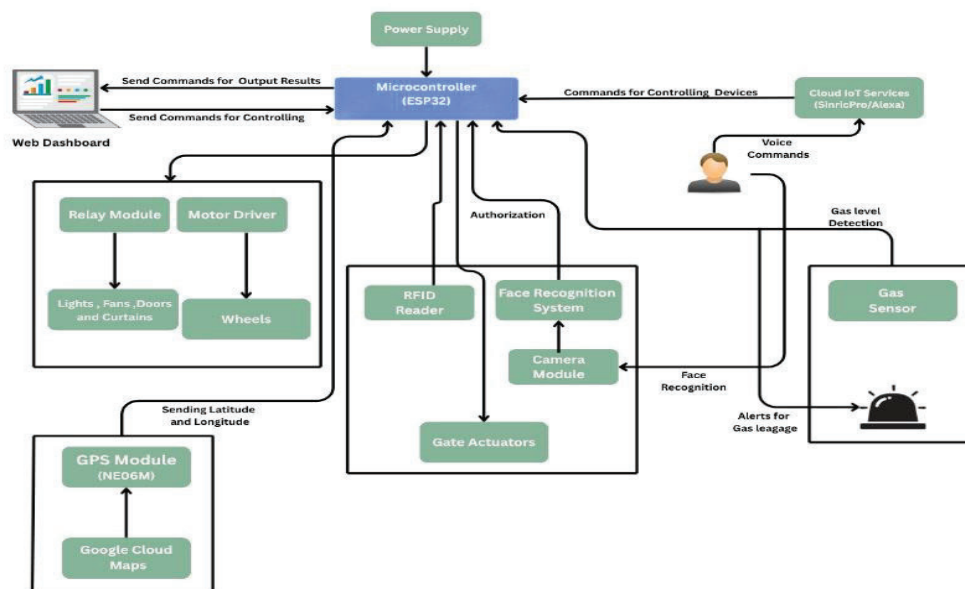


Fig 2: Hydra Smart Home Architecture

### 3.2 Working

The working process can be explained in the following steps:

**Step 1: System Initialization:** The system is powered using batteries, and the microcontroller ESP32 initializes all sensors and modules such as RFID, GPS, and Wi-Fi for IoT connectivity.

**Step 2: Data Collection:** Sensors continuously gather environmental and user data:

- RFID – verifies user access
- GPS – tracks location
- LDR/Motion sensors – detect movement or light conditions
- Gas sensor- detect harmful or excessive gas
- Moisture sensor- detect water

**Step 3: Data Processing:** The microcontroller processes sensor data and executes programmed logic, such as:

- Unlocking doors via valid RFID, face recognition
- Switching lights/fans automatically
- Activating floating mode on high water detection
- Activating wheels
- Real-time location tracking

**Step 4: IoT Communication:** Processed data is sent to the IoT cloud platform (e.g., Blynk) through Wi-Fi. Users can remotely monitor parameters and control appliances via a mobile app or dashboard.

**Step 5: Automation and Control:** Based on inputs or IoT commands, the controller activates relays, motors, and servos to operate lights, fans, doors, curtains, and mobility systems. This ensures real-time automation and environmental adaptability.

**Step 6: Security and Monitoring:** RFID ensures authorized access, while the GPS module tracks the home location in real time. The system alerts the user through IoT notifications in case of unauthorized entry or abnormal activity.

**Step 7: Feedback and Shutdown:** System status and sensor readings are displayed on the IoT dashboard. When powered off, the controller saves the last configuration and resumes automatically on restart.

## 4. Implementation

The Hydra Smart Home functions through the coordinated operation of sensors, actuators, controllers, and IoT modules. The system collects data from sensors, processes it through a microcontroller ESP32 and performs automated actions like controlling appliances, movement, ensuring security, and tracking the home's location.

