NORTH SOUTH UNIVERSITY

Department of Electrical & Computer Engineering (ECE)

CSE499B SENIOR DESIGN II
Section: 11
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Project Title: Precise Control Drone
Updated System Design

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SCORE:	REMARKS:
PENALTY:	

Introduction:

An unmanned aerial vehicle, commonly known as a Drone, is a remote-controlled flying vehicle with a vast potential in various sectors. Initially developed for military applications, drones are now advancing in sectors like agriculture, surveillance, security, entertainment, and aerial photography, promising a bright future for technology in Bangladesh.

A precise control drone, also known as a precision drone or precision-controlled drone, refers to an unmanned aerial vehicle (UAV) equipped with advanced control systems and technologies that enable it to maintain a high degree of accuracy and stability in its flight and operations. The term "precise control" encompasses a range of capabilities that include accurate positioning, stable hovering, and responsive flight in various environmental conditions.

Application of Precise Control Drone:

Drones with precise control have a wide range of uses in several industries, which boost productivity and security. They are extremely useful in search and rescue operations since they allow for the quick navigation of difficult terrain, the provision of real-time aerial images, and the location of missing persons. These drones are used in agriculture to optimize yields through focused pesticide or fertilizer administration, precision crop monitoring, and disease diagnosis. They facilitate quick situational awareness during emergency reactions, transport medical supplies to inaccessible locations, and efficiently analyze areas affected by disasters. Precise control drones simplify land management and urban planning by producing highly accurate 3D models, topographical maps, and real-time construction progress monitoring. They provide cutting-edge target acquisition and reconnaissance capabilities for military surveillance and combat operations, boosting national security. They provide stunning and steady aerial footage for the media business.

Objective and Outcomes:

Our objective is to create a drone system with precise flight control, advanced sensor integration, enhanced payload capacity, and increased stability. The outcome also includes:

- Achieve Precision Flight control, including position, orientation, and altitude.
- Enhance Stability and responsiveness to external factors.
- Increase payload capacity while maintaining precision in payload stabilization.
- Implement collision avoidance systems for safe navigation.
- Integrate sensors such as GPS, IMUs, and Ultrasonic Sonar Sensor

The expected outcome of this project is an extremely stable, controllable drone that can be used for a wide range of tasks and ensures precise movement in a variety of settings while maintaining safety.

Risk & constraints

Recognizing the risks and limitations is important before beginning any project. The difficulties, which might be caused by budgetary restrictions, technological limits, regulatory compliance, or outside variables, are essential to be addressed before planning. The potential risks related to this project are stated below:

- Overcoming complexities in drone control algorithms and systems.
- Working within the constraints of current technology.
- The risk of accidents or collisions.
- Staying within the allocated budget.
- Communication Range.
- Component Availability.
- Adverse weather conditions.

Project Roadmap:

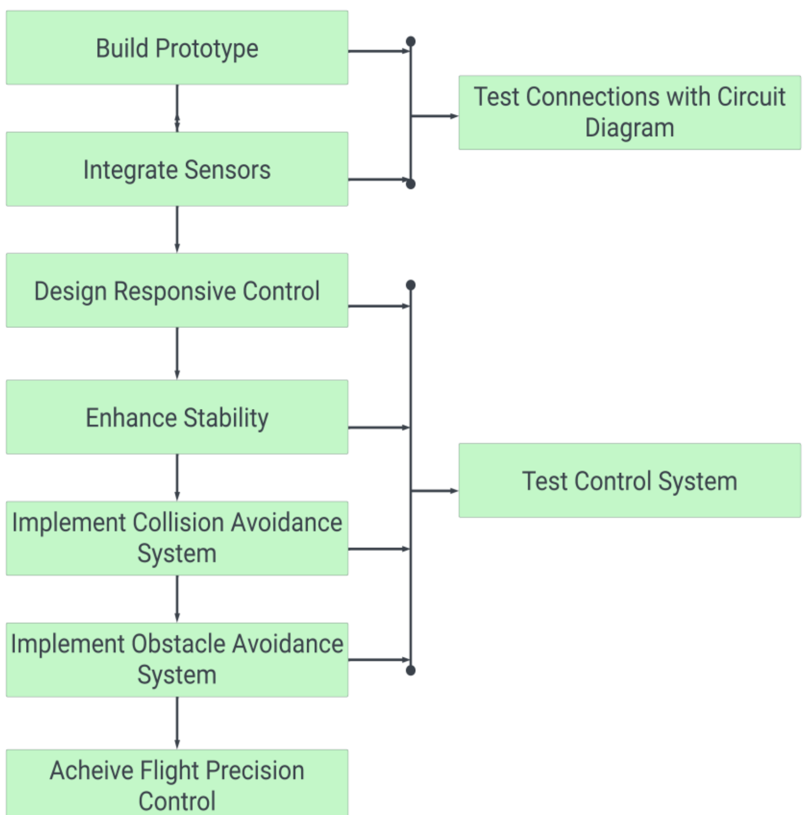

Figure: Project Roadmap

List of Components and Budget Estimation:

Components		Quantity	Price (**TK)**
1	DJI F450 Quadcopter Frame	1	999
2	1400KV Brushless Out-runner Motor A2212	4	1920
3	30A ESC Brushless Motor Speed Controller	4	1920
4	8045 Propeller 8x4.5 set 1CW 1CCW pair	3	315
5	Red Volcano 2200mah 3S 35C Lipo Battery	1	2350
6	Landing Gear Skid 4p for F450	1	395
7	MPU-9250 9 Degree of Freedom Breakout	1	850
8	BMP-280 Pressure Sensor Module	1	290
9	Arduino Nano	2	1080
10	U-Blox NEO-6M GPS Module	1	599
11	HC-SR04 Ultrasonic Sonar Sensor	6	558
12	ESP32 Development Board	2	1060
13	ESP32 Cam	1	848
14	Others	-	2000
		Total:	15,184

The estimated cost of our project is 20,000 takas. This is a tentative cost. The original cost can increase or decrease along with the market price of relevant components.

Design of Flight Controller

Designing a flight controller instead of purchasing one ready-made flight controller is the most challenging part of this project. It takes a lot of understanding and practical knowledge about the function of flight controllers deeply. We also need to know the basic principles of different sensors, processors, communication protocols, and transmitter pins. The sensors required for building the controller are:

a. U-Blox NEO 6M GPS
b. BPM 280 Pressure sensor
c. MPU-9250
d. HC-SR04 - Ultrasonic distance sensor
e. Arduino nano.

A GPS module is essential for navigation, tracking, mapping, surveying, etc. It allows to share the pinpoint location of the drone with its user, get the direction of its desired destination, and receive a real-time update about its flight. The NEO-6 module series is a family of stand-alone GPS receivers featuring the high-performance U-blox 6 positioning engine. We have selected this GPS module because it can operate in all weather conditions (from -40 to 85 degrees Celsius temperature), consumes low power (3.3V), and has a 5Hz position update rate that helps to deliver real-time information about the location and position of the drone. This GPS module is lightweight (12g) and smaller (in size 22x30x13mm) and delivers excellent performance in a compact design, which makes it the perfect choice for our flight controller.

However, there is a drawback of GPS technology. GPS doesn't function properly in indoor environments or if the signal strength is low. In order to remove that limitation, we have included an MPU-9250 sensor that is equipped with an accelerometer, magnetometer, and gyroscope. These three values contribute to making the drone more stable. The accelerometer measures the angular velocity and helps in determining the position and orientation of the drone. The gyroscope measures the rate of rotation and helps in balancing the drone. A magnetometer helps to scan the area and know if there is any magnetic field surrounding the system. It also allows obtaining geo-referenced maps of the area. In order to boost drone flight performance and stability MPU-9250 is a good choice. It is the smallest motion-tracking device with a dimension of (3x3x1mm), consumes less power, and provides high performance at a reduced cost. Although three independent sensors can be used for doing the same, it makes the circuit design more complex.

We cannot ignore the air pressure during the flight time of a drone. For this reason, we have used a BPM-280 pressure sensor in our flight controller. It can measure temperature, pressure, and relative humidity with great accuracy. Drones utilize this pressure sensor to stabilize at an altitude allowing hovering capabilities. MPU-9250 and BPM280 combinedly help in achieving precision flight of the drone.

In order to implement object avoidance and collision avoidance, we have used the HC-SR04 - Ultrasonic distance sensor as a part of our flight controller. This sensor provides an operating accuracy of up to 3mm and gives non-contact measurement functionality from 2cm to 400cm. It helps in measuring the distance of an object from the drone and avoids any obstacle in the flight trajectory. The controller is programmed in a way that it will move in the opposite direction if any object gets detected within 1.5 meters to avoid a collision.

We have used two Arduino Nano development boards for integrating the sensor and designed PCB for installing the sensors. The cost of the flight controller is around 3000 BDT. This flight controller is cheaper in price, but it can compete with the most advanced flight controller available in the market.

