

# Implementation of Multifunctional Camouflage Military Robot using IoT

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**Abstract-**In this modern era, huge capital of the country has been spent for the defense field to deploy primitive and high security measures and safeguard the border security forces from the trespassers. Some defense organizations utilize robotics in the defense field and the efficiency of robots are very high when compared to the human forces. Camouflage Robot plays a vital role in saving human loses as well as the damages that occur during disasters. Thus, it will gain more importance in the upcoming era. The robot basically consists of a vehicle mounted with one camera, which captures the images. The robot can quietly enter into enemy area and send information via camera to the controller. The main motive of this paper is to make the defense stronger by using the robots, which will help defense to safeguard the human lives. This paper has proposed the system using the Arduino, gas sensor, temperature sensor, MEMS sensor, ESP32 camera module, NodeMCU which helps the robot to do multi functionalities to do rescue operations.

**Keywords:** Arduino UNO, Camouflage, temperature sensor, gas sensor, MEMS sensor, ESP32 camera module, NodeMCU.

## 1. INTRODUCTION

The term "Internet of Things" (IoT) describes a network of physically connected objects, including appliances, cars, and other things, that are embedded with software, sensors, and network connectivity. This allows these objects to exchange and collect data. Robots are mechanical devices, that are capable of performing the difficult and complex tasks on their own and also based on the commands. As the technology was booming in the present era, it is safe to use robots rather than the human for performing particular tasks. Robots are very helpful in hazardous places as it's not possible to humans to reach out there in areas of enemies and places full of threats. Android Operating system is very much helpful in operating robotic system through smart phones easily. The activities assigned to the robotic system are controlled manually by human. Surveillance is very essential in hazardous environment which is dangerous

for human beings as these are life threatening. Places that required continuous monitoring are mining areas, urban disasters, hostage's situation, explosions and many more.

Defense system is a major asset to any country in this world. Safeguarding the country against the enemies is one of the prioritized things to keep the country's economy, assets, valuable treasures and lives of the people in a safest way. In the defense the most required and the new equipment's are the military robots. Nowadays, military robots are considered to be the future of modern warfare. At the same time, military robotics is considered to be the game-changing technology that could change the structure and employment of armed forces. Society is aware of the military employment of robots today. The last decade has witnessed a surge of military robots on the battlefield. These military robots are of various types for the uses like transportation, attacking enemies, disaster management and civil supplies. Nowadays, the robots are used in the defense system of many countries for attaining the supremacy and gaining a place towards supreme power in the world.

Robot systems have widely used in home automation application to provide safe, easy, and comfortable living environments. It is planned to create a wheeled robot and which is going to be programmed with embedded C language to follow our instructions. This robot consists of five motors and four wheels. It has a micro controller and motor driving IC with programmable input output ports. Robot has a wireless camera to show the live telecast of its environment controlled by a servo motor and a dc motor with some certain delay to capture the all side views.

Robot has a main module with the origin as AT MEGA-8 microcontroller. This has some specific characteristics than other microcontrollers. Motor driver in this robot is IC L293D to control the wheels. Here each dc motor takes their control over their respective wheel. Robot has some sensors like gas sensor, temperature sensor, MEMS sensor. Gas sensor is kept to detect the various hazardous gas value. Temperature sensor is used to sense the temperature in a new environment. MEMS sensor is used to detect the acceleration. These sensed collections of data are sent to a human operator. Charging system is implemented here to avoid the replacement of battery every time. It will decrease the cost and increase the efficiency of the robot. From a pair of rechargeable batteries, power supply is given to all the modules.

## 2. METHODOLOGY

The versatility of multifunctional camouflage military robots allows them to adapt to various mission scenarios, from urban warfare and reconnaissance missions to border patrol and search and rescue operations. Their ability to operate autonomously or in collaboration with human operators makes them valuable assets in both conventional and asymmetric warfare environments. There are several essential steps in the process of creating and deploying military robots with multifunctional camouflage. Initially, a comprehensive literature review is carried out to comprehend current technologies and research within the field. Subsequently, requirements are examined in conjunction with military specialists to establish the goals and capabilities of the robots. After conceptual designs are developed through prototyping and brainstorming, modeling and simulation are used to assess how well the designs work in different scenarios. Based on the completed designs, physical prototypes are constructed and put through rigorous testing and assessment in both lab and field environments. Iterative design optimization is used to enhance functionality, dependability, and usability by utilizing test results and user feedback. After being integrated into systems that are ready for production, the optimized designs are used to conduct military operations in the real world.

