Optimization of the Receiver in Visible Light Communications

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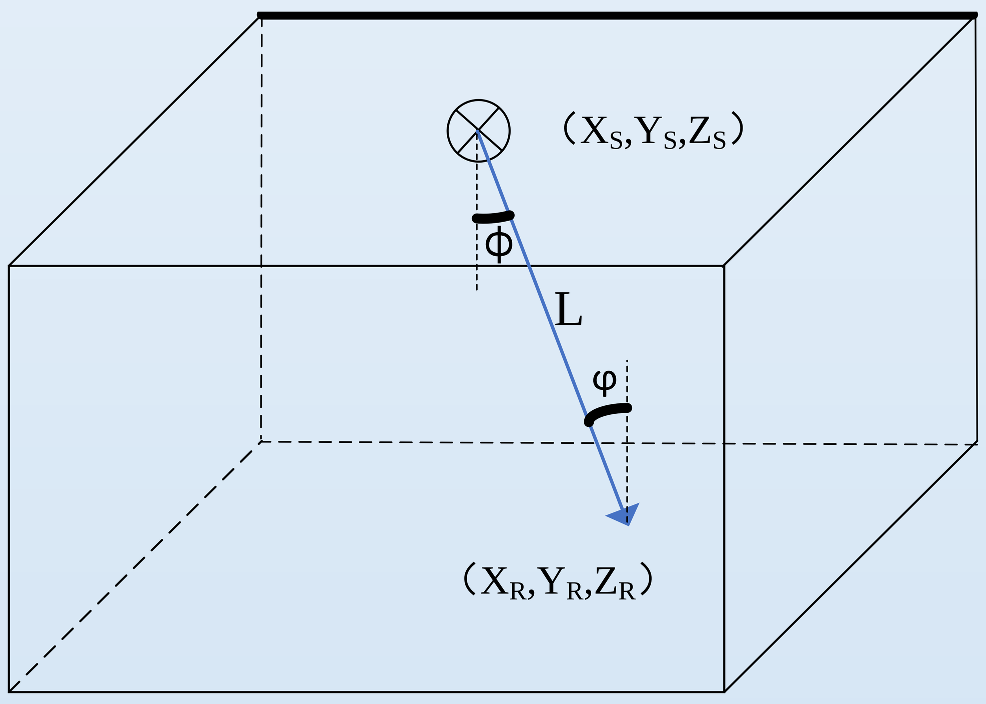
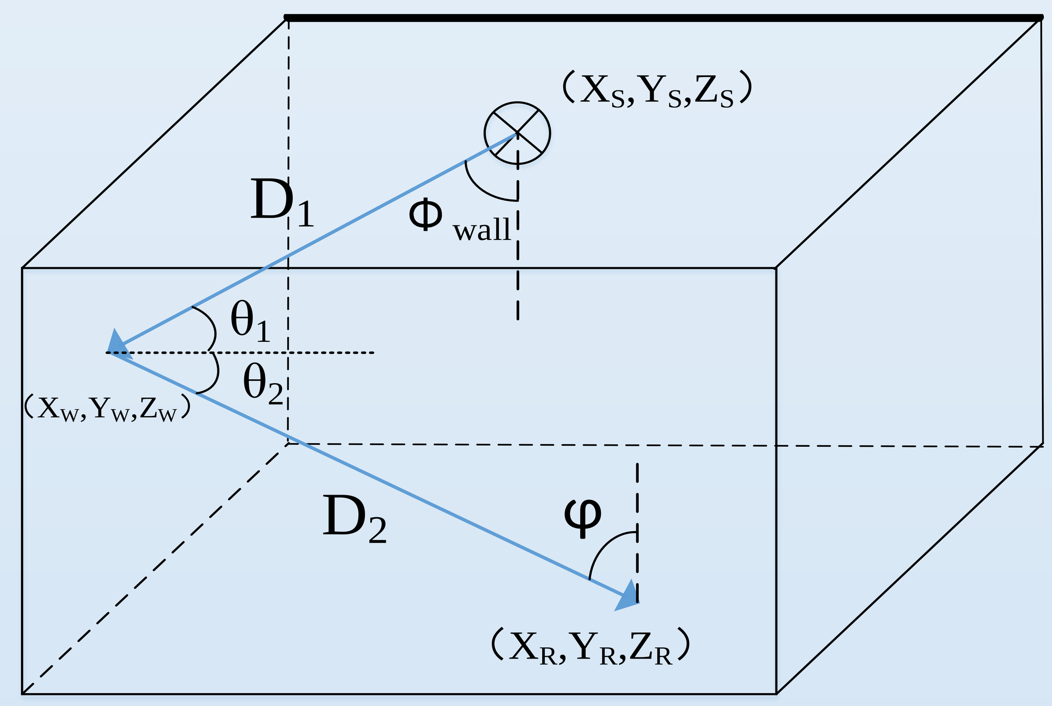
Line-of-sight link and non-line-of-sight link

