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Generic Iot Application Development and Testing Ecosystem

Tejal Irkhede

Kalinga University, Raipur

tejal.irkhede@gmail.com

Sanjay Kumar

Kalinga University, Raipur

Sanjay.kumar@kalingauniversity.as.in

Abstract: These days, there are more and more types of IoT, or connected gadgets. Very few businesses or organizations are currently developing SaS (Software as a Service) platforms that enable linked devices to send sensor data to cloud servers for statistics monitoring and report generation. However, connected devices have a set physical identity and are not as dynamically adjustable, which makes the system more vulnerable. The real-time or on-demand connectivity model used by connected devices means that enhancing security could shorten the reaction time of linked devices in real time. The goal of the proposed system is to create a web platform for on-demand notifications and safe generic SaS monitoring for Internet of Things or linked devices. With the help of this platform, any device with the necessary credentials and a unique API access key can connect to a web service and send its data to a server for additional analysis. The proposed system will use business intelligence (BI) to produce graphical data displays. The system will enable the user to receive notifications on predefined triggers on designated incoming records with the aid of triggering mechanisms. This model can be used with any compatible client and supports a wide variety of embedded or computing devices for data uploading thanks to web technologies. The basic idea behind the concept is to give embedded devices lightweight security and to create a secure generic platform for all linked devices.

Keywords: SaS, IoT, BI, API

1. INTRODUCTION

The Internet of Things is adding additional elements to people's and organizations' daily lives, much like any other new technology. Thus, both now and in the future, the business operations and opportunities will be given higher emphasis. Using these technologies as a foundation will help close the gap between computer systems, embedded systems, and industrial automation product ranges. A hardware and web platform for the creation of Internet of Things applications is what is being proposed.

This is a single board IoT device with several functions and modules that allows developers to create an interface between various sensors, devices, and systems. The hardware board will be a specially designed board that expands the Arduino platform's capabilities. Hardware platforms will provide all the web services and data analysis capabilities you need to start your own Internet of Things application at the lowest possible cost.

The proposed system will have numerous features, support for multiple protocols, and a ready-to-configure, live software platform. With a cloud platform, any product can be quickly registered and configured to be made available online with the least amount of work. It enables developers to alter the dashboard and monitoring interface in accordance with needs and preferences. Computer engineers no longer have to worry about hardware and embedded systems, and electronics engineers can stop worrying about online services, databases, and cloud hosting, among other things. It's the ideal fusion of cloud computing and electronics. The product's best quality at a fair price in comparison to other embedded programming platforms is its best feature. It offers both professionals and beginners a flexible platform. Existing components of development platform can be upgraded or extended with their specifications.

The proposed systems can be used by a wide range of users, including enthusiasts or academic institutions for introductory practical analysis; enthusiasts and engineers can view the product as a platform to become experts in IoT development; corporate training sessions or other workshops can be held to familiarize developers with the technologies; start-up businesses that can use the system as a hardware platform to implement their own ideas; and lastly, the product can be marketed on a B-2-B or B-2-C basis.

2. BACKGROUND

The Internet of Things (IoT) has revolutionized the way we interact with the world by connecting devices and enabling them to communicate seamlessly. As IoT continues to shape various industries, the integration of IoT development kits into

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technical education has become imperative. These kits play a crucial role in preparing students for the evolving technological landscape, offering hands-on experience and numerous advantages that enhance the learning process.

Role of IoT Development Kits in Technical Education:

Practical Learning Experience: IoT development kits provide students with a practical and tangible understanding of IoT concepts. The hands-on experience gained through working with these kits helps bridge the gap between theoretical knowledge and real-world applications. Students can experiment, troubleshoot, and apply their theoretical knowledge to solve practical problems, fostering a deeper understanding of IoT principles.