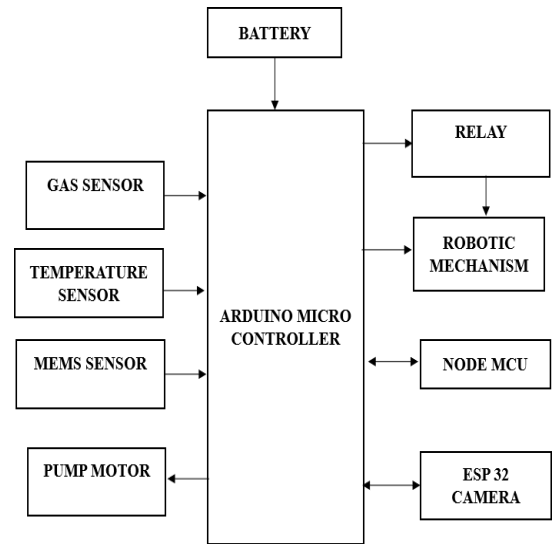
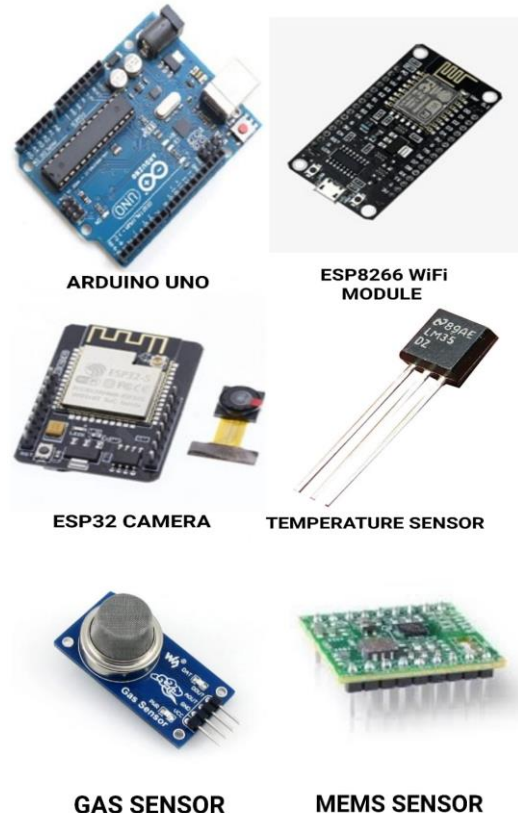
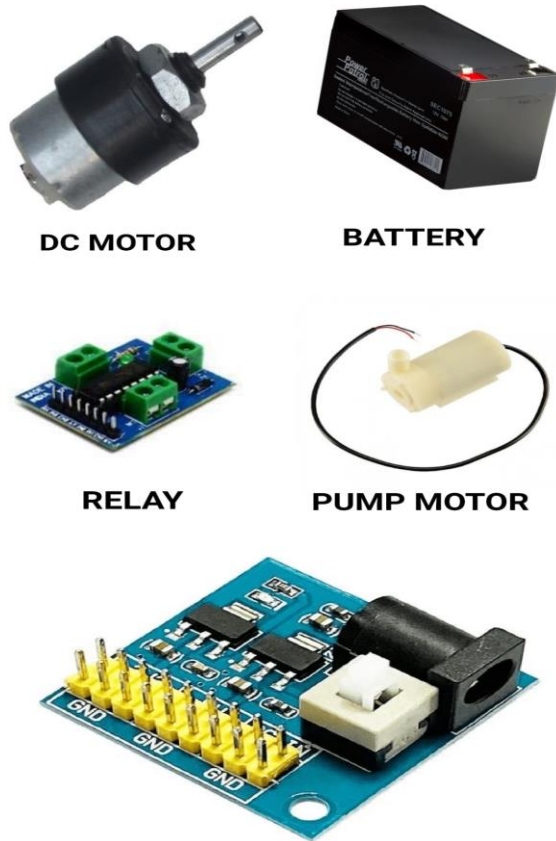