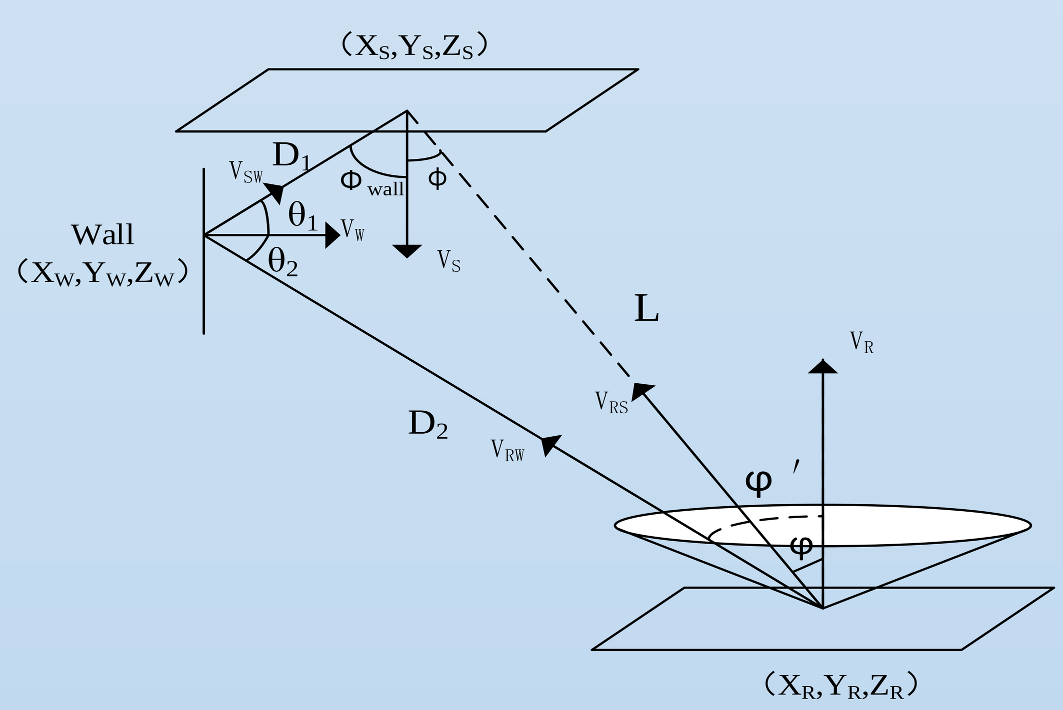


line-of-sight link

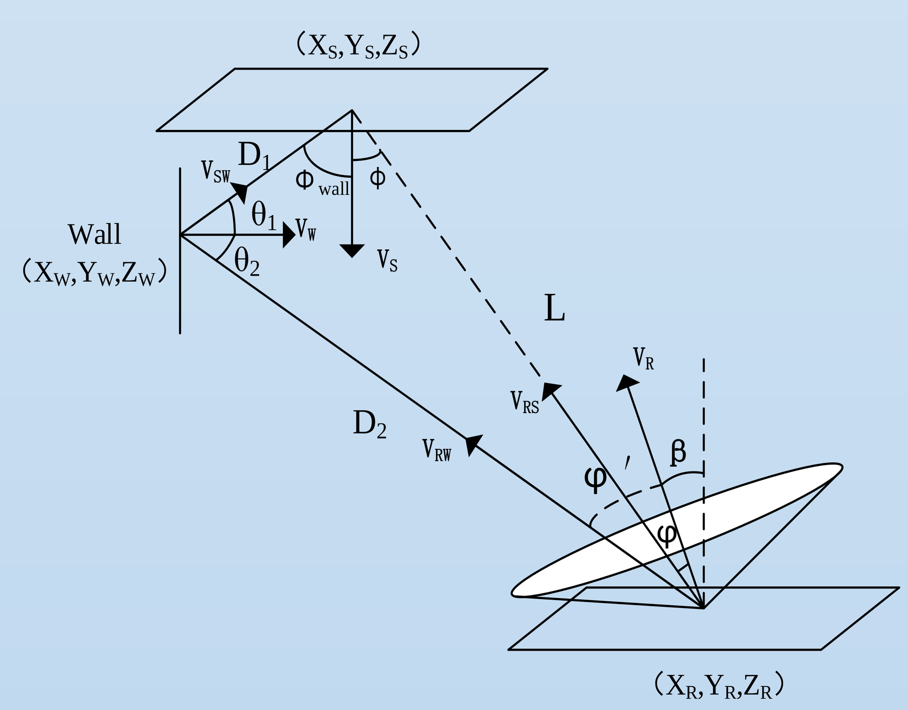


non-line-of-sight link (one reflection)

Design principle of single tilt receiver



The receiver is placed horizontally



The receiver is tilted

$$P_{LOS}=\begin{cases}\dfrac{(m+1)\cdot A_{RX}\cdot\cos^m\Phi\cdot(a\cdot\sin\beta\cos\alpha+b\cdot\sin\beta\sin\alpha)}{2\pi\cdot L^2\cdot\sqrt{a^2+b^2+c^2}}\cdot P_S\cdot g(\varphi)\cdot T_S(\varphi) & 0\le\varphi\le\Phi_C\\ 0 & \varphi>\Phi_C\end{cases}$$

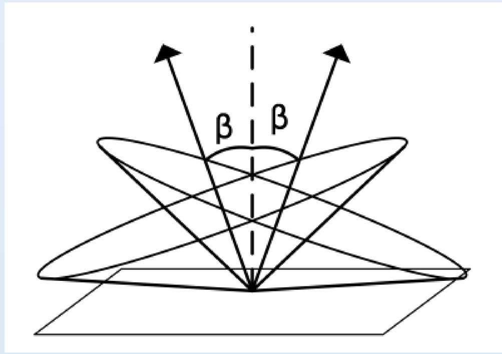
$$P_{NLOS}=\begin{cases}\displaystyle\int_{wall}\frac{(m+1)\cdot A_{RX}\cdot\cos^m\Phi_{wall}\cdot(a'\cdot\sin\beta\cos\alpha+b'\cdot\sin\beta\sin\alpha+c'\cdot\cos\beta)}{2\pi^2\cdot