# Intelli Domotics

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***Abstract*—In this paper, we present Intelli Domotics, a low-cost smart home automation system aimed at enhancing household convenience, energy efficiency, and security. The system integrates a servo motor-based garage shutter, infrared (IR) sensors for vehicle and obstacle detection, a Light Dependent Resistor (LDR) sensor for automatic room lighting, and a DHT11 sensor for humidity monitoring. The entire system is controlled by a microcontroller (Arduino Uno) and includes both automatic and manual control modes. The proposed solution demonstrates how simple hardware and logical integration can lead to powerful automation features in smart homes. Our prototype achieves reliable performance with minimal cost and complexity, making it ideal for real-time domestic applications.**

## I. Introduction

### *A. Research Background*

Intelli Domotics has significantly evolved over the past two decades, transitioning from basic wired systems and programmable logic controllers to more advanced IoT-based solutions integrating cloud services and AI. However, many existing systems are either overly complex, costly, or dependent on continuous internet connectivity, making them impractical for rural or budget-conscious users. In this context, microcontroller-based solutions—especially those built on Arduino platforms—have gained popularity due to their affordability, ease of implementation, and support for local decision-making without relying on cloud infrastructure. Previous research has explored various sensor-based automation techniques, including the use of IR sensors for object and motion detection, LDR sensors for automatic lighting based on ambient brightness, and DHT11 sensors for temperature and humidity monitoring. Despite these advancements, gaps remain in integrating these sensors into a unified, reliable, and modular home automation system that combines safety, energy efficiency, and offline functionality. Intelli Domotics addresses these gaps by offering a hybrid automation model that blends automatic environmental response (like auto-lighting and garage control) with manual override features (such as fan control), all while utilizing low-cost hardware and supporting real-time local operation. This makes the system highly adaptable, especially for deployment in semi-urban or rural areas where internet access may be unreliable and where cost-effective solutions are crucial.

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### *B. Novelty*

Novelty of the Project The "Intelli Domotics" system introduces a cost-effective, sensor-driven smart home automation platform tailored for Indian households and similar environments. Unlike high-end IoT systems that rely heavily on the internet and mobile apps, Intelli Domotics uses real-time physical sensors and local control logic to automate critical home functions such as lighting, garage access, and environmental monitoring.

Key innovations:

- Dual IR sensor logic to prevent false activation of garage shutters.
- Hybrid automation: automatic lighting and monitoring with manual fan control for power savings.
- Designed to be modular, scalable, and offline-operable, which is ideal for areas with limited internet access.

### *C. Advantages*

- Low-Cost Hardware: Utilizes easily available and affordable components like Arduino Uno, DHT11, IR sensors, LDR, and servo motors.
  Total system cost is significantly lower than branded smart home kits.
- User-Friendly and Scalable: Simple logic makes it easy for users or installers to understand, upgrade, or debug.
  New sensors/modules (e.g., gas, fire, motion) can be added with minimal coding changes.
- Energy Efficiency: Lighting automation based on real-time ambient light reduces unnecessary energy consumption.
  Manual fan control after humidity detection empowers users to decide when to activate appliances.
- Safety and Security: The garage shutter does not activate if an obstacle is detected, preventing accidents.

Sensors operate in real time, reducing the dependency on cloud connectivity or apps.

- Offline Functionality:
  Does not rely on Wi-Fi, cloud services, or smartphones. Useful for low-tech rural or semi-urbana applications.

### D. Applications

The Intelli Domotics system suggested here has a broad range of practical uses in both domestic and semi-commercial settings. Its sensor-based, modular design and offline capability make it particularly well-suited to environments with limited digital infrastructure and energy-efficient users.

- Residential Homes: Intelli Domotics is capable of automating basic household functions like lighting, garage entry, and fan operation. With the use of LDR sensors to sense ambient light and automatically turn lights on or off, the system becomes more energy efficient. Humidity is sensed by the DHT11 sensor, enabling users to manually turn fans on when necessary, thereby ensuring user control while maximizing power consumption.
- Smart Garages: Dual IR sensors used in the garage zone provide intelligent vehicle detection and obstruction avoidance. The system is perfect for home garages, as it avoids shutter closure by mistake and enables safe, automatic access control.
- Low-Income and Rural Housing: As the system is functionally independent of Wi-Fi, mobile apps, or cloud-based services, it proves especially effective in rural or economically disadvantaged areas. The inexpensive components and offline capability offer an attractive solution to areas where smart home systems traditionally prove too costly or impracticable.
- Apartments and Hostels: In common areas, Intelli Domotics may be utilized to automatically control lighting of rooms in terms of occupancy and light level to enhance collective energy consumption. Manual fan control using humidity as the input parameter is also enabled, with personalized comfort achieved without a complicated central control.
- Accessible and Elderly Friendly Homes: Light and entry system automation reduces physical labor for the elderly and disabled. Simple and automatic operation of the system enhances accessibility and security in the home setting.
- Off-Grid or Backup Smart Systems: Intelli Domotics is particularly well-suited for solar-powered homes or homes with intermittent power. Low-power sensors and offline capability provide uninterrupted basic automation even in the event of network failure or power outage.

