Date :

Embedded Systems

Digital Assignment 1

Course Code : BCSE305L
Slot : A1 + TA1

① Utilizing 8051 microcontroller in Robotic Applications : Enhancing Societal Impact

Description : The incorporation of 8051 microcontrollers has transformed robotics by facilitating precise control and seamless interfacing with sensors and actuators. A notable example is the robotic arm, which leverages programmable microcontrollers to drive motors and execute complex tasks efficiently. Initially designed for experimental use, this technology has found practical applications in industrial settings, such as the PUMA 560 robot arm. Through assembly language programming, microcontrollers can finely tune intricate operations like object manipulation. This integration enhances robotic systems and contributes to societal advancement by improving efficiency and safety.

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Societal Impact:

The integration of 8051 microcontrollers in robotics offers significant benefits to society, revolutionizing various sectors including industrial automation and healthcare. In industrial settings, the enhanced capabilities of robotic systems streamline production processes, leading to increased efficiency and reduced costs. Similarly, in healthcare, robotic assistance facilitated by 8051 microcontrollers enhances patient care, improves treatment outcomes, and alleviates the workload on medical professionals. Overall, the integration of 8051 microcontrollers in robotics results in tangible societal benefits, including enhanced productivity, safety, and quality of life.

Blueprint:

In this blueprint, we'll design a robotic arm for warehouse automation, leveraging the prowess of the 8051 microcontroller. This robotic arm efficiently manages inventory, enhances productivity, and ensures seamless operations in warehouses, thereby benefiting society through optimized resource utilization.

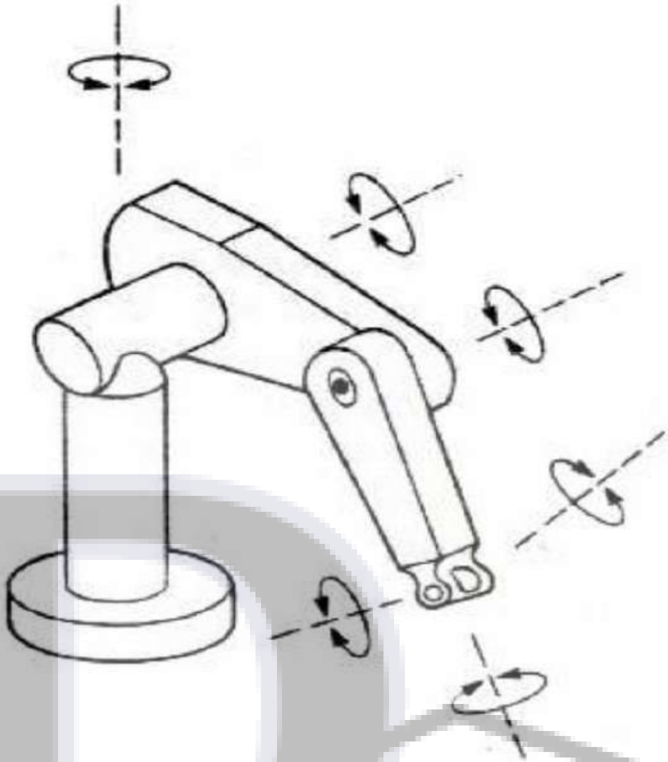

Figure 1. Anthropomorphic Type of Robot Design (Selig, 1992, p.29)

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Sensors

1. Proximity Sensors: Used to detect objects in the arm's vicinity, facilitating precise positioning.
2. Load Sensors: Measure the weight of lifted objects, ensuring safe handling.
3. Encoder Sensors: Monitor motor shaft rotation for accurate control of arm movements.

Actuators

4. DC Motors: Drive the robotic arm's joints for articulated movement.
5. Gripper Mechanism: Controls opening and closing of gripper for object manipulation.

Connections

Proximity sensors connected to digital input pins of microcontroller for object detection.

Analog output connected to ADC pins of the microcontroller for weight measurement

Encoder sensors connected to interrupt pins of microcontroller for precise feedback on motor shaft rotation.

DC motors controlled via PWM signals from microcontroller for speed and direction regulation

Requirements

1. Robust mechanical design : ensure robotic arm's structural integrity to withstand repetitive tasks.

2. Efficient Power Management : Utilize power-saving techniques to prolong battery life or minimize electricity consumption.

