Yagi-Uda Antenna

Yagi-Uda (further Yagi) antenna is array of dipoles. Radiation of all elements is summed in forward direction. Yagi antennas are used in radio links for computer networks (Wi-Fi). Some kinds of Yagi are used for receiving TV and FM radio signals.

Main characteristics of Yagi antennas are

- Gain 5-16 dBi,
- Narrow-band (relative bandwidth is ~10%).

WIPL-D Simulation

Models of Yagi antennas simulated in WIPL-D Pro are presented here. Simulated Yagi antenna consists of one reflector, one fed dipole and ten directors. One model is made of wires, while the other model is made of plates. Wire antenna is shown in Fig. 1, while the plate antenna is shown in Fig. 2 and the feeding area is zoomed-in in Fig. 3. Dimensions of both models are the same. That means that every wire in wire model is replaced by body of rotation and terminated using circle object in the plate model.

We will assume that given antenna is used in B-band (NATO band classification).

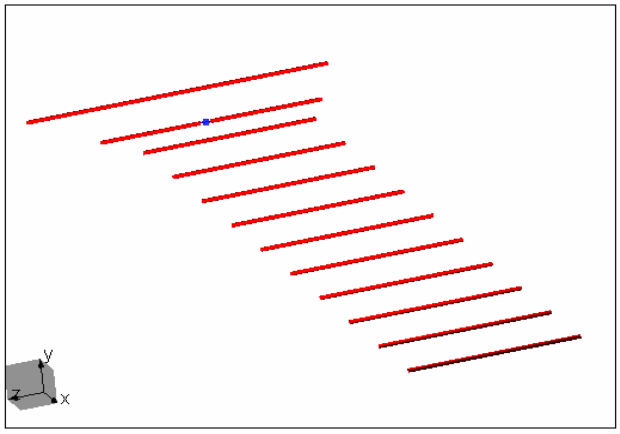

Figure 1. Yagi antenna modeled with wires

Our aim is to compare simulation times for wire and plate antenna models and show that wires are viable building blocks for many antenna types for which they can speed-up the simulation significantly.

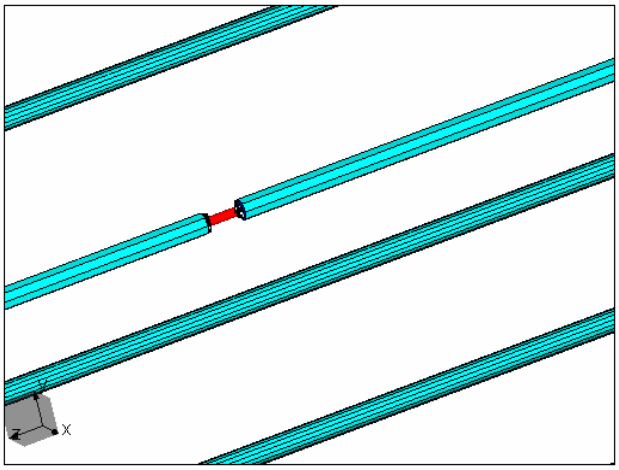

Figure 2. Yagi antenna modeled with plates

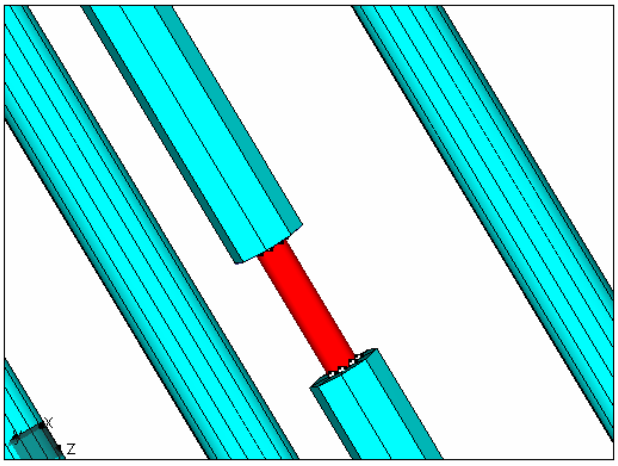

Figure 3. Yagi antenna modeled with plates – feeding area and plate approximation

In WIPL-D Pro, iterated structures can be designed using convenient built in features. Antennas shown on Fig. 1 and Fig. 2 can be modeled in several ways but the optimum way is to use (*Anti*-) *Symmetry* feature and *Copy*/*Move* manipulations to facilitate modeling. Metallic parts are considered to be perfectly conducting.