## II. Literature Review

Smart home automation systems have received much focus in recent times as technology progresses and the need for intelligent, networked systems increases. Previous research was primarily centered on using wired systems and microcontrollers to automate basic functionalities, but newer research has also included wireless and cloud-based systems.

### A. Smart Home Automation Using Arduino

Arduino-based automation has been widely explored due to its flexibility, low cost, and ease of implementation. Studies such as ”Smart Home Automation System Using Arduino” (International Journal of Scientific and Technology Research) highlight the effectiveness of Arduino platforms for controlling appliances based on sensor data. In this study, the integration of LDR sensors for light automation and DHT11 for temperature and humidity monitoring formed the backbone of the system. This approach aligns with Intelli Domotics, which uses similar sensors for room lighting control and humidity-based fan operation, but in a more energy-efficient, manual-override-capable system.

### B. IoT-Based Home Automation

Another body of research has examined IoT-based solutions for home automation. Papers like ”IoT-Based Smart Home Automation and Monitoring System” (International Journal of Computer Applications) show the widespread use of the Internet of Things (IoT) for integrating various home appliances, including lighting, HVAC, and security. While IoT solutions are powerful, they often rely on continuous internet connectivity, creating issues in areas with unstable or unavailable internet access. In contrast, Intelli Domotics uses a sensor-driven, offline solution, which increases reliability in low-bandwidth regions by eliminating the need for cloud services or internet connectivity.

### C. Motion Detection and Obstacle Avoidance Systems

Motion Detection and Obstacle Avoidance Systems The use of infrared (IR) sensors for motion detection and obstacle avoidance has been a significant area of research. The paper ”Obstacle Detection System Using IR Sensors” (International Journal of Advanced Engineering Research and Science) discusses how IR sensors are used to avoid accidents in automated systems, specifically in garages. Similarly, Intelli Domotics uses dual IR sensors for vehicle detection and garage shutter safety, ensuring that the shutter does not close when an obstacle is detected, preventing potential damage or injury.

### D. Hybrid Automation Systems

Hybrid Automation Systems Hybrid automation systems, which combine both manual and automatic controls, have also been explored in the literature. The paper ”Smart Home Automation System Using Hybrid Control” (Journal of Emerging Technologies in Web Intelligence) discusses how the combination of automatic decision-making (based on sensor inputs) and manual user control leads to better energy management and user comfort. This hybrid model is evident in Intelli Domotics, where room lighting is automatically controlled based on ambient light, and fans are manually controlled based on humidity, offering a balance between convenience and user control.

## III. Methodology

The methodology of the Intelli Domotics project outlines the step-by-step process of designing, integrating, and implementing a smart home automation system. It involves selecting suitable sensors (IR, LDR, DHT11) and actuators (servo motor, relays) connected to an Arduino microcontroller. The system uses real-time sensor data to automate lights, fans, and a garage shutter. Manual control is also integrated for user flexibility. Each component is tested and calibrated to ensure accuracy, efficiency, and reliable performance.

### A. System Design Overview

The Intelli Domotics system is designed to automate basic home functions, including controlling lights, fans, and garage shutters based on sensor inputs. The system aims to increase energy efficiency and user comfort by automating tasks and providing manual overrides. The design follows a modular structure to ensure scalability, and each subsystem is equipped with sensors for real-time monitoring and control.

- **Components** Arduino microcontroller (e.g., Arduino Uno), IR sensors, LDR sensor, DHT11 sensor, servo motors.
- **Objective** To create an automated system for controlling lighting, fan, and garage door based on environmental data and user preferences.

### B. Hardware Integration

This section details the integration of various hardware components for the project, ensuring that sensors and actuators function properly to achieve desired automation.

- **Arduino Platform**
  Selection: The Arduino Uno board is chosen as the central processing unit due to its simplicity, low cost, and compatibility with sensors.
  Role: Acts as the brain of the system, collecting data from sensors and controlling the actuators.
- **Sensor Selection and Integration**
  LDR (Light Dependent Resistor): Used in Room 1 to detect ambient light levels and trigger lighting when the room is dark.
  DHT11 Sensor: Located in Room 2 to monitor humidity levels and manually control the fan.
  IR Sensors: Two IR sensors are used for detecting vehicles in the garage and obstacles to prevent shutter malfunction.
- **Actuators**
  Servo Motor: Controls the garage shutter, allowing for automatic opening and closing based on vehicle detection.
  Relay Modules: Used for controlling the lights and fan manually, along with the automatic functions based on sensor input.

### C. Software Design and Control Logic

The software is developed using the Arduino IDE and follows a logical flow to control the connected hardware based on sensor data.