3. Real-time control algorithms : implement algorithms for precise motion control and object manipulation.

4. User Interface : Develop a user-friendly interface for intuitive operation and monitoring of robotic arm.

5. Safety Features : Incorporate emergency stop mechanisms and error detection algorithms to prevent accidents.

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Specifications

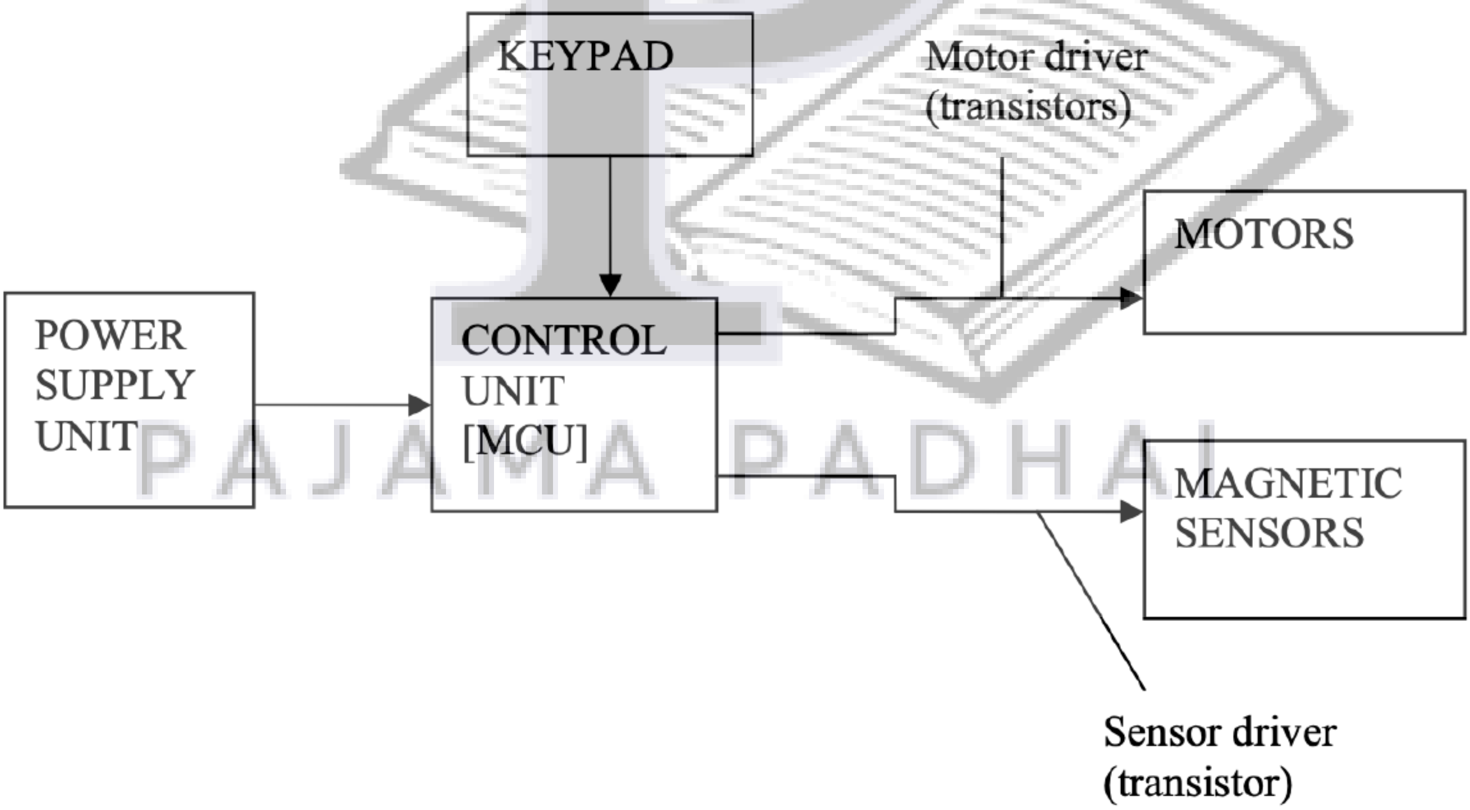
1. Payload Capacity : 5 – 10 kg

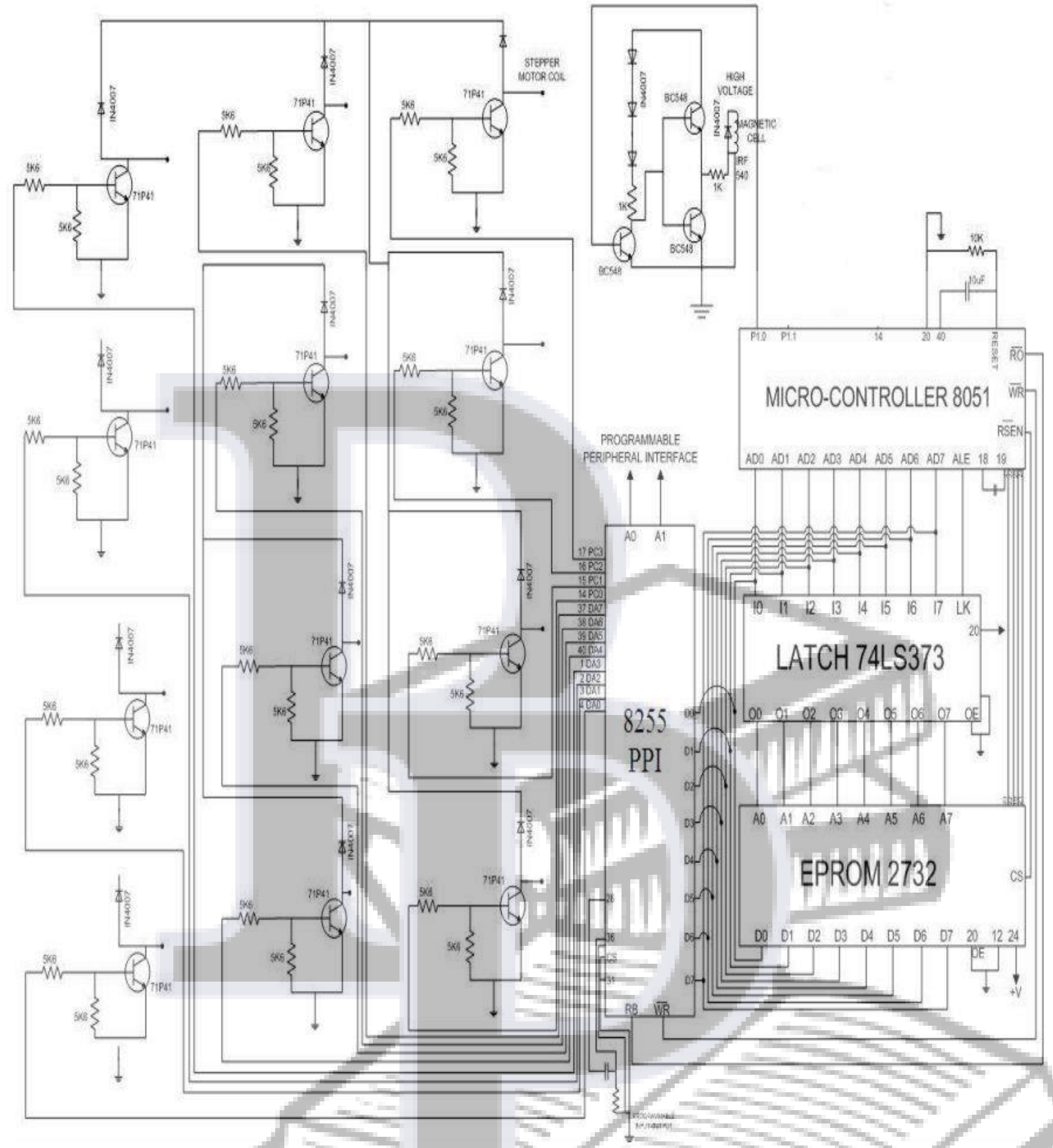
2. Accuracy : +/– 1 mm for positioning, +/– 100 grams for weight measurement.