### 4.1 HARDWARE COMPONENTS

1. **ESP32 Microcontroller:** Central controller for data processing and IoT communication.
2. **Relay Module** – To control high-voltage devices like lights, fans, and doors.
3. **Motor Driver (L298N)** – To drive motors for wheels and curtain/door movement.
4. **DC Motors with Wheels** – For land mobility of the home.
5. **Plastic Bottles / Floatation Units** – Provide buoyancy for water operation.
6. **Lights and Fans** – Electrical appliances automated through relays.
7. **Servo Motors / Actuators** – For door and curtain automation.
8. **PIR Sensor** – Detects human motion for automatic lighting or security alerts.
9. **Moisture Sensor** – Monitors soil or environmental moisture for automation.
10. **Gas Sensor** – Detects hazardous gases and triggers alerts.
11. **RFID Module** – Provides secure access control.
12. **GPS Module** – Tracks location of the home when mobile.
13. **Laptop/PC with Webcam** – Used for facial recognition module.
14. **Propellers (Optional)** – For water stabilization or air circulation.
15. **Batteries / Power Supply** – Powers all components, rechargeable.
16. **Connecting Wires** – For assembly and prototyping.

### 4.2 Software Components

1. **Arduino IDE** – For programming ESP32.
2. **Blynk App / GUI Dashboard** – IoT interface for remote monitoring and control.
3. **DeepFace Library (Python)** – Facial recognition for secure access.
4. **OpenCV and NumPy** – For image capture, processing, and facial detection.
5. **PySerial** – Communication between ESP32 and Python script for control actions.
6. **Libraries for ESP32** – For sensors, relays, motors, RFID, and GPS (e.g., WiFi.h, ESP32Servo.h, MFRC522.h).
7. **IoT Cloud Platform (Sinric Pro)** – For real-time monitoring and control.
8. **Serial Monitor / Debugging Tools** – To test and calibrate sensors and actuators.

### 4.3 Code Implementation

The Hydra Smart Home system is implemented using a combination of Arduino IDE for the ESP32 microcontroller and Python for facial recognition and advanced processing. The code is structured to handle sensing, processing, actuation, and IoT communication seamlessly.

1. **ESP32 Programming (Arduino IDE):** Initializes all sensors and modules, including RFID, GPS, PIR, gas, moisture, and relays. Continuously reads sensor data and decides actions based on programmed logic. Controls motors, servos, relays, lights, fans, doors, and curtain mechanisms automatically.
2. **Python Code for Facial Recognition:** Uses **DeepFace** and **OpenCV** libraries to capture images from a webcam and recognize authorized users. Communicates with ESP32 via **PySerial**, sending approval or denial signals for access control. Provides an additional layer of security by integrating with the IoT system.
3. **IoT Integration:** Sinric Pro app or GUI dashboard receives real-time sensor data and system alerts. Users can control lights, fans, doors, and mobility remotely using the app. All actions, alerts, and sensor readings are synchronized between hardware, software, and cloud.

## 5. Results And Outcomes

The Hydra Smart Home project successfully demonstrates a fully automated, secure, and amphibious home system. The sensors, microcontrollers, and actuators worked together to control appliances such as lights, fans, doors, and curtains automatically based on environmental conditions and user input. The system was able to move on land using wheels and maintain stability on water using flotation units, showcasing its amphibious capability. Security features like RFID and facial recognition ensured that only authorized users could access the home, while real-time alerts were sent for gas leaks or unauthorized attempts. Through the Blynk app and GUI dashboard, users could remotely monitor sensor data, control devices, and track the location of the home. Overall, the project achieved reliable automation, enhanced security, energy efficiency, and convenient remote control, demonstrating the practical implementation of an intelligent smart home system.