Circuit Diagram:

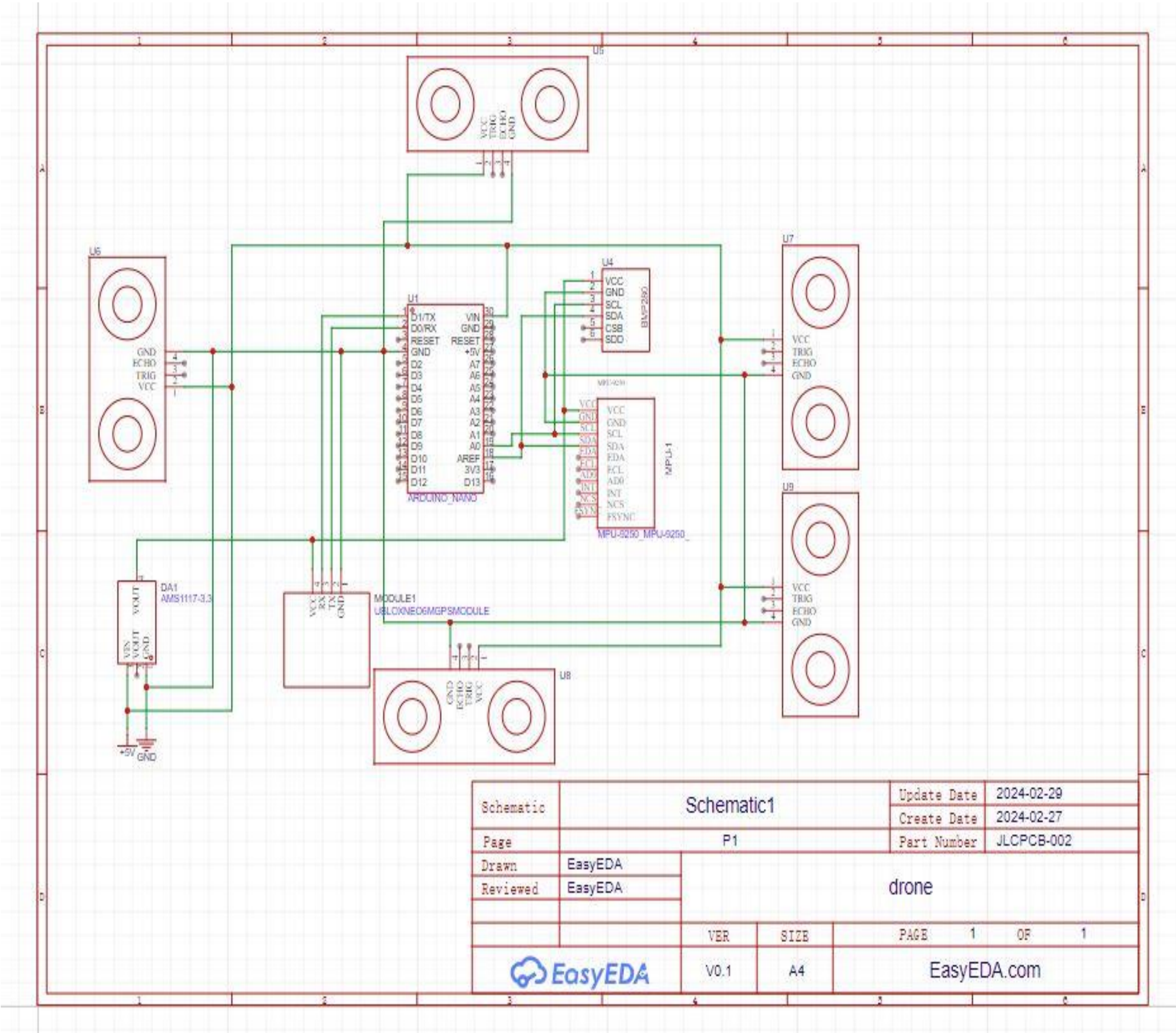

Figure 1: Schematic diagram of the flight controller