3. Speed : Adjustable within 0.1 – 1 m/s for optimal handling.

4. Power Supply : 12 V DC for motors, 5 V DC for microcontroller and sensors

5. Communication : Optional integration of wireless communication for remote operation and data logging.





By employing 8051 microcontrollers in robotics, such as the warehouse automation system described above, society benefits from increased efficiency, reduced labour costs and improved safety standards.

This blueprint serves as a template for designing similar applications, driving progress and innovation across various domains.

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(2) Improving Road Safety with PIC technology: Automatic Traffic Light Control for Emergency Vehicles.

Description:

Traffic lights play a crucial role in managing traffic flow on roads, but congestion, especially during emergencies, can impede the passage of emergency vehicles. To address the issue and enhance safety, an Automatic Traffic Light Controller for Emergency Vehicles has been developed. This system, utilizing a Peripheral Interface Controller (PIC), prioritizes emergency vehicles by allowing them to trigger traffic light signal to change from red to green automatically. This clears the vehicle's path, ensuring swift passage through intersections. Using Radio Frequency (RF), the traffic lights return to normal operation once the emergency vehicle has passed. Tests have demonstrated the system's effectiveness within a range of 55 meters, affirming its successful design and implementation.

Societal Impact:

The implementation of an Automatic Traffic Light Controller for Emergency Vehicles significantly improves public safety by expediting emergency response times. By prioritizing the passage of emergency vehicles through traffic intersections, the system ensures timely arrival at critical situations, potentially saving lives. Additionally, it enhances overall traffic efficiency by minimizing disruptions and congestion.

Blueprint:

1. Application utilizes a Peripheral Interface Controller (PIC) microcontroller, programmed to manage traffic light control system and interface with other components.

2. Radio Frequency (RF) sensor is employed to detect presence of emergency vehicles approaching the intersection.

3. The actuators consist of traffic light signals, which are controlled by PIC microcontroller to change from red to green when triggered by the RF sensor.

4. RF sensor is connected to PIC microcontroller to provide input regarding presence of emergency vehicles.

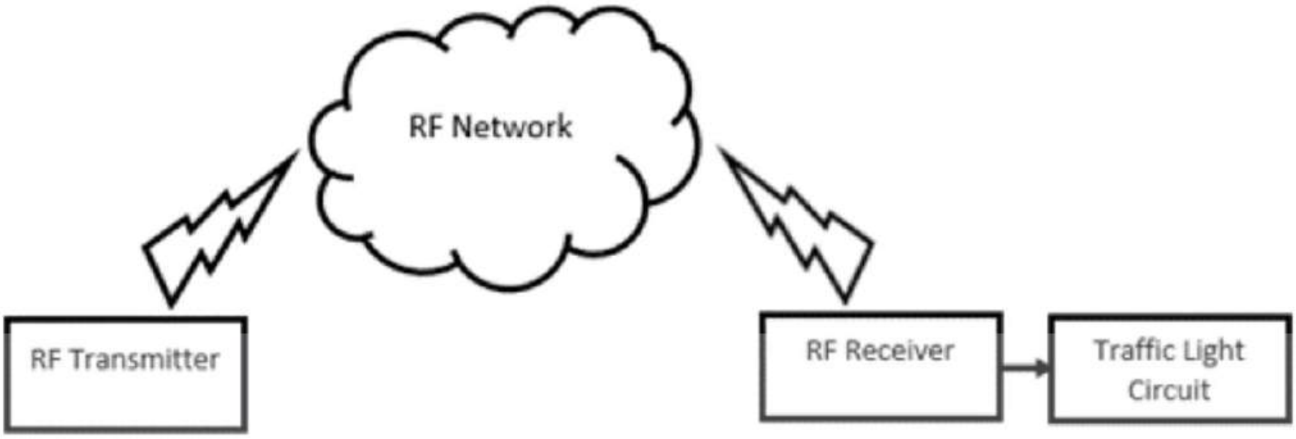

Figure 1. Overview of the proposed system

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Requirements

1. Reliable RF sensor capable of detecting emergency vehicles from a distance.

2. PIC microcontroller with sufficient memory and processing power to handle the traffic light control algorithm.

3. Robust traffic light system capable of changing signals promptly in response to microcontroller's commands.

4. Stable power supply to ensure continuous operation of the system.

5. Adequate housing and protection for all components to withstand outdoor environmental conditions.

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Specifications

1. RF sensor should reliably detect emergency vehicles within a range of at least 55 meters

2. System should respondly promptly to trigger traffic light signal change within a maximum of 5 seconds after detecting an emergency vehicle.

3. System should demonstrate high reliability with minimal false triggers or malfunctions.

4. System should consume minimal power to ensure cost-effectiveness and environmental sustainability.

5. Application should be compatible with existing traffic light infrastructure and regulations.

6. Design should allow for scalability to accommodate future expansions or modifications to the traffic management system.

