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AN INTELLIGENT PRISON ESCAPE DETECTION SYSTEM USING IOT AND RF TECHNOLOGY

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Abstract: This project is entitled as "AN INTELLIGENT PRISON ESCAPE DETECTION SYSTEM USING IOT AND RF TECHNOLOGY" and is an IOT-based application. The fact that such a number of inmates may still be roaming among us is itself scary. Well, so here we propose a prisoner tracking system that helps detect prison breaks and instantly alert authorities using IOT. The system makes use of a microcontroller-based circuit to achieve the task using RF technology. We make use of RF trackers on each inmate to detect their presence on the premises. The second central monitoring units are used to scan through all inmates as per data fed to it and constantly keep track of each prisoner. Each prisoner is mounted with an RF tracker transmitting a unique prisoner code wirelessly. Whenever a prisoner exits the facility, the centralized system is unable to receive his/her code. At that time the receiver circuitry instructs the controller to take action against the particular prisoner. The System now transmits the prisoner's details over to the officers alerting portal to send out an instant alert and catch the prisoner before he runs even 50 meters away from the facility. Here we use IOT Gecko to develop the online alerting portal system to receive input from monitoring devices and display alerts and sound alarms through the internet.

Keywords: RF Technology, Alerting system and IOT.

I. INTRODUCTION

1.1 PREAMBLE

The prison system in India, as known to everyone, is not as good as we see in the films. It is quite shocking to know that in a digitally modern country like India, the prison system is quite orthodox. So, in such an orthodox system jail breaks are very common and the most common thing to happen. There is no such count but prison escapes keep happening, either on large scale or on smaller scale. The thought of these inmates still roaming around within us is itself very scary. The changes required in today's prison system are that, that the system should be a bit digitalized rather than using human force to guard the inmates. The digital system to be used can be made reliable so that it can't be under cyber-attack. Some more aspects can be used to make this system more reliable against cyber-attacks. This paper targets the condition that if the prisoner tries to escape from the jail his/her movement can be detected as soon as his/her presence is not been found in the cell or the area he/she is supposed to be in. Geo-fencing has been done and Laser is used to faith idea of escaping. This paper gives a review of various Prison Security and Safety devices that are based on Wi-Fi, and Bluetooth for Internet as communication mode, as communication mode. But both of these systems have their restrictions. Wi-Fi and Bluetooth devices have a primary flaw of limited range. Poor internet connectivity can be an issue in densely populated areas and multi-story buildings.

1.2 PRISON ESCAPE DETECTION

The "Prison Escape Detection" project stands by propose a prisoner tracking system that helps detect prison breaks and instantly alert authorities using IOT. The system makes use of a microcontroller-based circuit to achieve the task using RF technology. We make use of RF trackers on each inmate to detect their presence on the premises. The 2 central monitoring units are used to scan through all inmates as per data fed to them and constantly keep track of each prisoner. Each prisoner is mounted with an RF tracker transmitting a unique prisoner code wirelessly. Whenever a prisoner exits the facility, the centralized system is unable to receive his/her code. At that time the receiver circuitry instructs the controller to take action against the particular prisoner. The System now transmits the prisoner's details over to the officers alerting portal to send out an instant alert and catch the prisoner before he runs even 50 meters away from the facility. Here we use IOT Gecko to develop the online alerting portal system to receive input from monitoring devices and display alerts and sound alarms through the internet.

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1.3 PROBLEM DESCRIPTION

This circuit is a small +5V power supply, which is useful when experimenting with digital electronics. Small inexpensive wall transformers with variable output voltage are available from any electronics shop and supermarket. Those transformers are easily available, but usually their voltage regulation is very poor, which makes then not very usable for digital circuit experimenter unless a better regulation can be achieved in some way. The following circuit is the answer to the problem. This circuit can give +5V output at about 150 mA current, but it can be increased to 1 A when good cooling is added to 7805 regulator chip. The circuit has over overload and terminal protection.