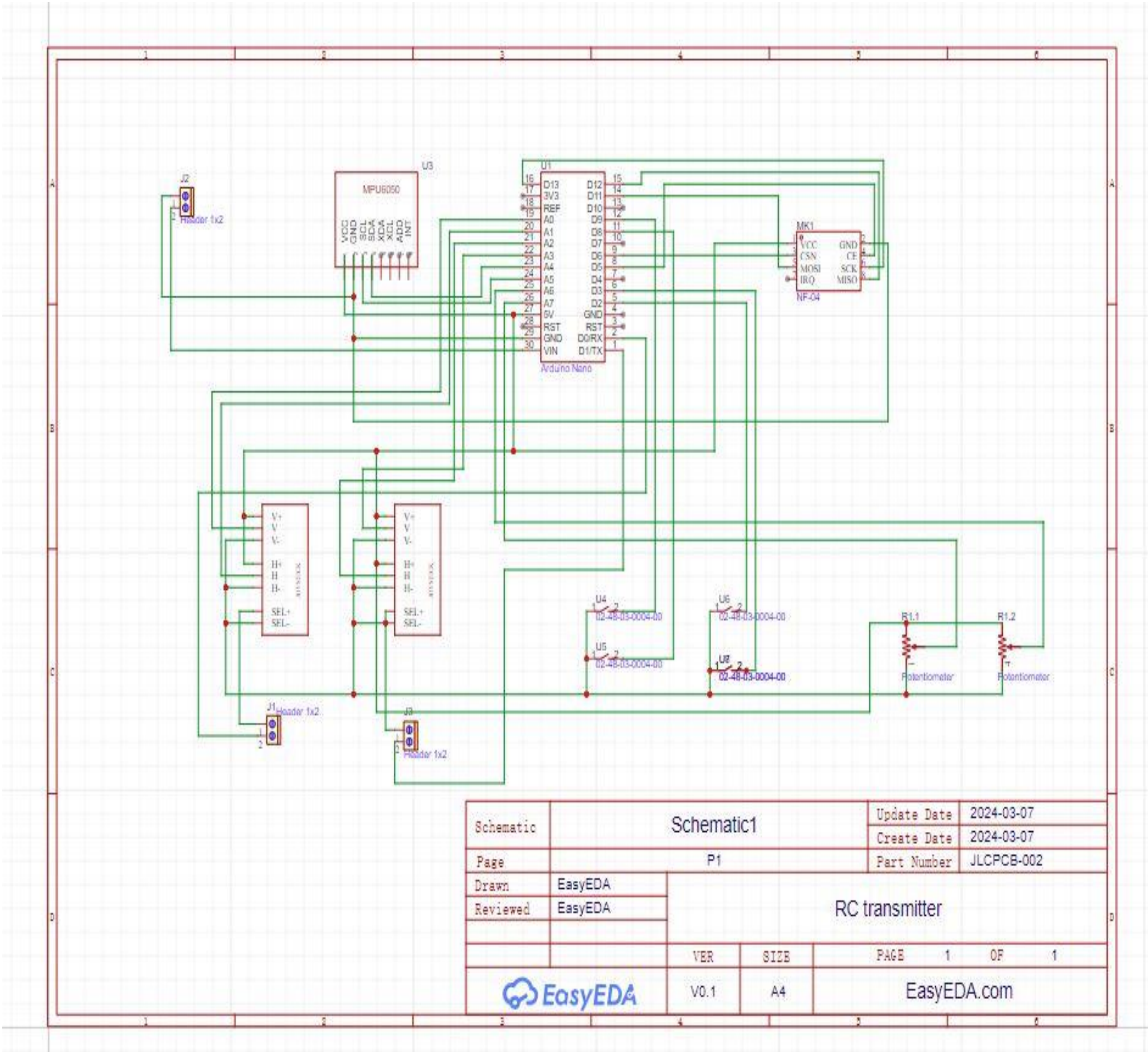

Figure 2: Schematic diagram of RC transmitter.