Interdisciplinary Learning: IoT development kits often incorporate elements from various disciplines such as electronics, programming, and networking. This interdisciplinary approach encourages students to develop a holistic skill set, enabling them to tackle complex challenges in IoT development. By working with these kits, students gain a comprehensive understanding of the interconnected nature of IoT systems.

Project-Based Learning: IoT development kits facilitate project-based learning, allowing students to conceive, design, and implement their IoT projects. This hands-on approach fosters creativity, problem-solving skills, and teamwork, preparing students for the collaborative nature of the industry. Through the execution of real-world projects, students learn to manage resources, meet deadlines, and deliver functional solutions.

Industry-Relevant Skills: Industry standards should be met by technical education, and IoT development kits facilitate this process. Students learn skills that are immediately applicable to the quickly changing IoT market by using these kits. Their employability and preparedness to contribute to the workforce after graduation are improved by this practical knowledge.

Prototyping and Rapid Development: With the help of Internet of Things development kits, students may swiftly test and refine their ideas using a platform for rapid prototyping. In a sector where innovation and time-to-market are critical, this expertise is essential. Pupils acquire the knowledge and abilities necessary to create workable IoT solutions in a timely manner, as well as an appreciation for the value of effective prototyping.

Advantages of IoT Development Kits in Technical Education:

Cost-Effective Learning: IoT development kits offer a cost-effective solution for educational institutions, eliminating the need for expensive equipment and infrastructure. These kits provide a simulated environment where students can experiment with IoT concepts without the need for extensive resources.

Accessible Learning Materials: IoT development kits often come with comprehensive documentation, tutorials, and online resources. This accessibility ensures that students have the necessary support to explore and understand IoT technologies at their own pace. The availability of learning materials enhances the self-directed learning aspect of technical education.

Enhanced Retention of Knowledge: Hands-on learning experiences with IoT development kits contribute to higher knowledge retention. Students are more likely to remember and apply concepts learned through practical experimentation, reinforcing their theoretical knowledge and building a solid foundation for future learning.

Preparation for Industry Certification: Many IoT development kits are designed to align with industry-standard certifications. By using these kits, students can acquire the skills needed to pursue certifications from reputable organizations. This not only adds value to their educational experience but also enhances their competitiveness in the job market.

Incorporating IoT development kits into technical education is a strategic move to prepare students for the challenges of the rapidly advancing IoT landscape. The hands-on learning experiences, interdisciplinary approach, and industry relevance offered by these kits contribute to a well-rounded education that equips students with the skills needed for success in the IoT-driven future. As educational institutions embrace the potential of IoT development kits, they empower students to become innovative problem solvers and valuable contributors to the ever-expanding field of IoT technology.

The Proposed system mainly focus on the commercial utilization and real-life product there must be some point of consideration before deployment. The system must be feasible from implementation point of view as well as generic and cost effective. The hardware or IoT development board will be mainly designed to control, monitor, track and communicate with things. Propose system is a hardware platform for microcontroller-based automation and intercommunication using multiple communication protocol like HTTP, GSM, FTP, SMTP, MQTT, Wi-Fi, Bluetooth and Serial which is supported and clubbed with cloud-based software platform for remote data analysis, control, and monitoring purpose. Proposed system will be useful for educational organizations for performing lab sessions on IoT applications and can be utilized by start-ups, beginners, and industries for IoT based product development. Finally, the system will be a single board and multi-functional board.

3. SYSTEM DESIGN

To avoid use of breadboards, jumper wires and tiny electronics components, to understand the Arduino programming and just concentrating on programming and application logic, there must be a system which take care of

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hardware deployment. Proposed system will be novel approach towards this, complete IoT application development platform. It takes the ease of Arduino programming IDE and the power of open-source Arduino Uno board, clubbed together with tons of on-board component and modules makes it perfect solution for the beginners who are willing to learn IoT and the experts who are ready to deploy IoT as applications or product.

