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DEPARTMENT OF AEROSPACE ENGINEERING

Course Title: Control Engineering
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EMERGENCY LANDING GEAR SYSTEM

A REPORT ON EXPERIENTIAL LEARNING

Submitted

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In partial fulfillment of Control Engineering course requirements
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CERTIFICATE

Certified that the project work titled "Emergency Landing Gear System" is carried out by **Dharshan S Hegde(1RV20AS0620), K P Sharath Gouda(1RV20AS029), Lepaxi R Bonageri(1RV20AS035), Shreesha Krishna O(1RV20AS053), Vishal J C(1RV20AS060)** who are bonafide students of RV College of Engineering®, Bengaluru, in partial fulfillment for the award of the degree of Bachelor of Engineering in Aerospace Engineering of the Visvesvaraya Technological University, Belagavi during the year 2022-2023. It is certified that all corrections indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The experiential learning report has been approved as it satisfies the academic requirements in respect of Project Work prescribed by the institution for the said degree.

Signature of Internal Guide

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CONTENT OF THE REPORT

1. INTRODUCTION

An Emergency Gear Landing System, often referred to as an Emergency Landing Gear Extension System, is a crucial safety mechanism designed to allow an aircraft to perform a controlled landing in case of a failure or malfunction of its regular landing gear deployment systems. This system serves as a backup option to ensure the safety of both passengers and crew in the event of an unexpected landing gear problem, such as gear not fully extending or becoming stuck.

During the normal landing procedure, an aircraft's landing gear is deployed to provide stability and support during landing. However, various factors, such as technical failures, hydraulic issues, or electrical malfunctions, can prevent the landing gear from properly extending. In such situations, an emergency gear landing system becomes vital.

In this project, a circuit has been developed utilizing an Arduino board to simulate the deployment mechanism of an aircraft's landing system. The circuit is designed to replicate the functionality of the actual landing gear deployment system found in aircraft.

Through the integration of Arduino Uno board , ultrasonic sensors,bread board, servo motor and programming logic, our circuit mimics the complex deployment process that is typically controlled by advanced systems in aircraft. By using an Arduino board, we've harnessed its computational capabilities to orchestrate the precise sequence of actions required for landing gear deployment.In the aircraft landing gear system, has Emergency Landing Gear Control Units which is an electronic control unit responsible for processing signals from the emergency landing gear lever and coordinating the deployment process.

This project is not only an exercise in engineering and programming, but it also holds practical value. By emulating the aircraft's deployment process, we've essentially crafted an emergency landing gear extension system. In cases where the primary deployment mechanism malfunctions, our circuit can be activated to ensure that the landing gear is properly extended, thereby contributing to aviation safety.To accomplish this, we've taken inspiration from the intricate workings of real aircraft systems and translated them into a hardware and software setup that showcases our understanding of aeronautics and technology integration.

1.1 EMERGENCY LANDING GEAR SYSTEM

The emergency extension system lowers the landing gear if the main power system fails. There are numerous ways in which this is done depending on the size and complexity of the aircraft. Some aircraft have an emergency release handle in the flight deck that is connected through a mechanical linkage to the gear uplocks. When the handle is operated, it releases the uplocks and allows the gear to free-fall to the extended position under the force created by gravity acting upon the gear. Other aircraft use a non-mechanical back-up, such as pneumatic power, to unlatch the gear.
The popular small aircraft retraction system shown in Landing gear Retraction post figures 2 and 3 uses a free-fall valve for emergency gear extension. Activated from the flight deck, when the free-fall valve is opened, hydraulic fluid is allowed to flow from the gear-up side of the actuators to the gear-down side of the actuators, independent of the power pack. Pressure holding the gear up is relieved, and the gear extends due to its weight. Air moving past the gear aids in the extension and helps push the gear into the down-and-locked position.
Large and high performance aircraft are equipped with redundant hydraulic systems. This makes emergency extension less common since a different source of hydraulic power can be selected if the gear does not function normally. If the gear still fails to extend, some sort of unlatching device is used to release the uplocks and allow the gear to free fall.