1.4 OBJECTIVE

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer. The surfaces of the electrodes that are in contact with the liquid crystal material are treated so as to align the liquid crystal molecules in a particular direction. This treatment typically consists of a thin polymer layer that is unidirectionally rubbed using, for example, a cloth. The direction of the liquid crystal alignment is then defined by the direction of rubbing. Before applying an electric field, the orientation of the liquid crystal molecules is determined by the alignment at the surfaces. In a twisted nematic device (still the most common liquid crystal device), the surface alignment directions at the two electrodes are perpendicular to each other, and so the molecules arrange themselves in a helical structure, or twist. Because the liquid crystal material is birefringent, light passing through one polarizing filter is rotated by the liquid crystal helix as it passes through the liquid crystal layer, allowing it to pass through the second polarized filter. Half of the incident light is absorbed by the first polarizing filter, but otherwise the entire assembly is transparent.

1.5 SCOPE

Important factors to consider when evaluating an LCD monitor:

- Resolution: The horizontal and vertical size expressed in pixels (e.g., 1024x768). Unlike CRT monitors, LCD monitors have a native-supported resolution for best display effect.
- **Dot pitch:** The distance between the centers of two adjacent pixels. The smaller the dot pitch size, the less granularity is present, resulting in a sharper image. Dot pitch may be the same both vertically and horizontally, or different (less common).
- **Viewable size:** The size of an LCD panel measured on the diagonal (more specifically known as active display area).
- **Response time:** The minimum time necessary to change a pixel's color or brightness.
- **Matrix type:** Active or Passive.
- **Viewing angle:** (coll., more specifically known as viewing direction).
- **Color support:** How many types of colors are supported (coll., more specifically known as color gamut).
- **Brightness:** The amount of light emitted from the display (coll., more specifically known as luminance).
- **Contrast ratio:** The ratio of the intensity of the brightest bright to the darkest dark.
- **Aspect ratio:** The ratio of the width to the height (for example, 4:3, 16:9 or 16:10).
- Input ports (e.g., DVI, VGA, LVDS, or even S-Video and HDMI).

II. SYSTEM SPECIFICATION

2.1 HARDWARE SPECIFICATION:

- Microcontroller - Arduino UNO
- RF Technology - TF Transmitter and Receiver
- Network - GSM Network
- Transformer - Mini Transformer
- Other Components - Buzzer

2.2 SOFTWARE SPECIFICATION:

- Operating system - Windows OS
- IDE - Arduino IDE

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III. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Describe the current methods or systems employed in prisons for escape detection. This might involve physical barriers, surveillance cameras, manual patrols, etc. Identify the shortcomings of the existing system in effectively preventing or detecting prison escapes. Discuss issues like blind spots, delay in response time, false alarms, etc. If there are any technological elements already in use (such as CCTV, access control systems, etc.), discuss their role in the existing system.

Disadvantages

- Blind Spots
- Delay in response time
- False Alarms

3.2 PROPOSED SYSTEM

Introduce the proposed "Intelligent Prison Escape Detection System" using IoT and RF technology, highlighting its core components and objectives.

- **IoT Integration:** Discuss how IoT devices (sensors, actuators, etc.) will be deployed within the prison environment to enhance security and escape detection.
- **RF Technology Integration:** Explain the incorporation of RF technology (RFID, wireless communication) and how it contributes to the proposed system's effectiveness in detecting and preventing escapes.
- **Advantages over Existing System:** Highlight the strengths and improvements of the proposed system compared to the existing one. Emphasize aspects like real-time monitoring, better coverage, reduced false alarms, quicker response times, etc.
- **Feasibility and Scalability:** Discuss the feasibility of implementing the proposed system in a prison environment, considering factors such as cost, maintenance, scalability, and ease of integration with existing infrastructure.
- **Security and Privacy:** Address any potential security or privacy concerns associated with implementing such a system, ensuring that it complies with ethical standards and legal requirements.
- **Case Studies or Simulations:** If available, present any simulations, prototypes, or case studies that demonstrate the efficacy of similar technologies in enhancing prison security or escape detection.