Unique Arduino and Atmega328p based development board will be having on-board components like SIM 808 with SIM slot, GPS, Bluetooth, ESP8266, DHT11, buzzer, 16x2 and 16x4 LCD support, 30amp. Relay, serial interface, mini-USB programming port, connectors for different configurable IOs, multilevel voltage out like 12v, 5v, 3.3v so you can connect any sensor directly to board, configuration DIP switches to control components or modules power state and LED indications for different modules.

To control these entire modules and to develop IoT applications, proposed system or the IoT development platform provides different sample codes and ready to deploy application where at single click IoT Development platform can be converted into real life applications this is the main idea behind the system. Finally, where all the beginners and developer stuck in IoT development is server, hosting, web services, data analysis, cloud storage or data push and pull services to interface IoT board or hardware with internet. Proposed system will be coming up with complete range of web services and data analysis tools with bare minimum cost to launch your own IoT application.

A. IoT Ecosystem Architecture:

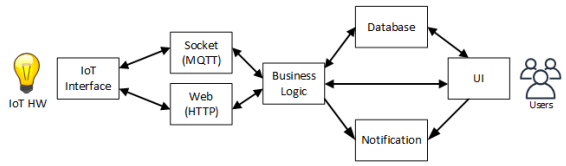

Figure 1.0: Proposed IoT Ecosystem primary implementation blocks

Since the IoT Ecosystem involves multiple functional blocks required to utilize as per the need of IoT application. IoT application could a real time connection oriented or on demand connection oriented with bi-directional or unidirectional communication. Each implementation needs different set of resources and methodology of implementation. Proposed system blocks are presented in figure 1.0 where IoT hardware can exchange information over socket or web channel using different protocols like for socket MQTT and for web HTTP. Each interface has different implementation process. Upon sending the data through any channel to cloud it will then first be analyzed by system business logic. This business logic or rule sets needs to define by user through configuring the IoT sensor dashboard. Business logic will calculate and decide the next route of the incoming data like store the information in database or ignore the false data or generate the user defined notification to and from user UI. The presented blocks are available dynamic in nature, where multiple processing possibilities could be implemented using right resource for user applications. Every block including software, hardware, and cloud configurations are planned and developed independently but still feasible enough to integrate with each other as and when required.