Fig 3: Hydra Smart Home

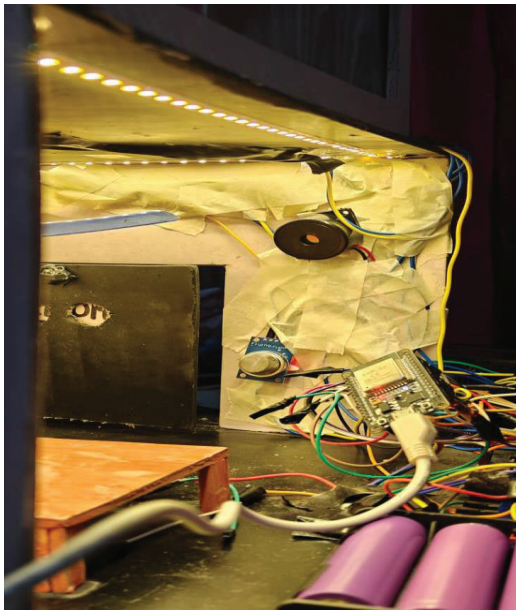


Fig 4: Gas alert

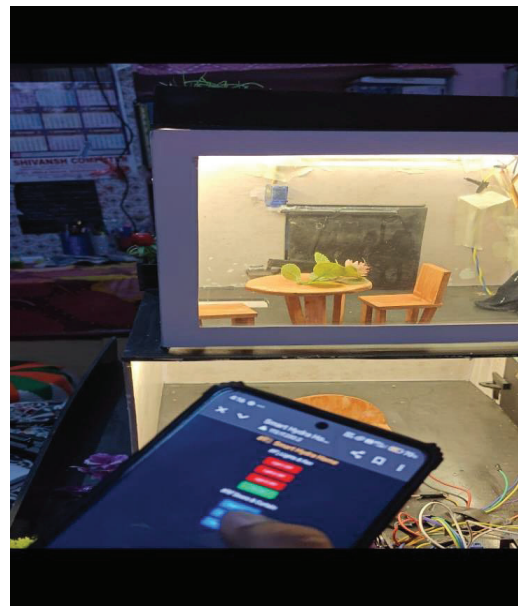


Fig 5: Home automation



Fig 6: RFID door automation

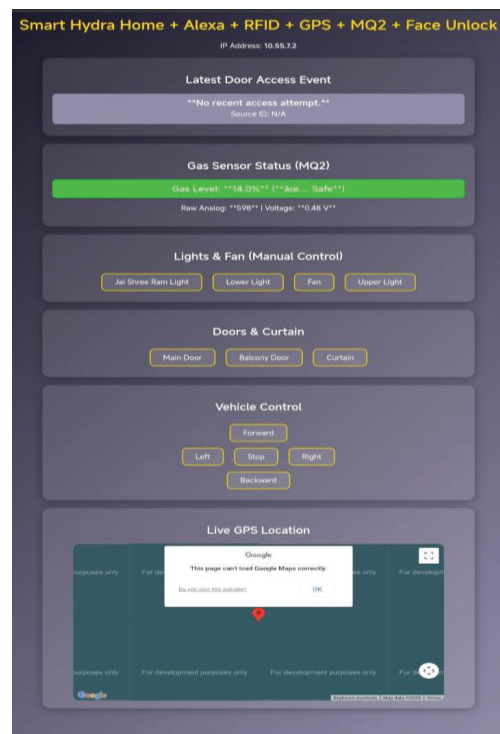


Fig 7: User Interface

## 6. Future Enhancements

- **Solar Panel Integration:** Incorporating solar panels will enable energy harvesting from sunlight, making the system self-sustainable and ideal for remote or disaster-prone regions.
- **Flood Disaster Detection System:** The system can include sensors to detect abnormal water levels and automatically activate safety mechanisms like alarms or evacuation movement.
- **Environmental Monitoring Sensors:** Additional sensors for air quality, temperature, and humidity will help transform the system into a complete smart environment monitoring unit.
- **AI and ML-Based Automation:** Integrating AI and machine learning can improve intelligent decision-making, predictive maintenance, and adaptive mobility control based on environmental conditions.
- **Enhanced Cloud and App Connectivity:** Cloud integration will allow control, and data analytics through mobile applications for a seamless smart experience.

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