Operating frequency is 266 MHz (B-band).

Radiation pattern in 3D is shown in Fig. 4. Overlayed 2D radiation patterns for a theta-cut are shown in Fig. 5. As can be seen, there is no difference in

calculated radiation pattern regardless of what type of geometrical entity (wires /plates) is used in the model.

Near field of the wire model is given in Fig. 6.

Number of unknowns and simulation time of analysis are given in Tab. 1. Computer used for these calculations is Pentium® Core2 Quad @ 2.83 GHz.

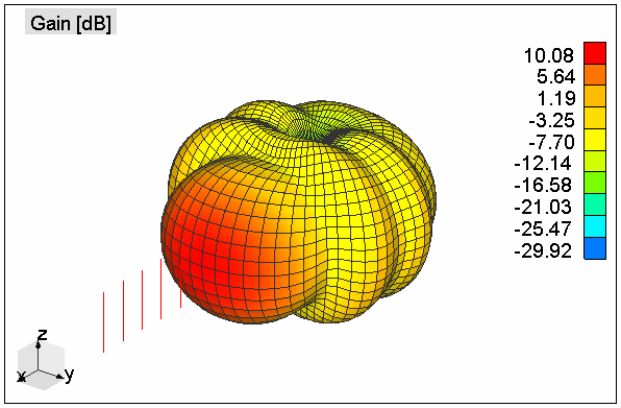

Figure 4. Radiation pattern of Yagi antenna made of wires

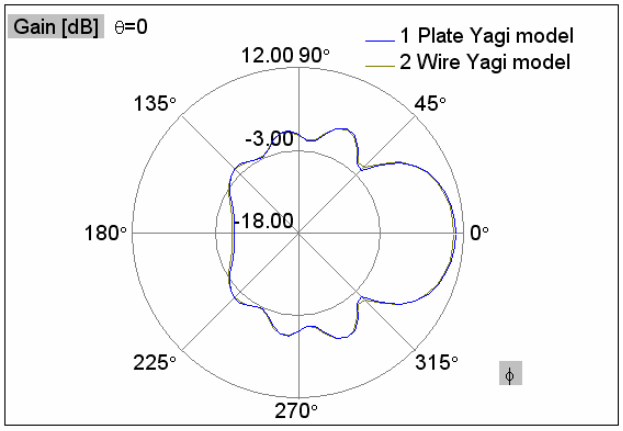

Figure 5. Overlaid 2D radiation patterns for theta cut

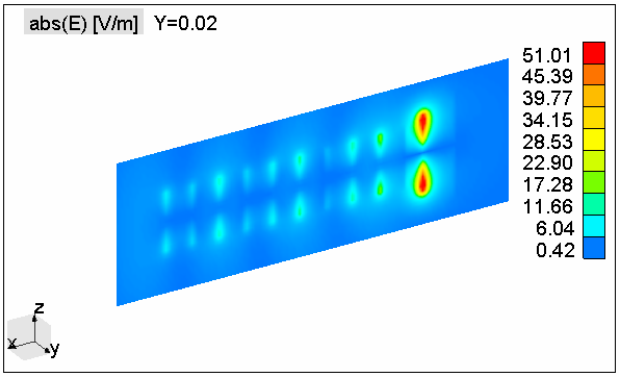

Figure 6. Radiation pattern of Yagi antenna made of wires

Table 1. Analysis characteristics

Model	No. of unknowns	Time @ 266 MHz [sec]
Wires	36	1
Plates	1560	24

Conclusion

We conclude that using wires to model a Yagi antenna leads to great diminishing of simulation time and number of unknowns. Various types of structures can similarly be simulated using wire models, and not plate models. Wires can be used to model cyliders whose radius is up to $0.1 \cdot \lambda$ and whose length is much larger than the radius. In those cases, simulation is faster hundreds of times, and memory usage can even be thousands of times lower.