Make Smart Devices More Accessible: Engineering of a Novel Low-Cost, Multi-Direction Distance Sensor and Its Application in Obstacle Avoidance of UAV

Huang, Hairong (School: Hangzhou Xuejun High School of Zhejiang Province)

Distance sensors are used in many smart devices such as UAVs, sweeping robots, etc. However, the common distance sensors usually have the disadvantages of high cost, large power consumption, heavy weight, and large size,which limit their extensive use. Smart devices normally only need to identify the approximate position of an obstacle rather than a precise distance to react appropriately. Therefore, a cheaper, simpler, and more practical obstacle distance sensor is in great demand. Generally, the Infrared Receiver Module (IRM) can only be used to measure a fixed distance. Nevertheless, in this project, the emission power of an infrared emitting diode (IR LED) is continuously changed in a step shape by a microcontroller, to adjust the radiation distance of the IR LED. In this way, the segmented (quantized) measurement of obstacle distance can be realized continuously with a simple circuit composed of cheap IRM. The sensor of this project integrates nine pairs of IR LEDs and IRMs to detect obstacles in nine directions simultaneously. A 3D printed optical shield is designed to prevent infrared interference inside the sensor, and a simple self-developed application to assist with testing of the sensor. The detection distance of this sensor is 0.2-3.0m with a total cost of approximately $3.70, which is 95% lower than that of the infrared TOF distance sensor. In addition, compared to common distance sensors, this sensor has definite advantages in weight, size, and power consumption. A UAV using this sensor can successfully conduct an autonomous obstacle avoidance flight in a small space, to demonstrate the practical nature of this sensor. Furthermore, this sensor could also be widely used in security alarm systems, smart home systems, and other fields.

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