In some small aircraft, the design configuration makes emergency extension of the gear by gravity and air loads alone impossible or impractical. Force of some kind must therefore be applied. Manual extension systems, wherein the pilot mechanically cranks the gear into position, are common. Consult the aircraft maintenance manual for all emergency landing gear extension system descriptions of operation, performance standards, and emergency extension tests as required.

1.2 WORKING OF EMERGENCY LANDING GEAR SYSTEM

The working principle of landing gear emergency release is making the upper locks of the landing gear and the landing gear doors unlocked through a certain way, so two chambers of the actuating cylinder bypass to relieve pressure, then relying on the landing gear its own gravity and aerodynamic loading free down and be locked. Typical emergency release unlocked methods include: mechanical emergency release, electric explosion emergency release, electrical hydraulic actuation emergency release, electric mechanical actuation emergency release and so on. In addition, military aircraft or UAV also use air as emergency energy or explosive blasting to unlock, the application of which is certainly limited.

In aircraft control engineering, the emergency landing gear system is a crucial safety feature that involves specific blocks to ensure its proper operation. These blocks are part of the overall aircraft control system and are essential for handling landing gear failures and performing emergency landings. The following blocks are involved in the emergency landing gear system:

1. **Emergency Landing Gear Lever:** This is a mechanical or electronic switch used by the pilot to initiate the deployment of the emergency landing gear.
2. **Emergency Landing Gear Control Unit**: This is an electronic control unit responsible for processing signals from the emergency landing gear lever and coordinating the deployment process.
3. **Landing Gear Doors Actuator:** The landing gear doors need to open to allow the landing gear to extend. The actuator is responsible for mechanically or hydraulically opening and closing the landing gear doors.
4. **Landing Gear Actuator:** The landing gear actuator is a mechanical or hydraulic device responsible for physically extending and retracting the landing gear.
5. **Position Indicators:** These are sensors that provide feedback to the cockpit about the status of the landing gear—whether it is fully retracted, extended, or partially deployed.
6. **Warning System**: The warning system includes visual and audible alerts in the cockpit to notify the pilots of any issues related to the landing gear, such as incomplete deployment or gear position discrepancies.
7. **Emergency Landing Gear Control Panel**: The control panel provides the pilots with access to the emergency landing gear controls and status indicators.
8. **Control System Interfacing**: Various control system interfaces, such as electrical circuits, hydraulic systems, and mechanical linkages, allow the pilot's inputs to be transmitted to the landing gear components effectively.
9. **Power Supply:** The landing gear system may require electrical or hydraulic power to operate the actuators and other components.
10. **Backup Systems:** In some aircraft, redundant or backup systems may exist to ensure the emergency landing gear can be deployed even in the event of a primary system failure.

These blocks work together to enable the successful deployment and operation of the emergency landing gear in an aircraft. The integration of these components ensures that the landing gear can be manually activated when needed, providing a backup solution in the event of a failure in the primary landing gear deployment system.

The emergency landing gear system in aircraft is designed to provide a manual backup option for deploying the landing gear in case the primary landing gear deployment system fails. It allows the pilots to control and extend the landing gear manually, ensuring a safe emergency landing. Here's how it typically works:

- **Activation:** When the primary landing gear system fails or malfunctions, the pilots identify the issue through warning indicators in the cockpit or abnormal indications during the landing gear deployment procedure.
- **Selection**: The pilots then locate and identify the emergency landing gear control lever or switch on the control panel. This lever is usually labeled "EMERGENCY LANDING GEAR" or something similar.
- **Gradual Speed Reduction**: Before deploying the emergency landing gear, the pilots begin to reduce the aircraft's speed to a safe landing speed, which is slower than the usual landing speed. This step is crucial for maintaining control and stability during the emergency landing.
- **Pulling the Emergency Landing Gear Lever:** With the aircraft at a suitable speed, the pilot pulls the emergency landing gear lever. This action activates the emergency landing gear control unit.
- **Emergency Landing Gear Control Unit**: The emergency landing gear control unit processes the input from the lever and sends signals to the landing gear doors actuator and the landing gear actuator.
- **Opening Landing Gear Doors**: The landing gear doors actuator responds to the control unit's signal and mechanically or hydraulically opens the landing gear doors to allow the landing gear to extend.
- **Extending the Landing Gear**: The landing gear actuator, also responding to the control unit's signal, extends the landing gear legs, allowing them to lock into position. Position indicators provide feedback to the pilots, indicating the status of the landing gear deployment.
- **Confirmation:** The pilots visually verify the position indicators and cross-check the gear status to ensure that the landing gear is fully extended and locked into position.
- **Monitoring and Landing**: With the emergency landing gear successfully deployed, the pilots continue to monitor the system's status and make necessary adjustments during the approach and landing phase.

