|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Use Case / Scenario** | **Recommended Sensor** | **Why** |
| 1 | 🟧 **Indoor robot vacuum** | **2D LiDAR** (or VSLAM in budget models) | Real-time, accurate floor mapping, good for obstacle avoidance |
| 2 | 🟧 **Outdoor robot mower** | **LiDAR + GPS + Vision** | Precise boundary mapping, terrain following, safer obstacle detection |
| 3 | 🟧 **Autonomous vehicles (cars, delivery bots)** | **LiDAR + Cameras + Radar** | LiDAR for 3D geometry, cameras for semantics, radar for weather robustness |
| 4 | 🟧 **Drone mapping (precision agriculture, inspection)** | **LiDAR (UAV)** or SfM + RGB | LiDAR penetrates canopy, SfM is cheaper for open/texture-rich areas |
| 5 | 🟦 **AR/VR headsets & glasses** | **Stereo vision** or **structured-light depth** | Low power, compact, good short-range 3D with texture |
| 6 | 🟦 **Mobile phone 3D scanning** | **ToF or structured-light depth** | Compact, close-range facial/body scanning |
| 7 | 🟧 **Forestry terrain & canopy structure** | **Airborne LiDAR** + optionally SAR | High-resolution 3D + canopy/ground separation + large-area coverage |
| **8** | **Disaster monitoring (earthquakes, landslides)** | **SAR (InSAR)** + optionally LiDAR | SAR for cloud-penetration and large-area displacement detection |
| **9** | **Satellite-based terrain mapping** | **SAR (IFSAR)** | Can operate in any weather, day/night |
| 10 | 🟦 **Indoor mobile robot navigation** | **Stereo camera** or **LiDAR** | Lightweight 3D sensing for SLAM and path planning |
| 11 | 🟧 **Warehouse robots (AMRs, AGVs)** | **LiDAR + RGBD or stereo** | LiDAR for mapping, depth for shelf and item interaction |
| 12 | 🟦 **Security cameras with person detection** | **Stereo vision or RGB-D** | Adds depth to improve detection and tracking accuracy |
| 13 | 🟦 **Self-checkout kiosks & smart retail** | **Depth camera** (structured light or ToF) | Depth improves gesture recognition and object scanning |
| **14** | **Cultural heritage / archaeology scanning** | **LiDAR or SfM from photos** | LiDAR for geometry, SfM for detailed textures |
| 15 | 🟦 **Gaming (Xbox Kinect, motion tracking)** | **Depth camera (IR-based)** | Real-time body tracking with low latency |
| 16 | 🟧 **Construction site monitoring** | **LiDAR or drone-based SfM** | Structural monitoring, progress tracking, terrain elevation |
| 17 | 🟧 **3D modeling of indoor spaces (real estate)** | **LiDAR or RGB-D SLAM** | Fast mapping with accurate room geometry |
| 18 | 🟦 **Robot arm manipulation in factories** | **Depth camera** or **stereo vision** | Close-range depth sensing for object grasping |
| 19 | 🟦 **Medical imaging / surgery assistance (3D vision)** | **Stereo vision** or **structured light** | Real-time perception of surgical area, minimal intrusion |

LiDAR applications

## ToF vs Structured-Light: Quick Comparison

| **Feature** | **Time-of-Flight (ToF)** | **Structured-Light** |
| --- | --- | --- |
| **Depth Range** | Medium (0.5–10+ m) | Short (0.2–2 m) |
| **Lighting Sensitivity** | Works in dark | Needs low ambient IR (indoor only) |
| **Speed** | Fast (real-time depth video) | Slower (frame-by-frame reconstruction) |
| **Accuracy (Close Range)** | Lower than structured light | Higher at <1 m |
| **Surface Limitations** | Struggles with translucent/mirrors | Struggles with shiny/textureless areas |

## LiDAR vs other imaging sensors

| **Feature** | **LiDAR** | **Depth Camera** | **Stereo Camera** | **SAR** |
| --- | --- | --- | --- | --- |
| **Active/Passive** | Active | Active (IR) | Passive | Active (microwave) |
| **Accuracy** | High (1–10 cm) | High (1–10 mm) | Medium (mm–cm) | Medium-Low (dm–m) |
| **Best Range** | 1–1000+ m | 0.5–5 m | 0.5–20 m | 100–1000+ km |
| **Texture Required?** | No | No | **Yes** (needs texture) | No |
| **Lighting Sensitive?** | No | Yes | **Yes** | No |
| **Color/Texture** | Needs RGB fusion | Built-in RGB sensor | Built-in RGB | No color (only backscatter) |
| **Cost** | $$$ | $–$$ | $–$$ | $$$$ |
| **Real-Time Capable?** | Yes | Yes | Yes | No (slow revisit) |
| **Robust to Outdoors?** | Good | Poor | Fair | Excellent |