Fig 1: BLOCK LAYOUT FOR AN IOT BASED MILITARY ROBOT

### 2.1 HARDWARE COMPONENTS INVOLVED:





POWER SUPPLY

Fig 2: COMPONENTS INVOLVED

## 2.2 WORKING PRINCIPLE

The Internet of Things (IoT)-based military robot combines multiple technologies to accomplish its goals, including temperature, gas detection, MEMS sensor data, and live webcam broadcasting. The robot is primarily composed of a sturdy hardware configuration that includes sensors, actuators, a microcontroller, and communication modules. The sensors include MEMS (Micro-Electro-Mechanical Systems) sensors for recording motion and orientation data, gas sensors for detecting hazardous materials, and temperature sensors for monitoring the environment. A microcontroller, such as an Arduino or Raspberry Pi, is connected to these sensors; it processes the sensor data and adjusts the actuators as necessary. Based on the processed sensor data, the actuators permit movement and other physical actions of the robot.

The microcontroller is also in charge of overseeing the system's communication component. It is linked to an Internet of Things communication module, like GSM or

Wi-Fi, so the robot can connect to the internet. This connection allows commands or instructions from the user to be received and allows the transmission of sensor data to a remote server or control interface. To protect the communication channel and stop unwanted access, security measures like authentication and encryption are put in place.

The robot has a camera module that records video of its surroundings so that it can be broadcast live from a webcam. The microcontroller receives the video data from the camera and uses appropriate protocols to process and stream it over the internet. Users can monitor the robot's surroundings in real time by accessing the live video feed via a specialized application or a web-based interface.

The robot continuously gathers sensor data from its surroundings while it is in operation, such as temperature, gas levels, and motion data. The microcontroller processes this data and examines it to look for irregularities or possible dangers. The robot can autonomously react by warning the user, changing its path, or carrying out preprogrammed actions to reduce the risk if any abnormal conditions are detected. In addition, the webcam's live video feed gives users a visual representation of the robot's surroundings, which improves situational awareness and facilitates well-informed decision-making. Overall, the military robot's utility and effectiveness in military operations are increased by the integration of IoT technologies, which allows it to detect environmental parameters, respond to threats, and give operators real-time visual feedback.

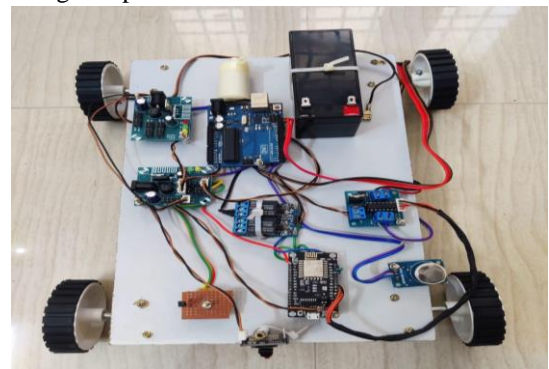


Fig 3: CIRCUIT CONNECTION

### 2.3 SOURCE CODE:

Using the Arduino IDE, the code for the military Robot is written. A few libraries must be added to the Arduino IDE. The provided Arduino sketch is designed for an ESP8266-based IoT device, intended for environmental monitoring and remote load control. It begins with the inclusion of necessary libraries for Wi-Fi connectivity (ESP8266WiFi.h), HTTP communication (ESP8266HTTPClient.h), and JSON parsing (ArduinoJson.h). These libraries enable the device to establish a connection to a Wi-Fi network, communicate with a remote server, and handle JSON data for message formatting.

Upon configuring the Wi-Fi network credentials (ssid and password), the sketch proceeds to define global variables required for storing sensor readings, sensor statuses, and other parameters necessary for operation. These variables include placeholders for temperature readings (t), gas sensor readings (g), and statuses for various sensors and loads (sensor1\_status, sensor2\_status, etc.).

The GPIO pins are then initialized for different purposes, including sensor input, load control, and LED indication. These pins are configured using the pinMode() function to specify whether they should function as inputs (INPUT) or outputs (OUTPUT). Additionally, the built-in LED pin (LED\_BUILTIN) is configured for visual feedback during operation.

In the setup() function, the serial communication is initialized for debugging purposes, allowing the device to communicate with a computer via a serial monitor. The Wi-Fi connection is established using the WiFi.begin() function, attempting to connect to the specified network. Once connected, the device retrieves its assigned IP address (WiFi.localIP()) and prints it to the serial monitor for reference.