Advantages

- Comprehensive Security Measures
- User-friendly Interface
- Scalability and Future Enhancements
- Adaptive Security Measures

IV. PROJECT DESCRIPTION

4.1 BLOCK DIAGRAM

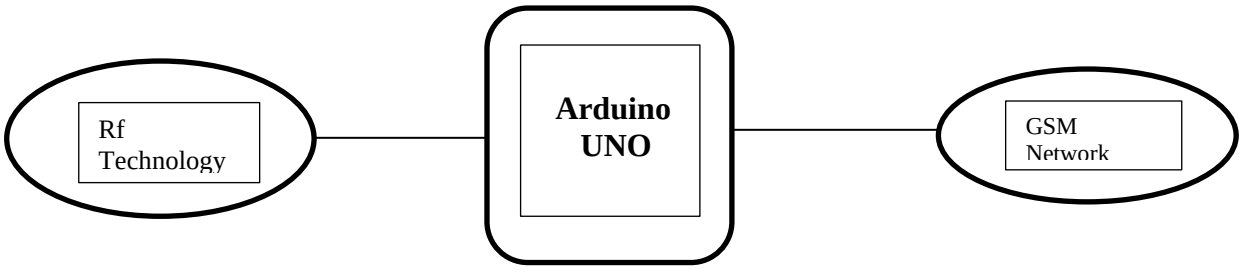

FIG 1. Block Diagram

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4.2 PROJECT EXPLANATION

4.2.1. GSM Network

Global System for Mobile communication (GSM) [Theodore S. Rappaport, 2002] is a standard for digital communication. GSM uses the Time Division Multiple Access (TDMA). The switching system is responsible for performance call processing and subscriber-related functions. The concept of cellular service is the use of low - power transmitters where frequencies can be reused within a geographic area.

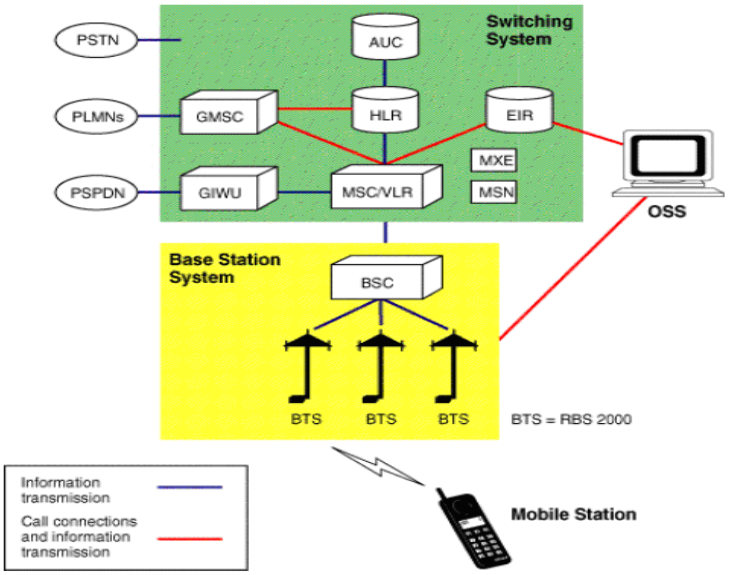

FIG 2. GSM Network Element

4.2.2 Arduino UNO

Arduino Uno is a popular open-source microcontroller board, renowned for its versatility and ease of use in electronics projects. Featuring an ATmega328P microcontroller, it offers a range of digital and analog input/output pins, making it ideal for interfacing with sensors, actuators, and other electronic components. With a USB connection for programming and power supply, it simplifies the development process for both beginners and experienced makers. Arduino Uno supports a wide range of programming languages and development environments, enabling users to quickly prototype and deploy projects in various fields such as robotics, home automation, and IoT applications. Its affordability and vast community support make it a staple in the maker community.