B. Hardware: IoT Development Board

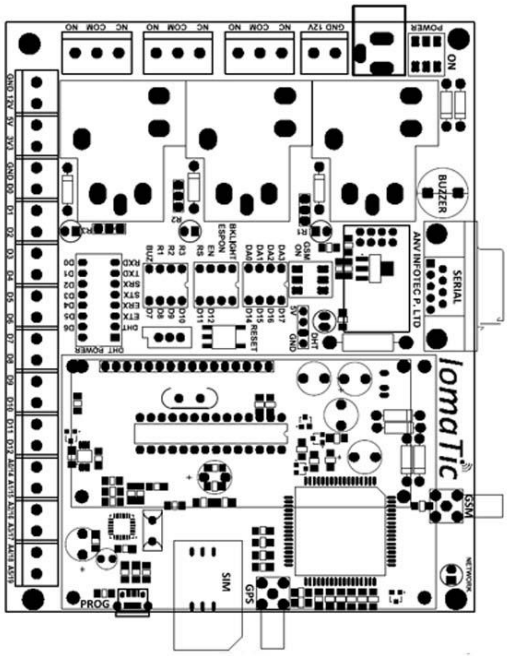

Figure 2.0 (A): Proposed IoT Development Boad PCB Layout

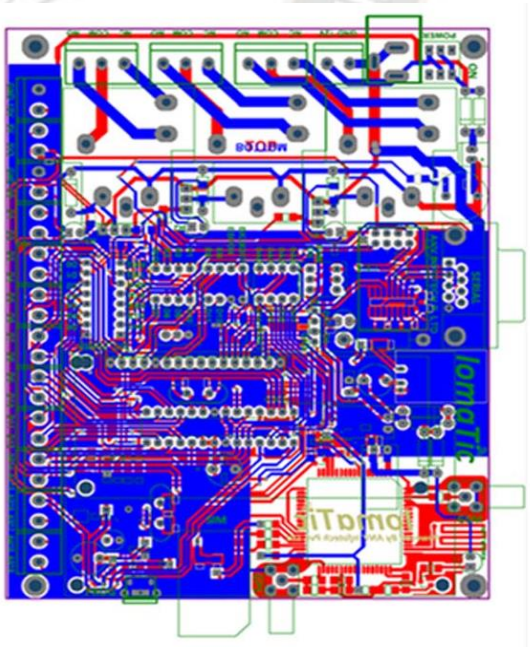

Figure 2.0 (C): IoT Development Board PCB Layout

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Figure 2.0 (A) & (B) illustrates the PCB layout of proposed IoT Development board PCB Layout. This PCB is Designed with "Altium Designer" Software. Library footprints are used for the design. Manual placement is done with trial and error to optimize the utilization of size and to achieve best electrical performance. Manual Netlist is generated, and routing is done. The design exported as gerber files and sent to manufacturer for printing. The PCB type is double sided Copper Clad - Glass Epoxy with PCB thickness - 1.6mm and Copper Thickness - 35 Micron. PCB masking is green tested BBT/Visual inspection method. Leadless SMD ICs are soldered with the Solder paste and Hot air Gun. Other Components are soldered with Soldering Iron and Solder wire.

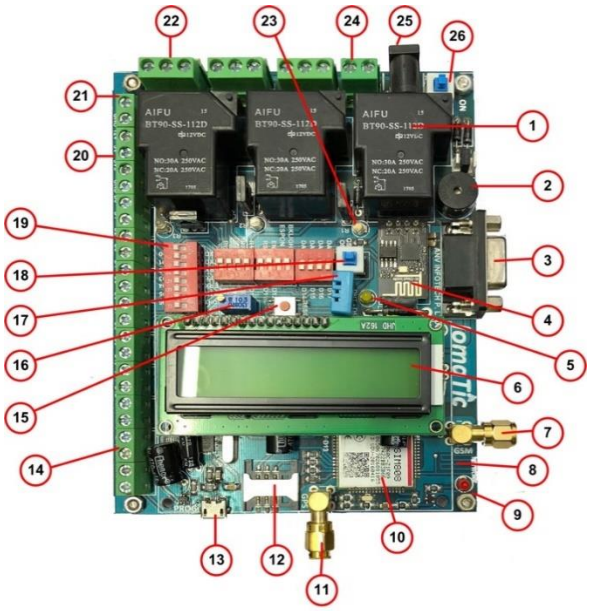

Figure 2.0 (C): Final developed IoT Development Board with Component Mounting

Figure 2.0 (B) illustrates the final component installed IoT Development board having different component like 1. Relay(s), 2. Buzzer, 3. RS232 communication port, 4. ESP32 Wi-Fi module, 5. ESP indication LED, 6. 16x2 LCD, 7. GSM antenna connector, 8. Bluetooth antenna, 9. GSM network indication LED, 10. SMS808 module, 11. GPS antenna connector, 12. SIM card tray, 13. USB connector port, 14. External module connector, 15. Reset switch, 16. LCD brightness control potentiometer, 17. DHT 11 temperature and humidity sensor, 18. SIM808 on/off switch, 19. Configurable DIP switches, 20. 5V power out, 21. 12V power out, 22. Relay connector, 23. Relay status indicator LED, 24. 12v Power in connector, 25. 12V DC power adaptor socket, 26. Power ON/OFF switch.

The hardware is designed with maximum possible control, monitor and sensory module of different type required to build different IoT applications. Using external connectors and configuring right DIP switch even the external sensors or electronics module can be interfaced with the board. The board is made on Arduino Uno development platform and could be programmed using Arduino IDE.