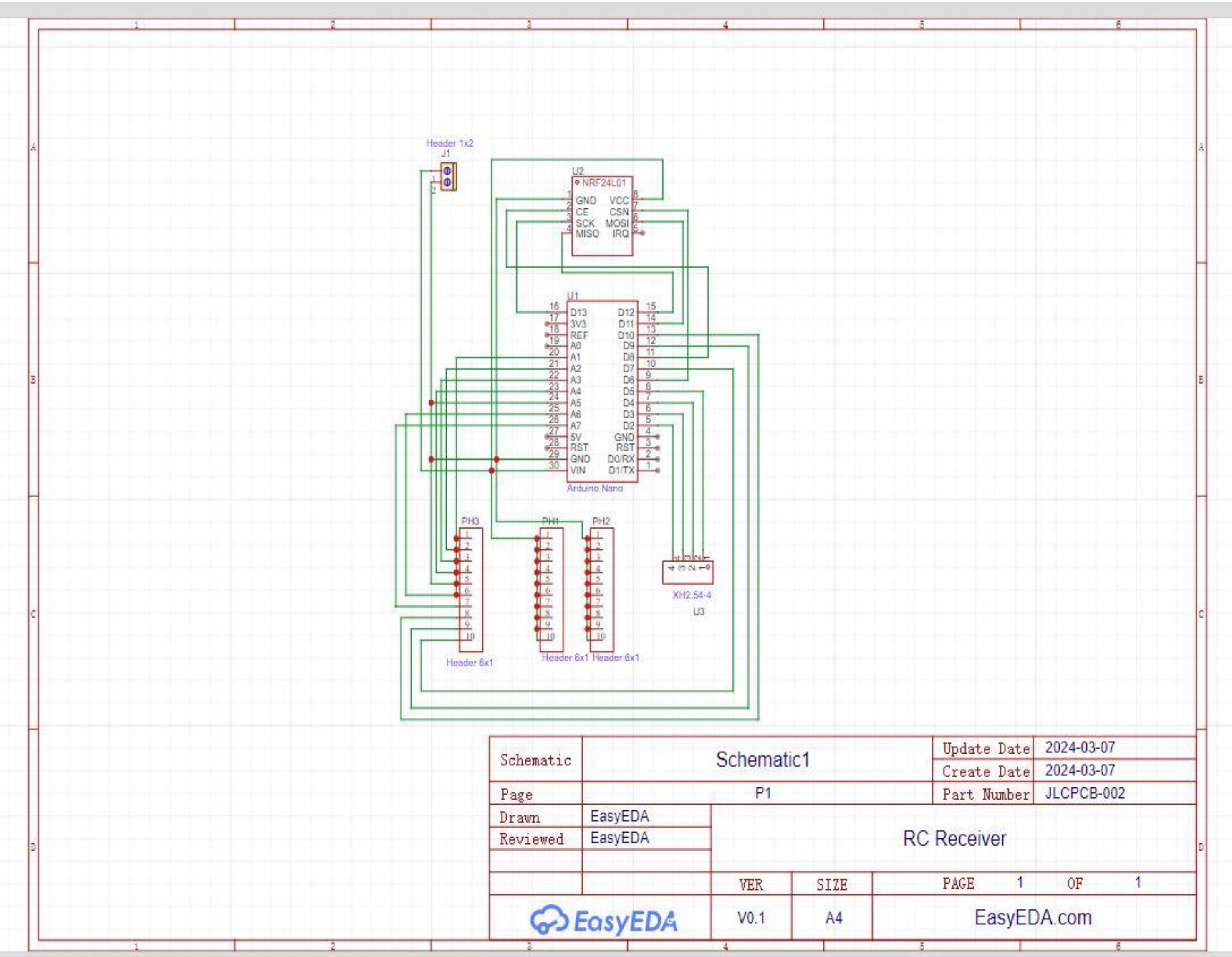

Figure 3: Schematic diagram of RC Receiver

Comparison between the previous design and the updated system design:
Our previous design was mainly based on ready-made flight controllers, RC transmitters, and RC receivers. However, we updated our design with a custom-built flight controller, RC transmitter, and RC receiver. For this reason, we have designed custom made PCB and installed different sensors and modules in the PCB board.
Initially, we planned to use the LoRa SX1278 long-distance wireless module for designing the transmitter and receiver because it can cover a range of 15 km up to 25 km. but after reading the datasheet and feedback forum, we found that this module is not suitable for drones. LoRa provides long-distance coverage, but the data transmission is comparatively low. This low rate of data transmission can hamper drone control and result in crashes or collisions. So, we modified our design with the NRF24L01 transceiver module. The operational distance of the NRF24L01 module is low compared to any LoRa module. But the data transmission rate is faster. So, it is suitable for application in Drones.

Testing and Debugging:
We will test the functionality of our drone in different situations and try to find its limitations. If there is any problem with the control, then the relevant hardware and code segment will be checked and modified. We need to update our code several times while testing and debugging. Modifying the code is an easy task, but modifying the hardware is quite challenging. For example, we cannot update or modify the code in Arduino if the Rx and Tx pin are connected to any other component. So, we designed our hardware in such a way that it supports easy update of code if necessary.

Conclusion:
In conclusion, this project represents a significant step forward in the realm of drone technology, aimed at delivering a highly controlled and versatile UAV system with a focus on precision and adaptability. Through proper project planning, we have navigated challenges, expanded capabilities, and laid the groundwork for a drone system that promises enhanced stability, safety, and reliability across various applications. As we move forward, the opportunities for this technology are boundless, and the potential for impactful contributions in industries such as agriculture, aerial photography, infrastructure inspection, and beyond is substantial.