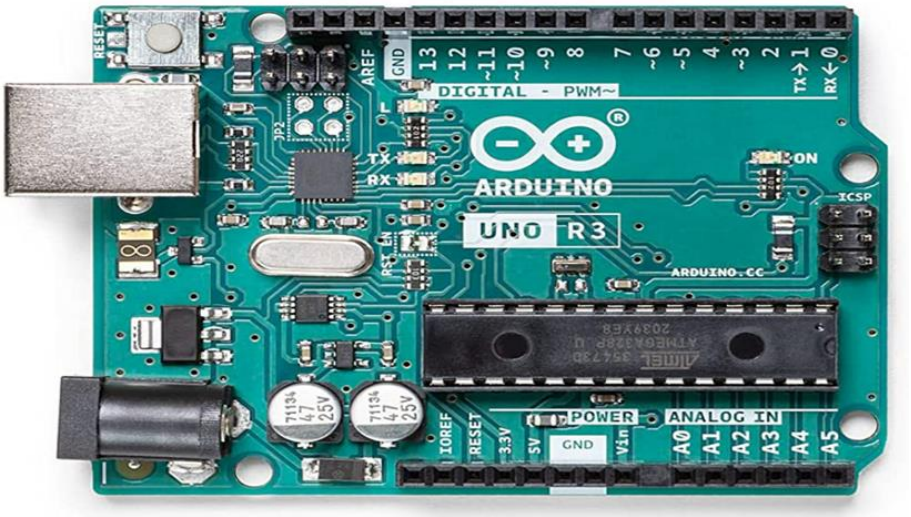

FIG 3. Arduino UNO

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Digital Pins (0 - 13):
D0 (RX): Digital pin used for receiving serial data.
D1 (TX): Digital pin used for transmitting serial data.
D2: General-purpose digital input/output pin.
D3: General-purpose digital input/output pin.
D4: General-purpose digital input/output pin.
D5: General-purpose digital input/output pin.
D6: General-purpose digital input/output pin.
D7: General-purpose digital input/output pin.
D8: General-purpose digital input/output pin.
D9: General-purpose digital input/output pin.
D10: General-purpose digital input/output pin. Also used as SPI SS (Slave Select) pin.
D11: General-purpose digital input/output pin. Also used as SPI MOSI (Master Out Slave In) pin.
D12: General-purpose digital input/output pin. Also used as SPI MISO (Master In Slave Out) pin.
D13: General-purpose digital input/output pin. Also used as SPI SCK (Serial Clock) pin.

Analog Pins (A0 - A5):
A0: Analog input pin for reading analog voltage levels.
A1: Analog input pin for reading analog voltage levels.
A2: Analog input pin for reading analog voltage levels.
A3: Analog input pin for reading analog voltage levels.
A4: Analog input pin. Also used as I2C SDA (Serial Data) pin.
A5: Analog input pin. Also used as I2C SCL (Serial Clock) pin.

Special Function Pins:
RESET: Pin used to reset the microcontroller.
5V: Provides regulated 5V power output.
3.3V: Provides regulated 3.3V power output.
GND: Ground pins for providing reference voltage.
AREF: Analog reference voltage pin. Used to set the reference voltage for analog-to-digital conversion.

Communication Pins:
TX (Transmit) and RX (Receive): Pins 0 and 1 for serial communication (UART) with external devices like computers.
I2C Communication:
SDA: Serial Data Line for I2C communication.
SCL: Serial Clock Line for I2C communication.
SPI Communication:
MISO: Master In Slave Out for SPI communication.
SCK: Serial Clock for SPI communication.

4.2.3. Transformer
Transformer, device that transfers electric energy from one alternating-current circuit to one or more other circuits, either increasing (stepping up) or reducing (stepping down) the voltage. Transformers are employed for widely varying purposes; e.g., to reduce the voltage of conventional power circuits to operate low-voltage devices, such as doorbells and toy electric trains, and to raise the voltage from electric generators so that electric power can be transmitted over long distances.

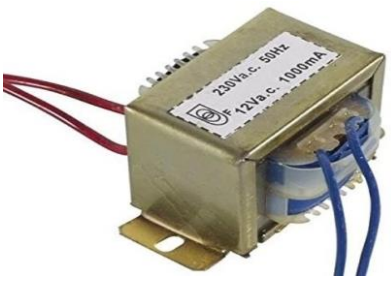

FIG 4. Transformer

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4.2.4. LCD

A liquid crystal display (commonly abbreviated LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

FIG 5. LCD Display

4.2.5. Buzzer

Buzzers are commonly used in various applications such as alarms, timers, electronic devices, and more, to provide auditory feedback or alerts. They are often used as simple sound generators due to their compact size, low power consumption, and ease of use. The working principle of a passive buzzer, such as a piezoelectric buzzer, involves utilizing the piezoelectric effect to produce sound.

FIG 6. Buzzer.