The main functionality of the device is encapsulated within the loop() function, where it calls the FUN() function to handle sensor readings, data processing, HTTP requests, and load control. Within the FUN() function, the device reads sensor data from the temperature sensor (analogRead()) and the gas sensor (digitalRead()). The obtained sensor readings are processed to determine their status, distinguishing between normal and abnormal conditions based on predefined thresholds.

The sensor data and statuses are then formatted into a JSON object using the ArduinoJson library. This JSON object encapsulates all relevant information and is

subsequently sent to a designated server endpoint (<http://iotbeginner.com/api/sensors>) via an HTTP POST request using the HTTPClient object. This allows the device to provide real-time sensor data to the server for monitoring and analysis.

Simultaneously, the device periodically sends HTTP GET requests to specific server endpoints to retrieve commands for load control and serial data, respectively. These commands are parsed and processed accordingly, enabling the device to adjust loads based on received instructions and handle any incoming serial data for further action.

Visual feedback is provided through the blinking of the built-in LED, serving as an indication of the ongoing functionality of the IoT device. This feature enhances user awareness and aids in troubleshooting and debugging during operation. Overall, the code demonstrates a comprehensive IoT system capable of environmental sensing, remote communication, and actuator control, facilitating a wide range of applications in home automation, industrial monitoring, and beyond.

```
#include <ESP8266WiFi.h>
```

```
#include <ESP8266HTTPClient.h> //
```

#### 2.7.2

```
#include <ArduinoJson.h>
```

```
const char* ssid = "iotbegin480";
```

```
const char* password = "iotbegin480";
```

```
String sensors;
```

```
String sensor1_status;
```

```
String sensor2_status;
```

```
String sensor3_status;
```

```
String sensor4_status;
```

```
String sensor5_status;
```

```
String sensor6_status;
```

```
String sensor7_status;
```

```
String sensor8_status;
```

```
String sms_status;
```

```
// HTTPClient http; //Declare object of class HTTPClient
```

```
http.begin("http://iotbeginner.com/api/devices" ); //Specify request destination
```

```
http.addHeader("username","iotbegin480");
```

```
//Specify content-type header
```

```

int httpCode = http.GET();
String payload = http.getString(); //Get the response
payload
//Serial.println(httpCode); //Print HTTP return code
//Serial.println(payload); //Print request response payload

Serial.println(" FORWARD ");
} else if ((device1_status == "0") && (device2_status
== "1") && (device3_status == "0") && (device4_status
== "0")) {
digitalWrite(load1_gpio, LOW);
digitalWrite(load2_gpio, HIGH);
digitalWrite(load3_gpio, LOW);
digitalWrite(load4_gpio, HIGH);
Serial.println(" BACKWARD ");
} else if ((device1_status == "0") && (device2_status
== "0") && (device3_status == "1") && (device4_status
== "0")) {
digitalWrite(load1_gpio, LOW);
digitalWrite(load2_gpio, HIGH);
digitalWrite(load3_gpio, HIGH);
digitalWrite(load4_gpio, LOW);
Serial.println(" RIGHT ");
} else if ((device1_status == "0") && (device2_status
== "0") && (device3_status == "0") && (device4_status
== "1")) {
digitalWrite(load1_gpio, HIGH);
digitalWrite(load2_gpio, LOW);
digitalWrite(load3_gpio, LOW);
digitalWrite(load4_gpio, HIGH);
Serial.println(" LEFT ");
} else {

digitalWrite(load1_gpio, LOW);
digitalWrite(load2_gpio, LOW);
digitalWrite(load3_gpio, LOW);
digitalWrite(load4_gpio, LOW);
}
}

void blink_led() {
digitalWrite(LED_BUILTIN, LOW); // Turn the LED
on (Note that LOW is the voltage level
delay(1000); // Wait for a second
digitalWrite(LED_BUILTIN, HIGH); // Turn the LED
off by making the voltage HIGH
delay(1000); //Wait for two seconds (to demonstrate the
active low LED)
}