D_1^2\cdot D_2^2\cdot\sqrt{a'^2+b'^2+c'^2}}\cdot\rho\cdot P_S\cdot\cos\theta_1\cdot\cos\theta_2\cdot g(\varphi')\cdot T_S(\varphi')dA_{wall} & 0\le\varphi'\le\Phi_C\\ 0 & \varphi'>\Phi_C\end{cases}$$

Total received power of the system:

$$P=P_{LOS}+P_{NLOS}=\frac{(m+1)\cdot A_{RX}\cdot\cos^m\Phi\cdot(a\cdot\sin\beta\cos\alpha+b\cdot\sin\beta\sin\alpha+c\cdot\cos\beta)}{2\pi\cdot L^2\cdot\sqrt{a^2+b^2+c^2}}\cdot P_S\cdot g(\varphi)\cdot T_S(\varphi)+$$

$$\int_{wall}\frac{(m+1)\cdot A_{RX}\cdot\cos^m\Phi_{wall}\cdot(a'\cdot\sin\beta\cos\alpha+b'\cdot\sin\beta\sin\alpha+c'\cdot\cos\beta)}{2\pi^2\cdot D_1^2\cdot D_2^2\cdot\sqrt{a'^2+b'^2+c'^2}}\cdot\rho\cdot P_S\cdot\cos\theta_1\cdot\cos\theta_2\cdot g(\varphi')\cdot T_S(\varphi')dA_{wall}$$