4.3 CIIRCUIT DIAGRAM

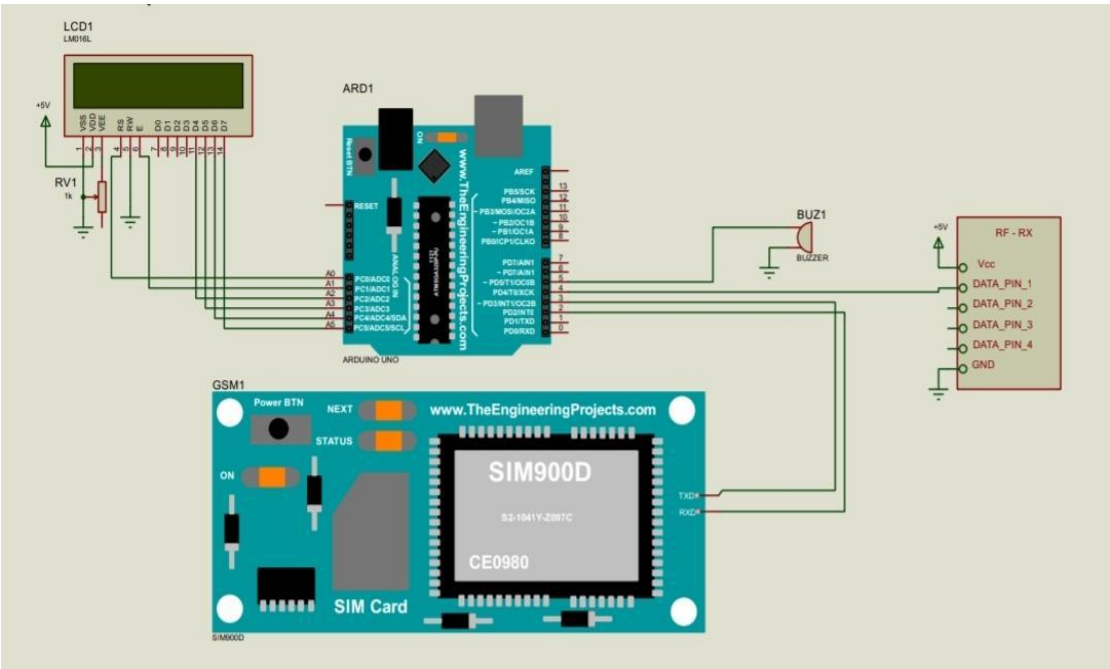

FIG 7. CIRCUIT DIAGRAM

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V. IMPLEMENTATION

System Design and Setup:

- Design the system architecture based on the specified hardware and software requirements.
- Install and configure IoT sensors, RF devices, networking equipment, and the central control system within the prison environment.
- Develop or integrate software components for data processing, analytics, and user interface.

Integration and Testing:

- Ensure proper integration of all hardware and software components.
- Conduct rigorous testing to verify the functionality of individual devices and the system as a whole.
- Test different scenarios simulating potential escape attempts to assess system responsiveness and accuracy.

Deployment and Calibration:

- Deploy the system in a controlled environment within the prison, ensuring proper calibration of sensors and devices.
- Train staff members responsible for monitoring and using the system.

VI. RESULT ANALYSIS

Performance Evaluation:

- Monitor the system's performance in real-time, analyzing its ability to detect escape attempts or unusual activities.
- Measure the system's accuracy in identifying and responding to potential escape scenarios.

Data Analysis:

- Collect and analyze data generated by IoT sensors and RF devices.
- Use statistical methods and data visualization techniques to interpret the data.

Accuracy and False Alarm Rate:

- Calculate the accuracy of escape detection and evaluate the rate of false alarms.
- Determine whether the system effectively differentiates between normal activities and potential escape situations.

Response Time and Notification Mechanism:

- Measure the system's response time from detection to alerting security personnel or initiating appropriate actions.
- Evaluate the effectiveness of the notification mechanism (alarms, alerts to control centers, etc.).

User Feedback and System Improvements:

- Gather feedback from prison staff and administrators regarding the system's usability and effectiveness.
- Identify areas for improvement based on user feedback and performance analysis.

Report and Documentation:

- Compile a comprehensive report detailing the implementation process, results, and findings.
- Document any challenges faced, lessons learned, and recommendations for further enhancements.

Continuous Improvement:

- Implement changes and improvements based on the analysis and feedback to enhance the system's accuracy, responsiveness, and reliability.
- Conduct periodic assessments and updates to ensure the system remains effective against evolving security threats.

VII. CONCLUSION

The conclusion of the project is that if this system is implemented in our prison system it would add a new level to the security rules of our country. This system will bring some difference in the number of jail breaks happening per year. The implementation of an intelligent prison escape detection system integrating IoT and RF Technology stands as a pivotal advancement in ensuring enhanced security within correctional facilities.

