2] Seven Categories of Robot:

- **Manipulator:**
  https://www.youtube.com/watch?v=Eujvqg-3J-0
  https://www.youtube.com/watch?v=ygqfWKRHVQg
- **Mobile: Autonomous Mobile Robots (AMRs) in Action and Youibot Robotics, a global leading industrial mobile robot solution provider.**
- **Legged: 4-legged walking robot and Robots At Work: Four-legged robot gets 'go faster' wheels**
- **Aerial: DJI Phantom 4 Pro - Drone aerial view - 4K - YouTube and DJI Mavic Air 2 - Drone aerial view - 4K - YouTube**
- **Underwater: Underwater Robot - YouTube and Underwater Robot - YouTube**
- **Humanoid: [14 Most Advanced Robots Doing Complicated Actions Humanoid … and Humanoid Robot NAO Next Gen - YouTube**
- **Swarm: Swarm Robotics - YouTube and Swarm Robotics - YouTube**

3] Most common types of motors:

All the electric motors can be classified into two types that is AC motors and DC motors.

1] **AC motors:** AC motors are of two types that is synchronous and asynchronous motors(Induction motors). Synchronous motor is a machine whose rotor speed and the speed of the stator magnetic field is equal. The rotor of the asynchronous motor rotates with a relatively lesser speed than the speed of the rotating magnetic field (or synchronous speed).
Synchronous motors are more efficient than asynchronous motors.

2] **DC Motors:** DC motors can be classified into two main categories based on whether they are brushed or brushless:

1] Brushless DC motor(BLDC) : Most commonly, they are three phased. They are used in electric vehicles, drones, computer cooling fans etc. Higher efficiency due to absence of brushes, longer lifespan, lower maintenance and better speed control.

2] Brushed DC motors: The simplest type of motor is the brushed DC motor. In this type of motor, electrical current is passed through coils that

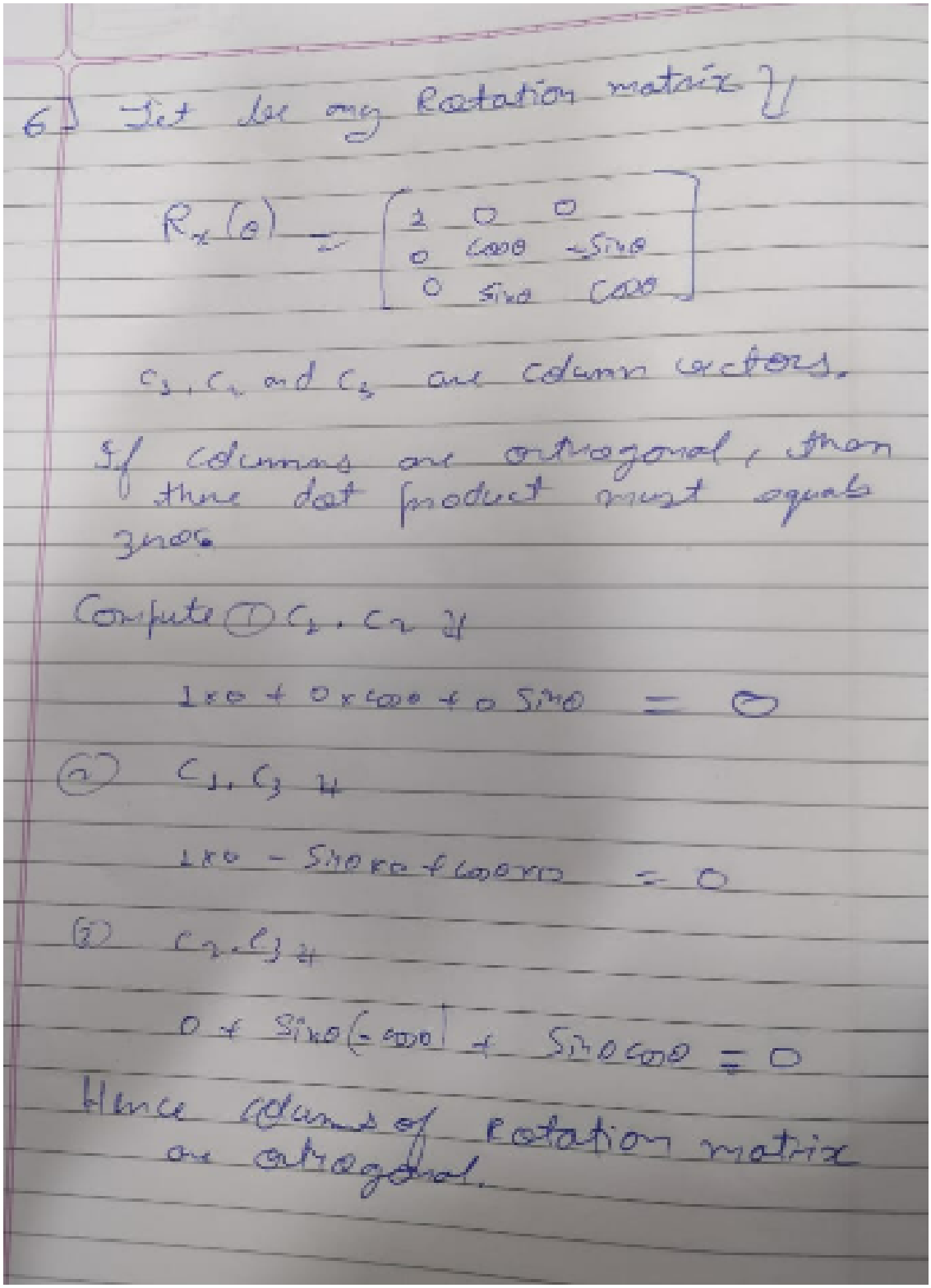
are arranged within a fixed magnetic field. Used in small appliances, toy RC car, low-cost robotic platforms,etc.

Other important motors are :

1] **Stepper Motors:** Stepper motors move in discrete steps, making them suitable for applications that require precise control over rotation, like robotics and 3D printers. They do not have any feedback system like encoders. It is a brushless motor. To control this motors, we need stepper drivers. The drivers of this motor mainly provide variable current control. Different servo motors have different rotation angle per pulse.

2] **Servo Motors:** Servo motors are designed for accurate control of angular or linear position. They use feedback devices (like encoders or potentiometers) to maintain the desired position, speed, and torque.
Thus for robotics related stuff, servo motors are the best because of accuracy in positioning.

6] Show that columns of the rotation matrix R are orthogonal.



7] Show that det(R) = 1.

7] We know that R_0^1 is a Rotation matrix, so it is orthogonal.

$$\therefore \quad R \cdot R^T = I$$

$$\therefore \quad |R\,R^T| = |I|$$

$$|R|\,|R^T| = 1$$

$$|R|^2 = 1$$

$$\therefore \quad |R| = 1$$