- **Control Logic**
  LDR-based Lighting Control: When the LDR sensor detects low ambient light, the system automatically turns on the light in Room 1.
  DHT11-based Fan Control: Humidity levels in Room 2 are continuously monitored, and if the humidity exceeds a predefined threshold, the fan is activated.
  Garage Door Control: The IR sensors detect the presence of a vehicle in the garage. If no vehicle is detected, the garage door remains closed. If a vehicle is detected, the servo motor is activated to open the shutter.
- **Manual Override** The system provides manual control through a web interface or physical switches, allowing users to control lights and fans independently of sensor readings.
  Offline Operation: The system is designed to work offline, without the need for an internet connection. This ensures that the automation system remains functional even in areas with limited connectivity.

### D. Communication and Integration

The communication between the various components of the system is critical for seamless operation. The system uses wired connections between the Arduino and sensors, ensuring reliability in real-time data collection and control.

- **Wiring and Circuit Design**
  Sensors (IR, LDR, DHT11) are connected to the Arduino's analog and digital pins.
  Actuators (servo motor, relays) are controlled through digital pins, with relays switching on/off the fan and lights.

### E. Testing and Calibration

After hardware integration and software implementation, testing and calibration are performed to ensure that the system functions as expected.

- **Testing Procedures**
  Sensor Functionality: Verify that the sensors detect environmental parameters (light and humidity) correctly. Test different conditions for the LDR sensor (day vs. night) and the DHT11 sensor (dry vs. humid environments).
  Actuator Control: Ensure that the lights turn on/off based on the LDR readings and that the fan operates correctly based on the humidity threshold.
  Garage Shutter Operation: Test the IR sensors to confirm that the servo motor operates smoothly when detecting vehicles.
- **Calibration**
  The sensitivity of the LDR sensor is adjusted to ensure that it detects adequate light levels for room illumination.
  The DHT11 sensor threshold for activating the fan is calibrated to provide comfort without excessive energy usage.

### *F. Results*

The following figures illustrate the physical hardware implementation and the user interface of the Intelli Domotics system.

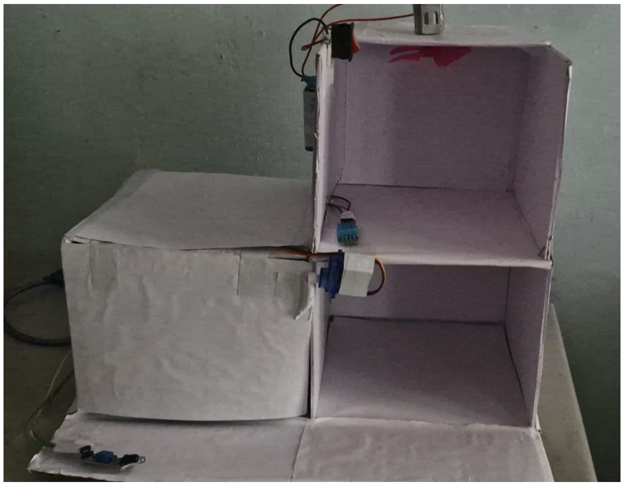

Fig. 1. Intelli Domotics physical prototype showing cardboard-structured setup with IR sensors, DHT11, LDR, and servo motor connected to an Arduino Uno.

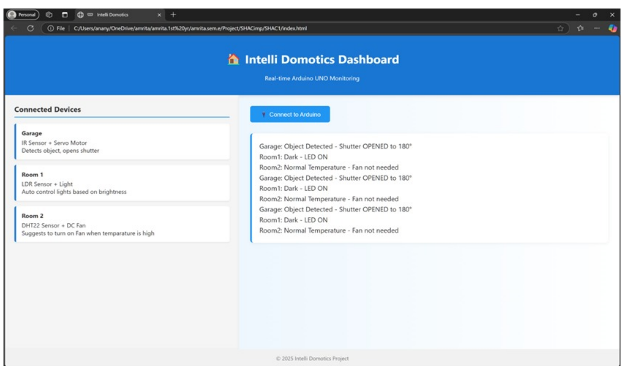


Fig. 2. User interface of Intelli Domotics showing device control, rule configuration, and real-time status updates.

## IV. Conclusion

The Intelli Domotics project successfully demonstrates an efficient and affordable smart home automation system using Arduino and various environmental sensors. By integrating IR sensors, LDR, DHT11, servo motors, and relay modules, the system automates essential home functions such as lighting, fan control, and garage door operation. The combination of automatic and manual modes ensures both convenience and user control. This project not only enhances energy efficiency and home security but also lays the groundwork for scalable smart home systems. Future enhancements can include IoT integration, cloud-based monitoring, and machine learning for predictive automation.

## V. Future work

While the system functions well within its initial scope, there are several potential areas for improvement:

- Cloud Integration: Adding cloud connectivity would allow for remote monitoring and control, enabling users to manage their home automation system from anywhere.
- AI Integration: Implementing machine learning to predict user behavior could help the system optimize energy usage and automate even more functions based on user preferences.
- Additional Sensors: More sensors (such as motion detectors or gas sensors) could be integrated to enhance home security and automation.

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