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Through the amalgamation of real-time monitoring, data analytics and RF-based tracking, this system pro-actively detects and responds to potential escape attempts, fortifying the security infrastructure of prisons. Its capacity to swiftly identify anomalies, coupled with its automated alerting system, offers a robust shield against unauthorized movements, thereby significantly mitigating escape risks and bolstering the safety measures crucial for efficient prison management.

VIII. FUTURE ENHANCEMENT

Integrate various types of sensors (motion, thermal, acoustic, vibration) to enhance the accuracy of detecting escape attempts. Implement biometric sensors to monitor the health and activity of prisoners, ensuring they are within designated areas. Utilize advanced machine learning techniques to analyse sensor data for predictive insights and anomaly detection. Develop algorithms to study prisoners' behaviour patterns and identify deviations that may indicate escape attempts.

IX. WORKING IMAGE

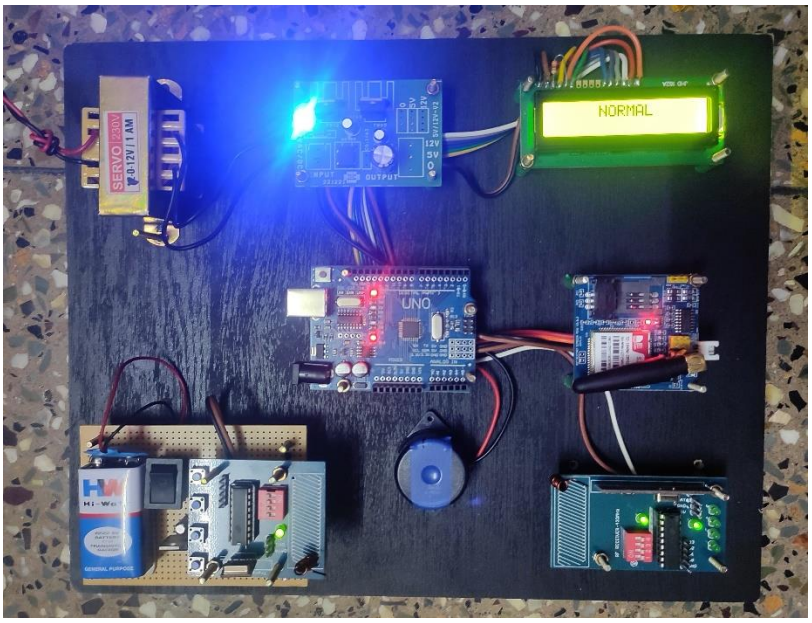

FIG.8. **(LCD Display shows normal, while connected)**

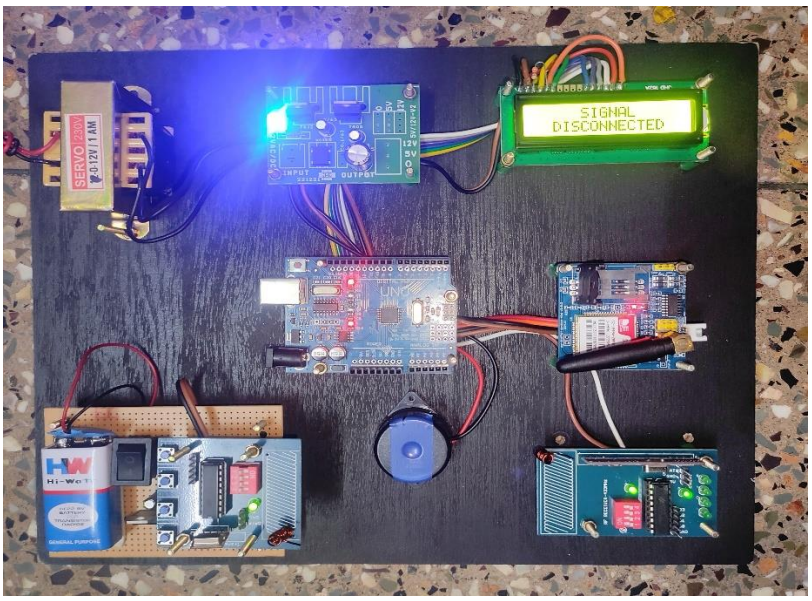

FIG 9. **(LCD Display shows disconnected, while disconnected)**

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