C. IoT Cloud Platform

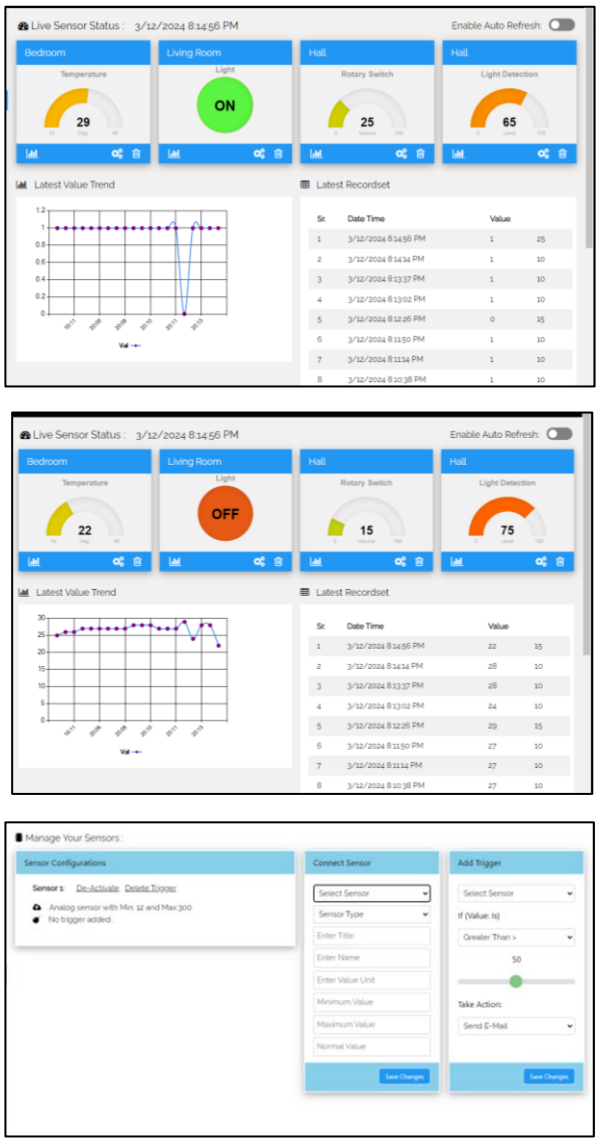

Figure 3.0: (A) & (B) Sensor current state with its digital and analog value presented in graph and reporting format (C) Sensor type, value range and trigger event configuration.

Any IoT application needs external world connection by the means of cloud or web services. Figure 3.0 illustrates the different functionalities and the configuration facilities provided in the proposed system. (A) illustrated the last available sensor value through gauge like chart control and in labels control. It also shows the IoT node ID which will be a unique identifier of every IoT device connected to the portal along with the last available record timestamp. (B) Every sensor value record is stored in database for further utilization hence the graph shows the selected record values with its timestamp. (C) In order to make decision or perform business

logic based on the received incoming sensor value, system allow configuration of individual sensor. This part illustrates the sensor configured statistics. Every sensor connected to IoT web portal can be aliased with specific name or metadata. It shows the example of analog sensor This way user can define the feasible ranges of values. Secondly IoT portal allow user to define a rule for every sensor value. User can set a trigger to specific range value and define an action to perform upon satisfying the defined condition. Here user can generate a notification like SMS, Email, or push notification. As described in "C" same functionality can be provided to digital sensor as presented here.

4. CONCLUSION

The entire IoT cloud platform designed keeping generic nature of IoT application requirement and hence it can be mold as per the requirement of the application. Propose system is developed and presented to demonstrate how complete IoT ecosystem can be provided and incorporated together to enable developers and hobbyist to make it easy to test and deploy different IoT application using single platform. We have successfully deployed and tested the presented IoT platform with live application in couple of industrial and domestic application. This platform in future can be combined with multiple sensors or module to make it more functional and covering wide area of IoT applications.

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