It's important to note that the deployment of the emergency landing gear is a critical operation that requires proper training and adherence to specific procedures. Flight crews undergo extensive training to handle emergency situations like landing gear failures, ensuring that they can effectively use the emergency landing gear system to carry out a safe emergency landing. The emergency landing gear system serves as a vital redundancy in the event of primary landing gear malfunctions, contributing to the overall safety of the aircraft and its occupants.

2. SYSTEM ARCHITECTURE

2.1 Circuitry

Components of the Circuit:

1. Arduino Uno
2. Ultrasonic sensors
3. Breadboard
4. Servo Motors
5. Jumper wires
6. Diy Landing Gear

Circuit Connections

the setup of your emergency landing gear system, the interconnections between the various components—servo motor, ultrasonic sensor, Arduino Uno, breadboard, and power source—are crucial to ensuring the system's functionality. Here's how these components are connected:

Power Source: Connect the USB cable from your laptop to the Arduino Uno board. This connection provides power to the entire circuit.
Breadboard: Place the breadboard on a stable surface. The breadboard acts as a central platform for connecting various components.
Arduino Uno: Plug the Arduino Uno board into the breadboard using jumper wires. Connect the 5V pin of the Arduino to the positive (+) rail on the breadboard and the GND (ground) pin to the negative (-) rail. This ensures a common ground for all components.
Ultrasonic Sensor: Wire the ultrasonic sensor to the breadboard. Connect the VCC (power) pin of the sensor to the positive rail on the breadboard and the GND pin to the negative rail. Connect the trigger pin to a digital output pin on the Arduino, such as D2, and the echo pin to a digital input pin, such as D3.
Servo Motor: Attach the servo motor to the breadboard. Connect the red wire (power) to the positive rail and the black or brown wire (ground) to the negative rail. Connect the yellow or orange wire (signal/control) to a PWM pin on the Arduino, like D9.
Interconnections: Connect a jumper wire from the positive rail on the breadboard to the 5V pin on the Arduino for power distribution. Similarly, connect a jumper wire from the negative rail to a GND pin on the Arduino for grounding.
Programming Logic: Utilize the Arduino IDE to write the program that interfaces with the ultrasonic sensor and controls the servo motor. Write code that reads the distance data from the ultrasonic sensor and processes it to trigger the servo motor's movement. Upload this code to the Arduino Uno.