```

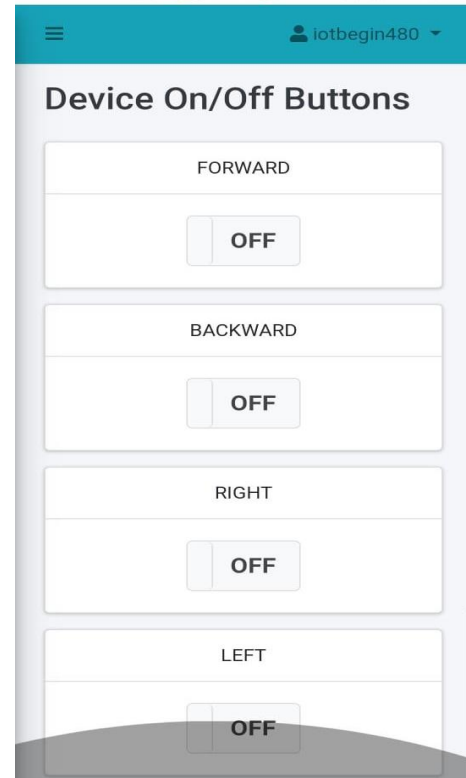


Fig 4: APP SCREENSHOTS AND WORKING STAGE

The Arduino is, as far as we know, the robot car's brain. The Arduino IDE (Integrated Development Environment) is used to program it to receive and execute orders received through Wifi. The programming code is designed to decipher the signals that are received and convert them into commands for the motors, which include turning left or right, going forward, and stopping. Make sure the

robot car's switch is on and that the batteries are completely charged before continuing. Furthermore, make sure all connections are tight and secure by carefully inspecting them. The robot movement can be operated by using the monitor or mobile phone. Based on the necessity the robot can be moved forward, backward, left and right directions to find the harmful traces in the surroundings. The Robot will sense temperature and gas in the surroundings. These outputs will be displayed in the mobile phone for every instance. Additionally the Camera shows real time data that can be processed or viewed at the monitor or mobile phone of the user. It gives the fast and accurate data as the transmission of data takes place through the wifi module. It is very fast and most reliable. This integrated system enhances military operations by providing actionable intelligence, remote monitoring, and agile maneuverability, contributing to improved situational awareness and mission success in diverse operational scenarios.

## 2.4 WORKING PROTOTYPE:

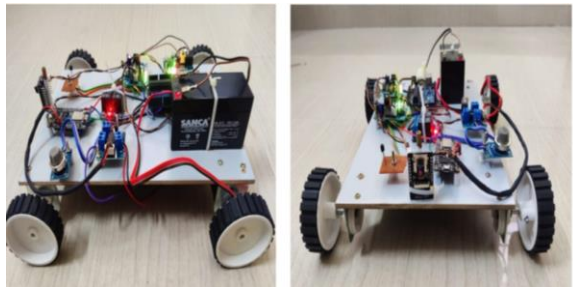


Fig 5: FRONT VIEW AND LATERAL VIEW OF WORKING PROTOTYPE

## 3. RESULTS AND DISCUSSIONS

The essential point of the surveillance robot is that it has various capabilities of detecting and sending the signals to the authorised user from different environments. Depending on the sensor data of the robot, it provides the information to the user to move the robot in the desired direction properly like left, right, forward and backwards. It can sense various objects and also things coming towards it. It shows proper live streaming of video contents. Every sensor has the capability to work on different aspects like detecting gas, live human detection. The robot can be easily controlled from outside environment with the help of any android device and laptops. This project is very beneficial and convenient for the places where human access is impossible and life

threatening.

Real Time Sensor Values

Filter By Date: 15/02/2024 Find

Show 10 entries Search:

#	TEMPERATURE STATUS	GAS STATUS	MEM STATUS	Date & Time	Action
1	26.00 TEMPERATURE NORMAL	41 GAS NORMAL	MEM NORMAL	2024-02-15 22:54:00	
2	26.00 TEMPERATURE NORMAL	34 GAS NORMAL	MEM ABNORMAL	2024-02-15 22:53:56	
3	26.00 TEMPERATURE NORMAL	25 GAS NORMAL	MEM NORMAL	2024-02-15 22:53:52	
4	26.00 TEMPERATURE NORMAL	16 GAS NORMAL	MEM ABNORMAL	2024-02-15 22:53:48	
5	26.00 TEMPERATURE NORMAL	3 GAS NORMAL	MEM NORMAL	2024-02-15 22:53:44	