Design and analysis of stereo combined receiver

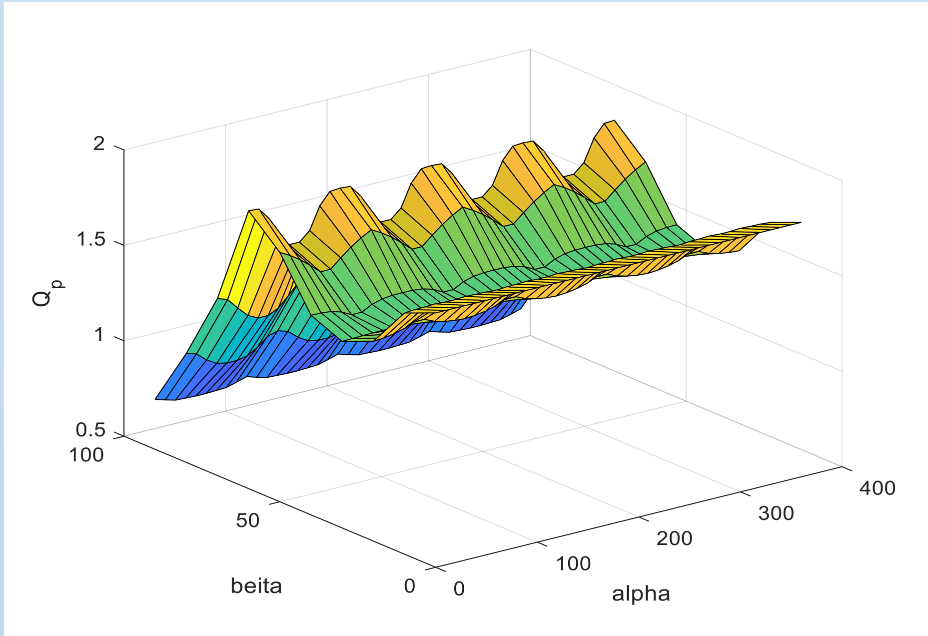


Schematic diagram of stereo combined receiver

The design concept of the stereo combined receiving end is that two or more detectors are combined at the same receiving point, the detectors rotate relatively stationary at a fixed angle, and the receiving plane is divided equally. Due to the combination of multiple detectors, the field of view receiving angle increases, the receiving blind area decreases, the receiving power is improved and the signal-to-noise ratio is balanced.

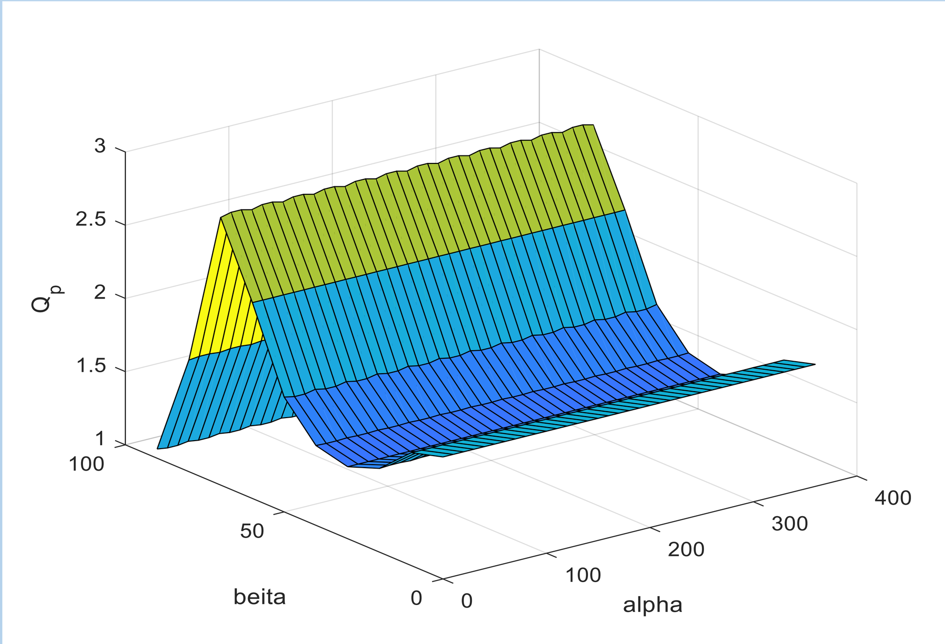
Simulation results and analysis

Dual detector stereo combined receiver



Relationship between Q_P and inclination angle, azimuth angle of single lamp double detector combination

Three detector stereo combined receiver



Relationship between inclination angle, azimuth angle and Q_P of single lamp three detector combination

Conclusion

In this study, we propose a stereo combined receiver design scheme.

Different from the fixed-point receiver, the research is trying to find out an optimal combination of inclination and azimuth, so that the signal power and signal-to-noise ratio received by such receiver on the whole plane are the most balanced; that is, no matter where the receiver is installed on the receiving plane, the difference between power and signal-to-noise ratio is the smallest.