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Antenna & Propagation

Yagi Uda

by

Nor Hadzfizah Binti Mohd Radi
Faculty of Electric & Electronics Engineering
hadzfizah@ump.edu.my



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Chapter Synopsis

In this chapter, the student will be exposed about Yagi Uda antenna. Some of that are, basic elements in Yagi Uda, the radiation pattern, the characteristics, calculation related to the designing of Yagi Uda and its parameters.



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Teaching Outcome

At the end of this course student should be able to:

- Understand the operation of Yagi Uda as broadband antenna.
- Know how to calculate the dimensions of Yagi Uda and related parameters.
- Understand the features, advantages and disadvantages of Yagi Uda.



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Outline

Introduction

Radiation Pattern

General Characteristics

Yagi Uda Calculations

Advantages and Disadvantages



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Introduction

- Often referred to as "Yagi" antennas. It is a high gain antennas.
- VHF and UHF TV & FM radio reception.
- HF-VHF-UHF (30 MHz – 3 GHz) point-to-point wireless communications
 - long-range wireless communications
 - base-station for two-way voice and/or data communications
 - telemetry of sensor data



Source: <https://th.wikipedia.org>



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History

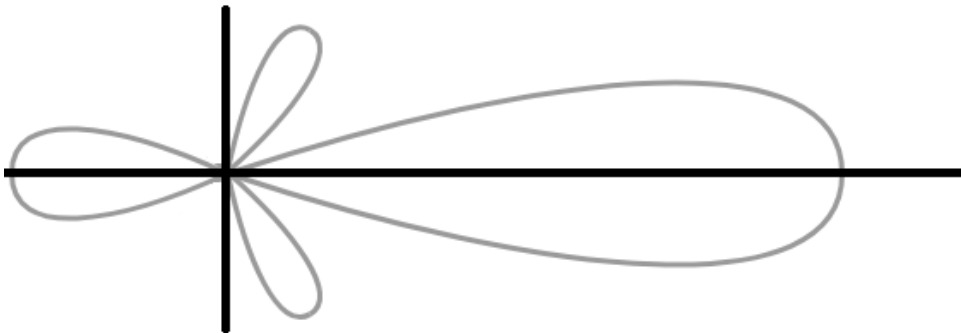
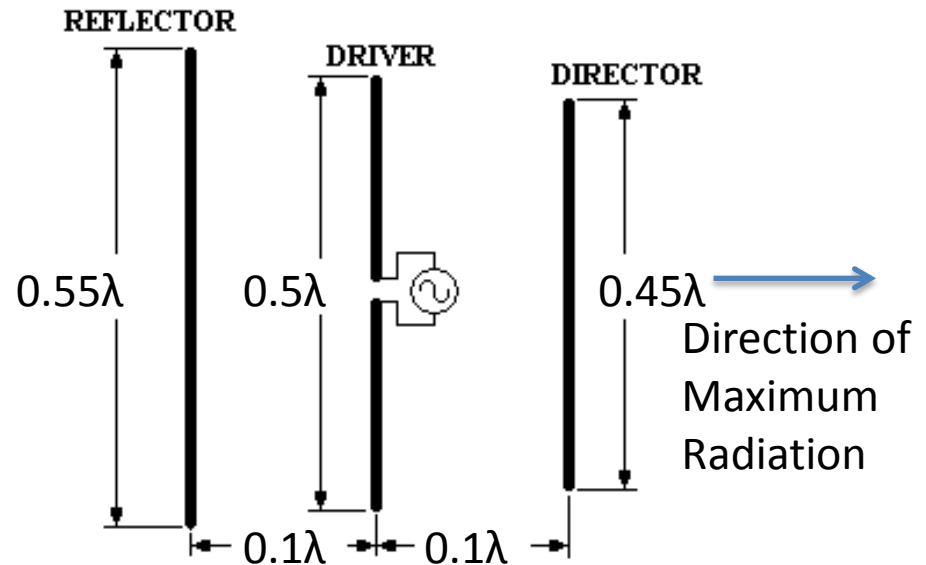
- The antenna was first invented by a Japanese Prof. S. Uda in early 1940's.
- Afterwards it was described in English by Prof. H. Yagi.
- Hence the name of 'Yagi-Uda' was given after their names.
- Prof. Uda performed several experiments. Starts with single reflector, a driven and a single director and up to 30 directors.
- He found that highest gain is possible with the reflector of length equal to $\lambda/2$ located at a distance $\lambda/4$ from the driven element, along with director of length approx. 10% less than $\lambda/2$ located at a distance $\lambda/3$ from the driven element.