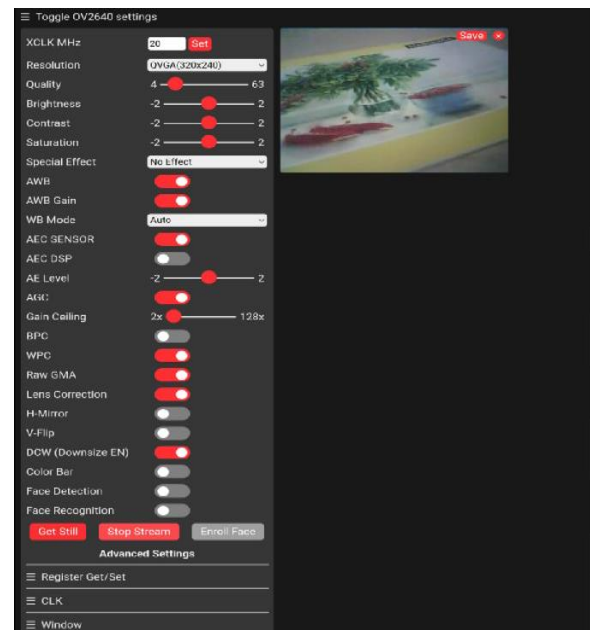


Fig 6: OUTPUTS OF THE PROTOTYPE

**Enhanced Situational Awareness:** By combining environmental sensing with live video streaming, the IoT-based military robot provides operators with a comprehensive understanding of the operational environment. This heightened situational awareness enables proactive decision-making, minimizes risks to personnel, and enhances mission success rates.

**Remote Operation:** The ability to control the robot remotely offers numerous advantages, including reduced risk to human operators in hazardous environments, extended operational range, and the ability to deploy resources more efficiently. Remote operation also enables centralized command and control, facilitating coordination between multiple robots or units in complex missions.

**Scalability and Customization:** The modular design of the IoT-based military robot allows for scalability and customization to suit specific mission requirements. Additional sensors, communication modules, or payload capabilities can be integrated as needed, ensuring versatility and adaptability across a wide range of operational scenarios.

**Data-driven Decision Making:** The wealth of sensor data collected by the robot enables data-driven decision-making processes. By analyzing environmental data in real-time, operators can identify patterns, trends, and anomalies, facilitating predictive analytics and proactive risk mitigation strategies.

#### 4. CONCLUSION & FUTURE WORK

The development of an IoT-based military robot with environmental sensing, live webcam broadcasting, and movement based on commands demonstrates significant potential for enhancing military operations. Through the integration of temperature, gas, and MEMS sensors, the robot can effectively monitor its surroundings, providing real-time data on environmental conditions crucial for situational awareness. The inclusion of a webcam enables remote operators to visually assess the operational environment in real time, further enhancing decision-making capabilities. Movement based on commands offers flexibility and adaptability, allowing the robot to navigate diverse terrain and respond dynamically to mission requirements. Overall, this project showcases the value of IoT technologies in improving operational efficiency, reducing risks to personnel, and enhancing mission success rates in military settings.

**Autonomous Navigation:** Implementing autonomous navigation capabilities using machine learning and computer vision algorithms would further enhance the robot's autonomy and operational flexibility, enabling it

to navigate complex environments without constant human supervision.

**Integration of Additional Sensors:** Incorporating additional sensors such as LIDAR, radar, or biological sensors could expand the robot's sensing capabilities, enabling it to detect a broader range of threats and hazards in the operational environment.

**Enhanced Communication:** Improving communication systems to support higher bandwidth and longer-range communication would enable more robust data transmission and remote control capabilities, enhancing the robot's effectiveness in remote and challenging environments.

**Payload Customization:** Exploring options for customizing the robot's payload to support specific mission requirements, such as payload delivery, reconnaissance, or surveillance, would increase its versatility and applicability across a wider range of military operations.

**Integration with Command and Control Systems:** Integrating the robot with existing military command and control systems would enable seamless coordination and collaboration with other assets, enhancing overall operational effectiveness and interoperability within military frameworks.

By addressing these future works, the IoT-based military robot can evolve into a more capable and versatile platform, capable of meeting the evolving needs and challenges of modern military operations.

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