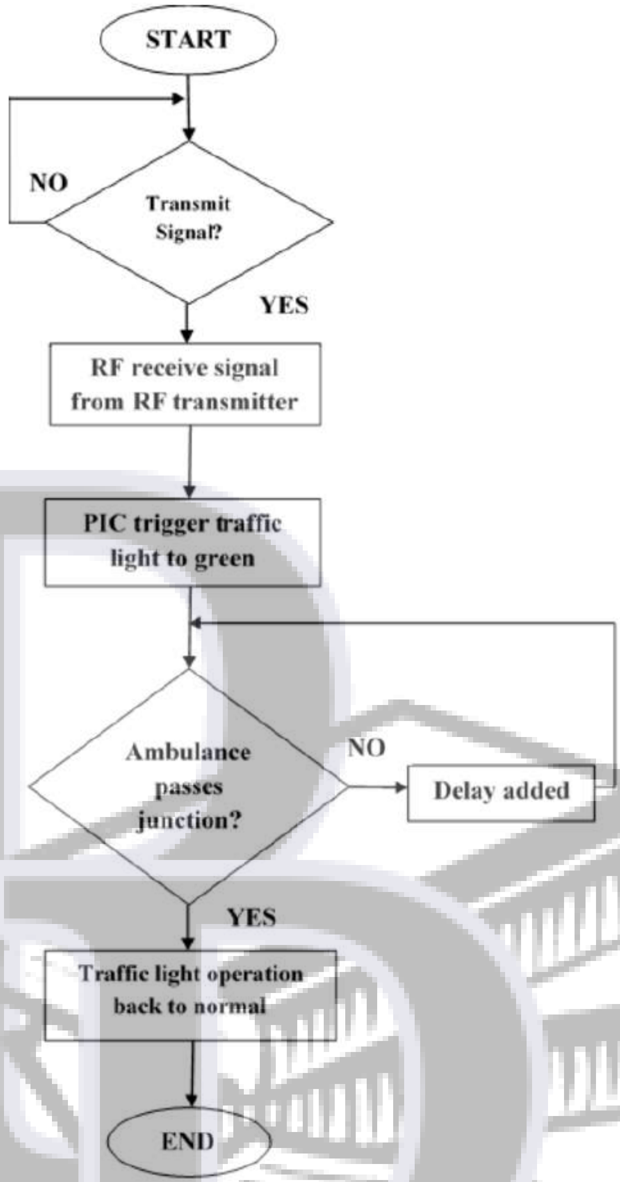

Figure 2. Flowchart of the system

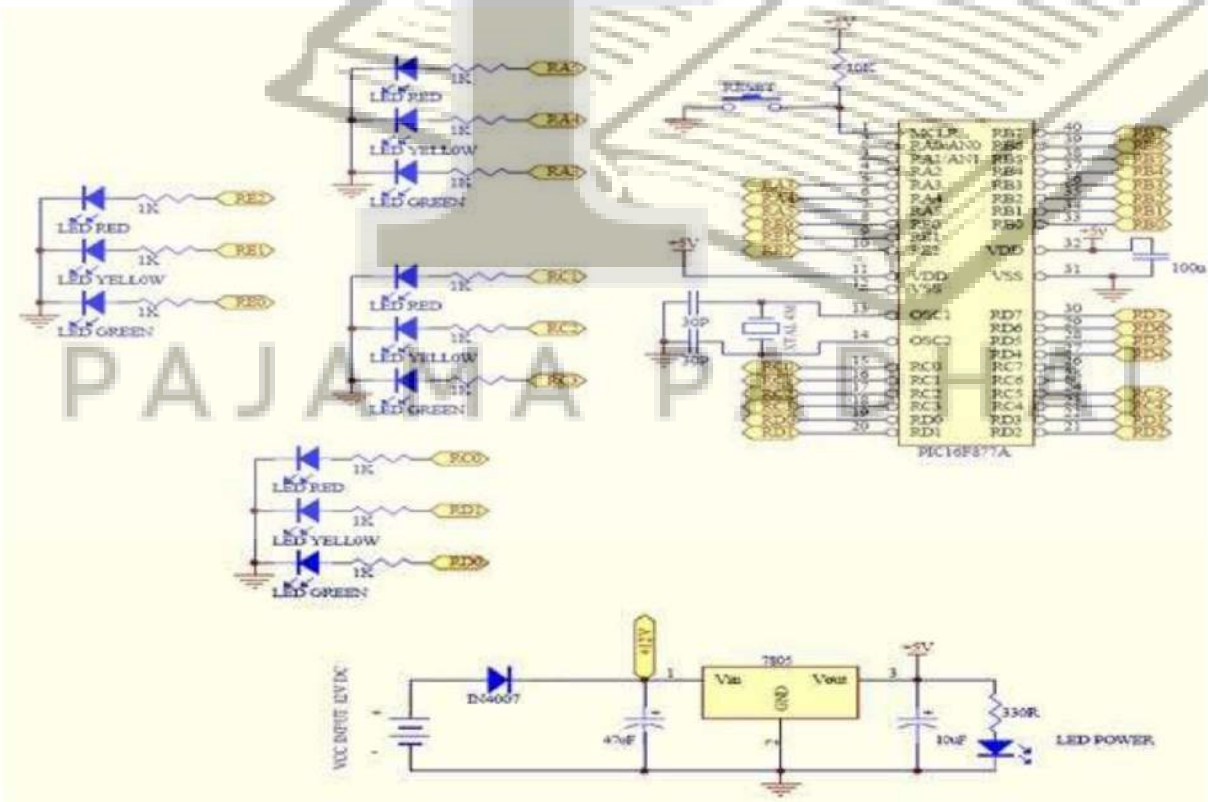

Figure 3. Schematic of traffic light circuit

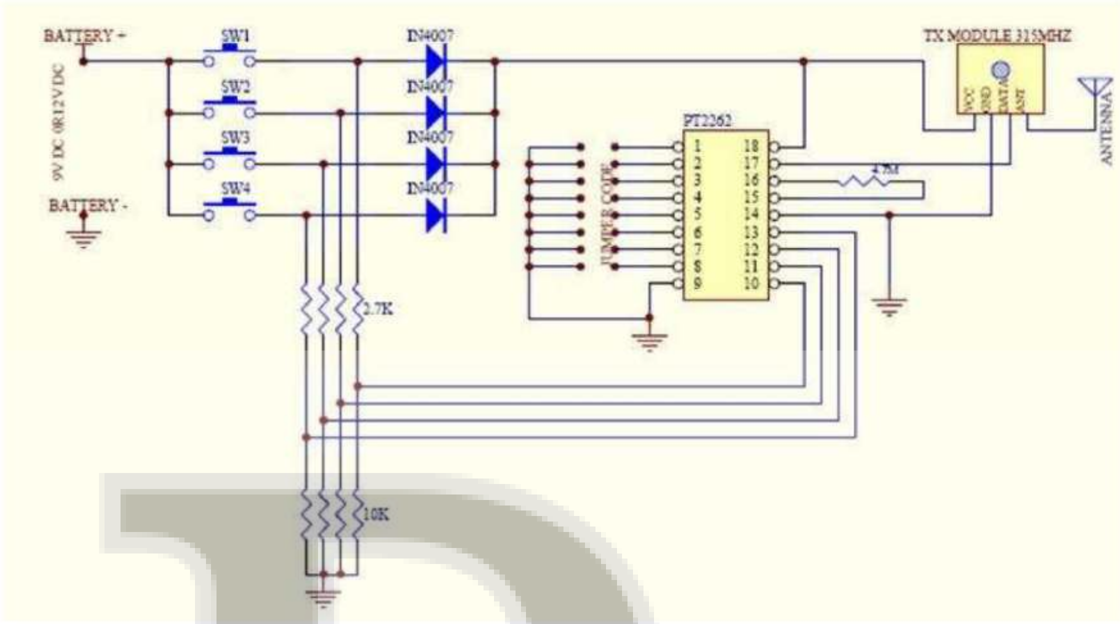

Figure 4. Transmitter schematic circuit

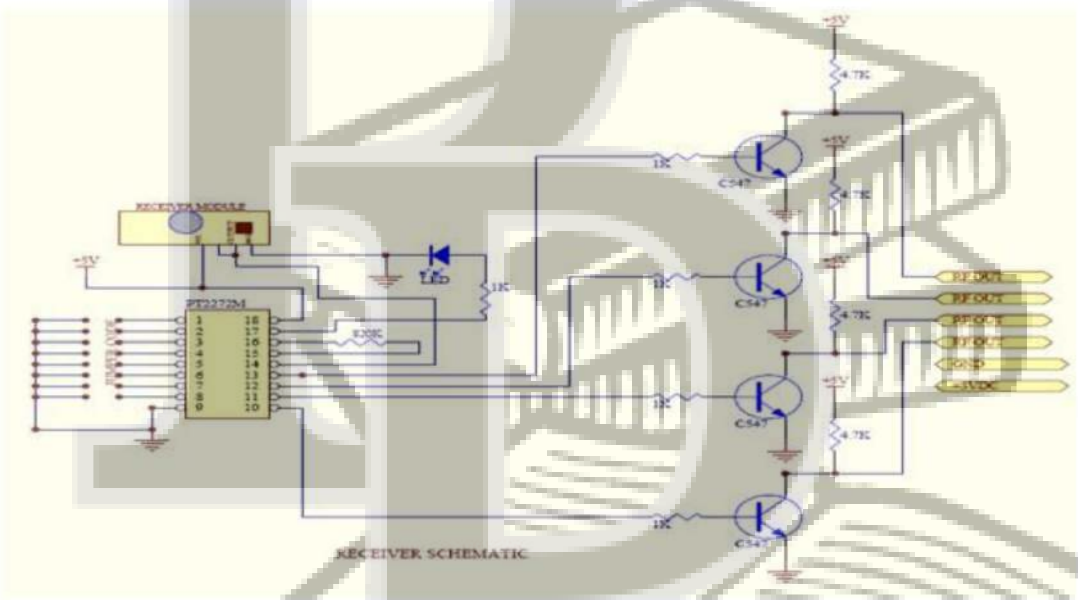

Figure 5. Receiver schematic circuit

Figure 6. Traffic light model

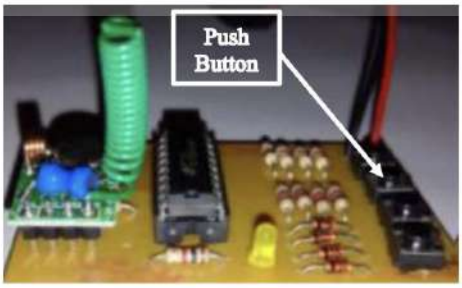

Figure 7. Transmitter schematic circuit

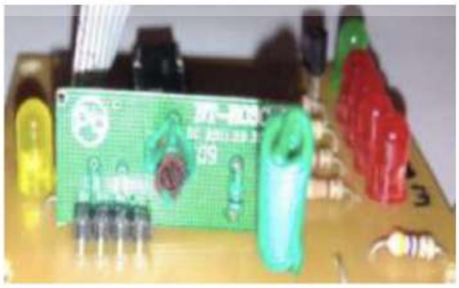

Figure 8. Receiver schematic circuit

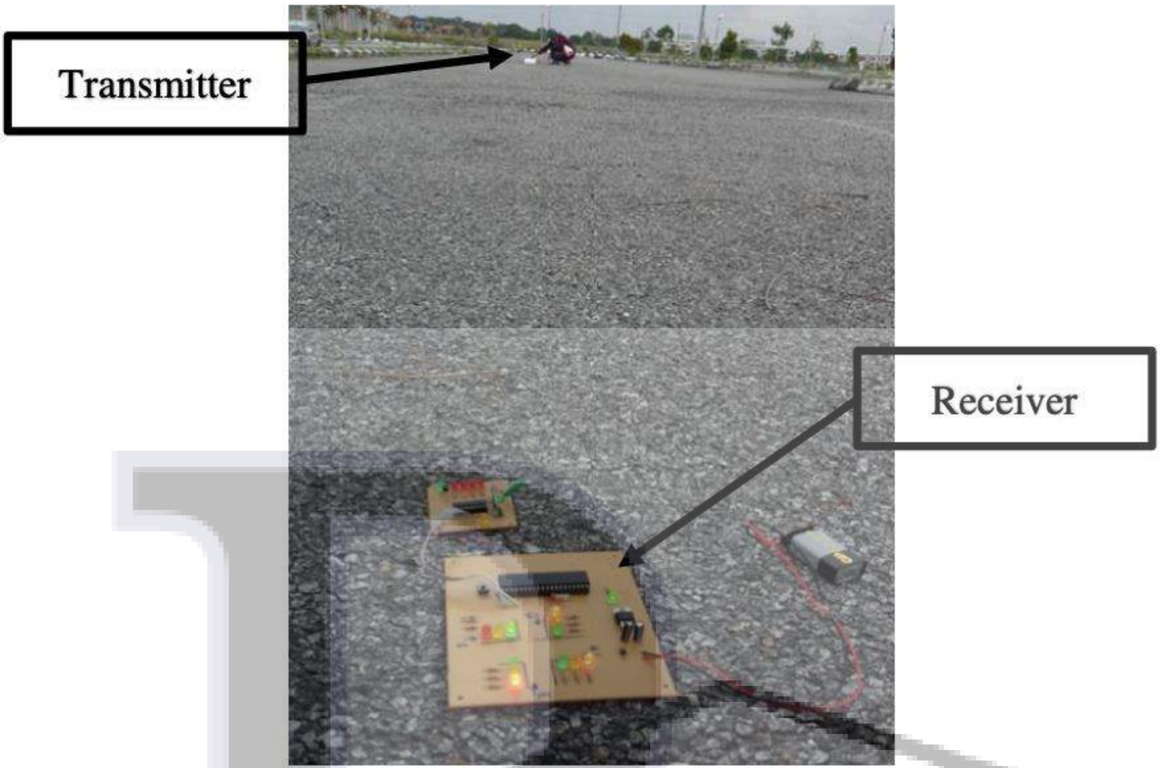

Figure 9. Experiment setup

Future enhancements may include integrating alternative wireless technologies like LoRa, adopting solar powered batteries for increased efficiency, and exploring different microcontrollers to enhance processing speed.

(3) ARM based Healthcare Monitoring Services using wireless network

Description