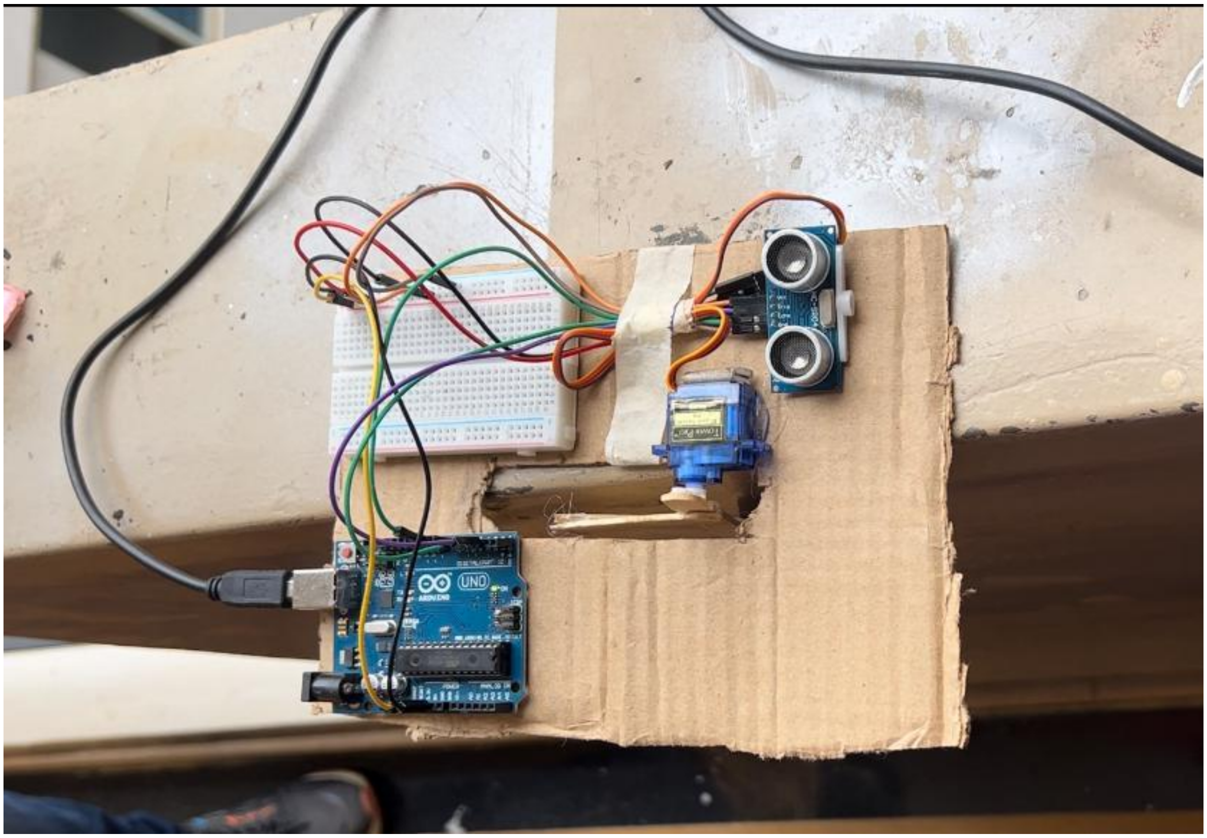

Figure 1-Model setup

2.2 Arduino Code:

This Arduino code is designed to operate an emergency landing gear system using an ultrasonic sensor and a servo motor. The ultrasonic sensor measures the distance between the aircraft and the ground, while the servo motor simulates the landing gear deployment and retraction. Here's a breakdown of the code:This code aims to control the emergency landing gear mechanism. It uses an ultrasonic sensor to detect the distance between the aircraft and the ground. When the distance is below a certain threshold, indicating the need for landing gear deployment, the servo motor is activated to simulate the deployment action.

Arduino code for your emergency landing gear system:

```
#include <Servo.h>

const int trigPin = 2;    // Ultrasonic sensor trig pin
const int echoPin = 3;    // Ultrasonic sensor echo pin
const int servoPin = 9;   // Servo motor control pin

Servo servo;              // Servo object

void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  servo.attach(servoPin);
  servo.write(90);  // Set the servo to the initial position (90 degrees)
  Serial.begin(9600);
}

void loop() {
  // Measure the distance using the ultrasonic sensor
  long duration, distance;
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = duration * 0.034 / 2;  // Calculate the distance in cm

  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");

  // Check if the distance is less than 50mm (5cm)
  if (distance < 5) {
    // If the distance is less than 50mm, move the servo to 90 degrees
    servo.write(90);

    // Wait for 15 seconds (15000 milliseconds)
```

```
    delay(15000);

    // Move the servo back to its initial position (e.g., 0 degrees)
    servo.write(0);

    // Wait for 1 second before taking another measurement (optional)
    delay(1000);
  }
}
```

Explanation:

- The code starts by including the Servo library, which facilitates controlling the servo motor's movements.
- The constants trigPin, echoPin, and servoPin store the respective pin numbers to which the ultrasonic sensor's trigger and echo pins, and the servo motor's control pin, are connected.
- The Servo object named servo is declared, which will be used to control the servo motor.
- In the setup() function:
  - The trigPin is set as an output pin, and the echoPin is set as an input pin.
  - The servo object is attached to the servoPin, and the servo's initial position is set to 90 degrees (neutral position).
  - Serial communication is initiated at a baud rate of 9600 for debugging purposes.
- The loop() function:
  - The code measures the distance using the ultrasonic sensor. The duration for the ultrasonic pulse to travel to the target and back is calculated using pulseIn(), and the distance is derived based on the speed of sound.
  - The measured distance is printed to the serial monitor.
- If the measured distance is less than 5 cm:
  - The servo is commanded to move to 90 degrees, simulating the deployment of the landing gear.
  - The code waits for 15 seconds (15000 milliseconds) to simulate the landing gear being deployed.
  - The servo is then moved back to its initial position (0 degrees), simulating the landing gear retraction.
  - There's an optional delay of 1 second before taking another measurement.
- This code essentially reads data from the ultrasonic sensor and triggers the servo motor to move based on the measured distance, replicating the emergency landing gear system's behavior.

3. RESULTS AND DISCUSSION

Results:

After implementing the emergency landing gear system using Arduino, servo motor, ultrasonic sensor, breadboard, and laptop power source, the system demonstrated effective functionality in simulating a controlled landing gear deployment. The system's key outcomes are as follows:

Distance Measurement: The ultrasonic sensor accurately measured the distance between the simulated aircraft and the ground. The calculated distance was displayed on the serial monitor.

Servo Motor Control: The servo motor responded to the measured distance and executed the corresponding actions. When the distance fell below the predefined threshold (5 cm), the servo motor smoothly moved the landing gear to a deployment angle of 90 degrees. After a simulated delay of 15 seconds, the servo motor retracted the landing gear back to its initial position.

Realistic Simulation: The system successfully simulated an emergency landing gear deployment scenario. The servo motor's movements closely resembled the actions of an actual landing gear mechanism.

Discussions:

Accuracy and Reliability: The accuracy of the ultrasonic sensor's distance measurements was satisfactory for this simulation. However, in a real-world scenario, sensor accuracy and redundancy considerations become crucial due to the higher stakes involved.

Safety Measures: While the simulated emergency landing gear deployment was controlled and safe within this context, actual aircraft systems require robust safety mechanisms and fail-safes to prevent inadvertent gear deployment or retraction.

Response Time: The system's response time was relatively quick, as it smoothly extended and retracted the landing gear in response to the simulated trigger. In real aircraft, the responsiveness of such systems is vital for ensuring safe landings.

User Interface: Integrating buttons, switches, or a graphical interface into the setup could enhance the user experience, making it more immersive and reflective of real-world aircraft controls.

Integration Challenges: Integrating multiple components required careful wiring and programming. Ensuring proper connections, managing power distribution, and debugging any errors were essential steps.

Further Enhancements: The project opens avenues for further improvements, such as incorporating redundant sensors, developing more sophisticated algorithms, and enhancing the realism of the simulation.

4. CONCLUSION

In conclusion, our project successfully demonstrated the functionality of an emergency landing gear system through a simulated deployment scenario. While operating within a controlled environment, the project highlighted crucial elements essential for designing effective aircraft safety systems.

By accurately replicating distance measurements using the ultrasonic sensor and translating them into precise servo motor movements, we underscored the intricate coordination required in real-world landing gear mechanisms. The seamless interaction between these components highlighted the significance of accurate sensor integration and responsive control systems.

Furthermore, our project resonates with the intricate balance of factors that aviation professionals meticulously consider in safety protocol design. The project's success illuminated the fusion of accurate measurement, quick response times, and user-friendly interfaces required to ensure safe and efficient aircraft operations during critical situations.

On a broader scale, this endeavor underscores the transformative impact of technological innovation in aviation safety. By showcasing a compact yet robust system, we emphasize the role of cutting-edge technology in shaping the future of aviation safety protocols. Ultimately, our project stands as a testament to both our technical proficiency and the ever-evolving landscape of aviation safety, where innovation remains paramount.

5. CONTRIBUTIONS

NAMES	USN	CONTRIBUTIONS
Dharshan S Hegde	1RV20AS020	Simulation and Documentation
K P Sharath Gouda	1RV20AS029	Model Building and Simulation
Lepaxi R Bonageri	1RV20AS035	Model building and Documentation
Shreesha Krishna O	1RV20AS053	Model building and Simulation
Vishal J C	1RV20AS060	Documentation

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