In areas lacking healthcare infrastructure, patients often struggle to access timely medical care due to a shortage of electronic medical equipment and physician availability. Following blueprint proposes leveraging modern technology, including sensor-based systems and Internet of Things (IOT) devices, interfaced with ARM microcontrollers, to securely transmit vital patient biomedical data over wireless channels to remote locations where doctors can provide immediate assistance. Additionally, a smart medication box with LED indicators and alarm functions is introduced to address medication adherence issues.

Societal Impact

The implementation of ARM-based healthcare monitoring services using wireless networks has significant societal implications, particularly in underserved rural areas. By enabling remote monitoring and transmission of vital patient data, this technology bridges the gap between patients and medical professionals, ensuring timely interventions and potentially saving lives.

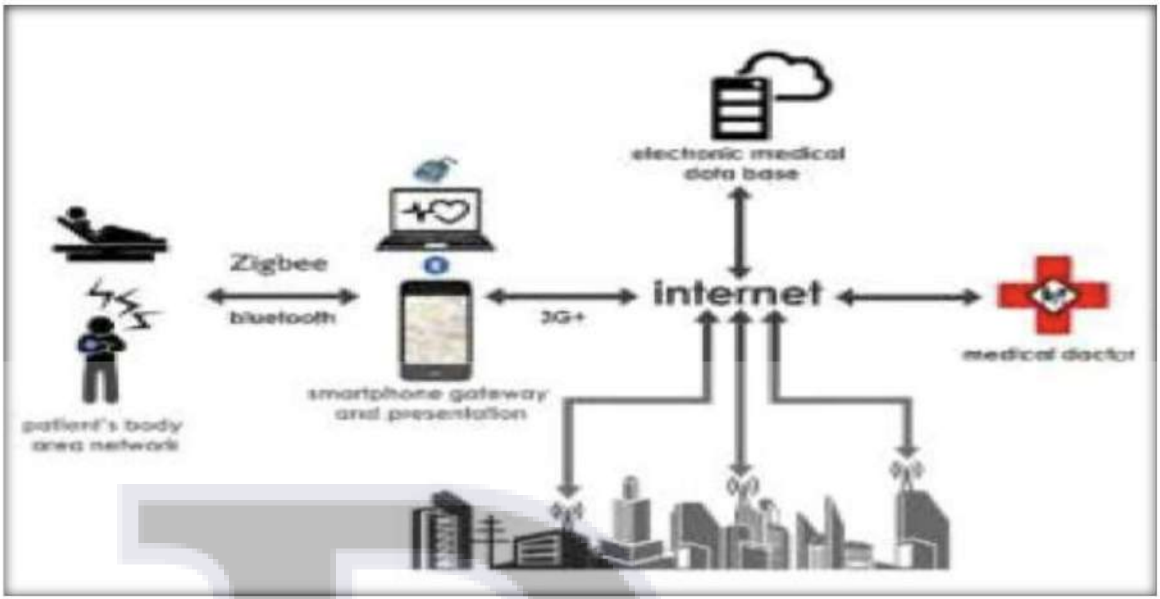

Fig-1: Health Care Monitoring System

Blueprint

1. Application utilizes an ARM microcontroller or microprocessor to serve as the central processing unit for data processing and control functions.

2. Various sensors are incorporated into the system to collect biomedical data such as heart rate, ECG, body temperature and blood pressure.

These sensors may include pulse sensors, ECG electrodes, thermistors and pressure sensors.

3. Actuators include LED indicators and alarm systems integrated into smart medication box to alert patients about medication schedules.

4. Sensors are connected to the ARM microcontroller through appropriate interfaces such as ADC converters or digital I/O pins.

Additionally, the microcontroller may be connected to wireless communication modules such as Bluetooth or GSM for data transmission to remote locations.

Requirements

1. Sensors must accurately collect biomedical data to ensure the integrity of the patient monitoring system.

2. ARM microcontroller or microprocessor should have sufficient processing power and memory to handle data processing tasks efficiently.

3. Application requires reliable wireless communication modules to transmit patient data securely to remote locations.

4. System should be designed to minimize power consumption to prolong battery life, especially in portable devices.

5. Data transmitted wirelessly should be encrypted to ensure patient privacy and confidentiality.

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Specifications

1. Sensors should have a high level of accuracy in measuring vital signs such as heart rate, ECG, body temperature, and blood pressure.

2. Wireless communication modules should have sufficient range to transmit patient data reliably to remote locations, even in rural areas.

3. System should respond promptly to sensor inputs and patient interactions to provide timely feedback and alerts.

4. Application should be designed to minimize power consumption, especially in battery operated devices, to ensure long-term usability.

5. System should be compatible with existing healthcare infrastructure and standards to facilitate integration and interoperability with other medical devices and systems.

6. Application should be reliable and robust, capable of functioning in diverse environments and conditions without compromising patient safety or data integrity.

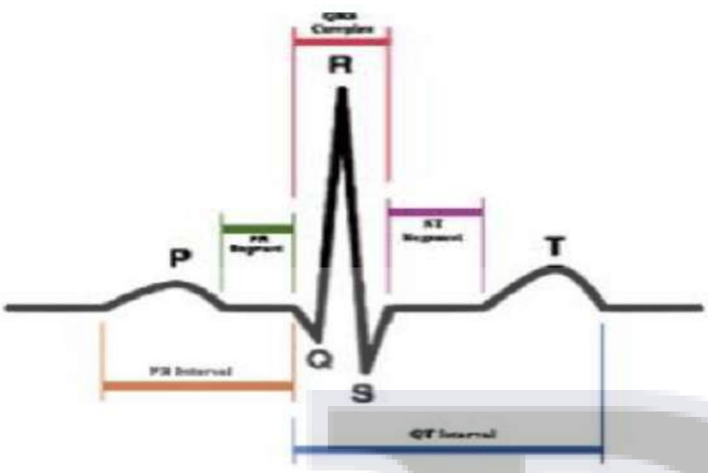


Fig-2: Representative Schematic of Normal ECG Waveform

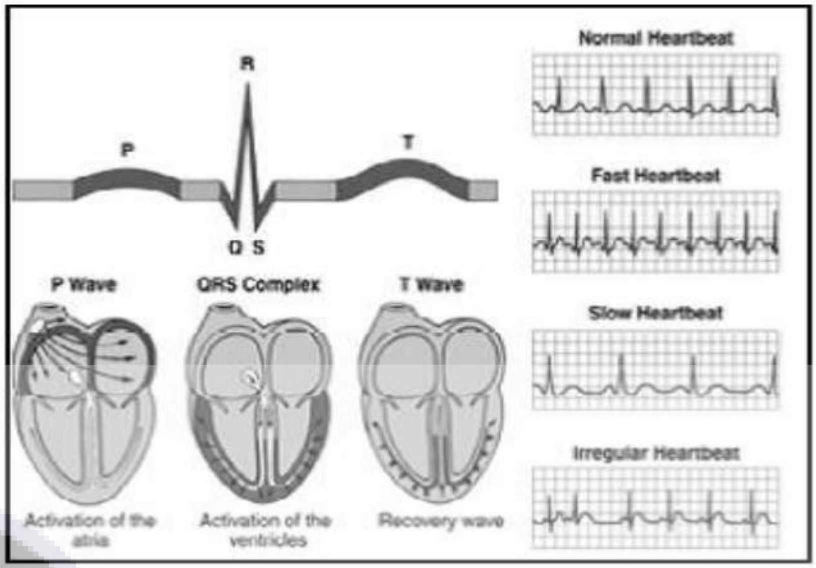


Fig-3: Analysis of ECG Waveform

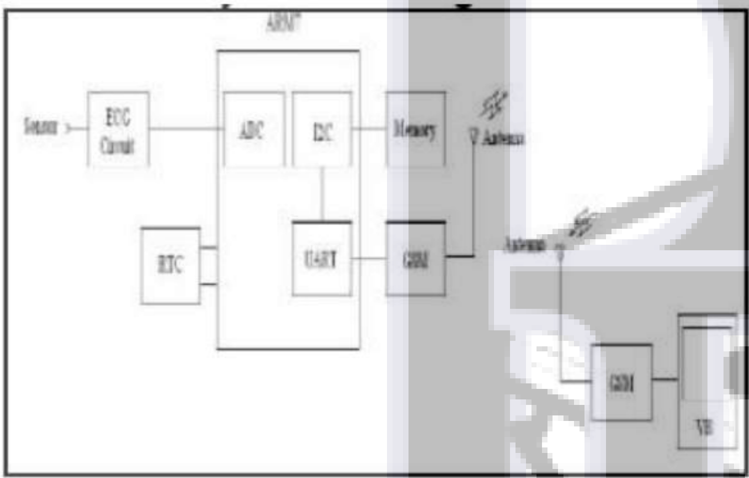


Fig-4: Functional System Block Diagram

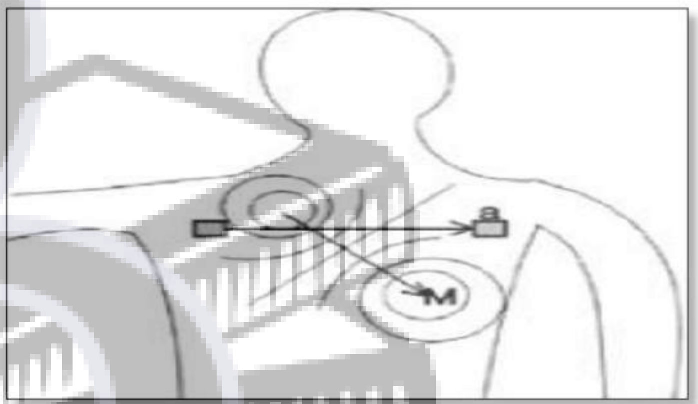
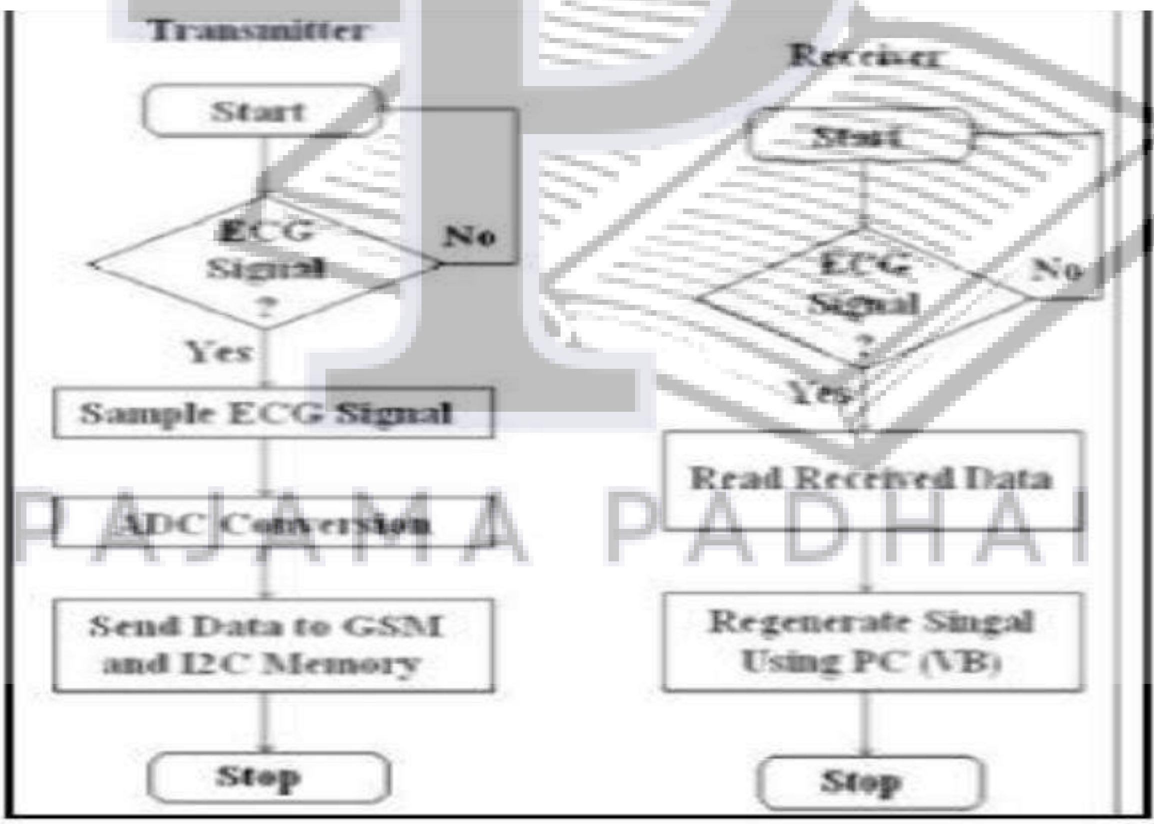
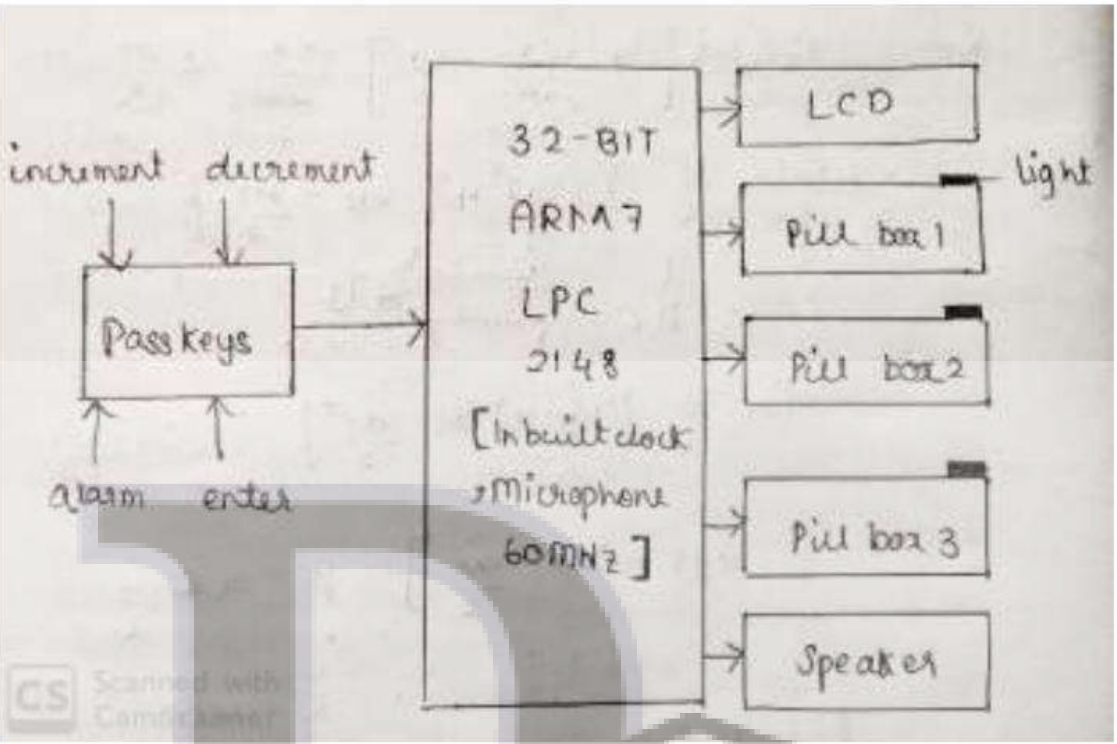


Fig-5: Vector Model of Heart and Electrode Interaction





Using ARM microcontrollers in embedded systems, we can create circuits to monitor temperature and heart rate via mobile devices. These devices are user-friendly and portable, making them suitable for elderly users with limited IT skills. Adding sensors like ECG and MEMs enhances functionality, allowing real-time data transmission to doctors for remote monitoring. Integration with Android/iOS platforms and custom IoT devices further enhances efficiency.