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Basic Yagi-Uda and its Radiation Pattern

- Consists of a driven element, one reflector and one director.
- The driven is a resonant half wave dipole made of metallic rod.
- All elements are placed parallel and close to each other.
- This antenna radiation pattern is called directional antenna

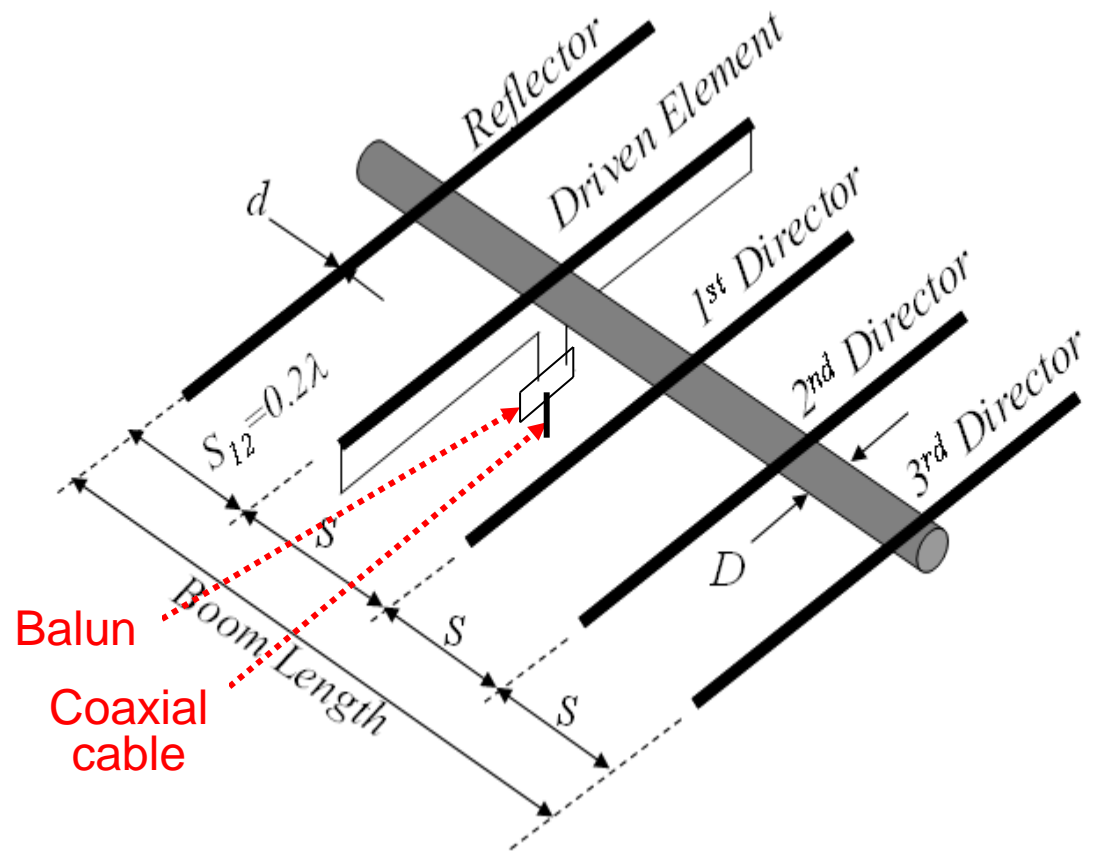


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Basic Structure

Basic structure is an array of dipoles made up of:

- usually one **reflector** element (parasitic)
- a **driven** element
- one or more **director** elements (parasitic)
- A "balun" is required for connection to a coax cable.



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Length of Elements

- The length of the different elements can be obtained by using following formula:

Reflector Length (meter)	$\frac{152}{f(MHz)}$
Driven Length(meter)	$\frac{143}{f(MHz)}$
Director Length(meter)	$\frac{137}{f(MHz)}$



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The Elements

Reflector

- Reflects the signal coming from front side
- Totally attenuates the transmission signals from back sides

Driven

- An active element that electrically connected to the receiver or transmitter.

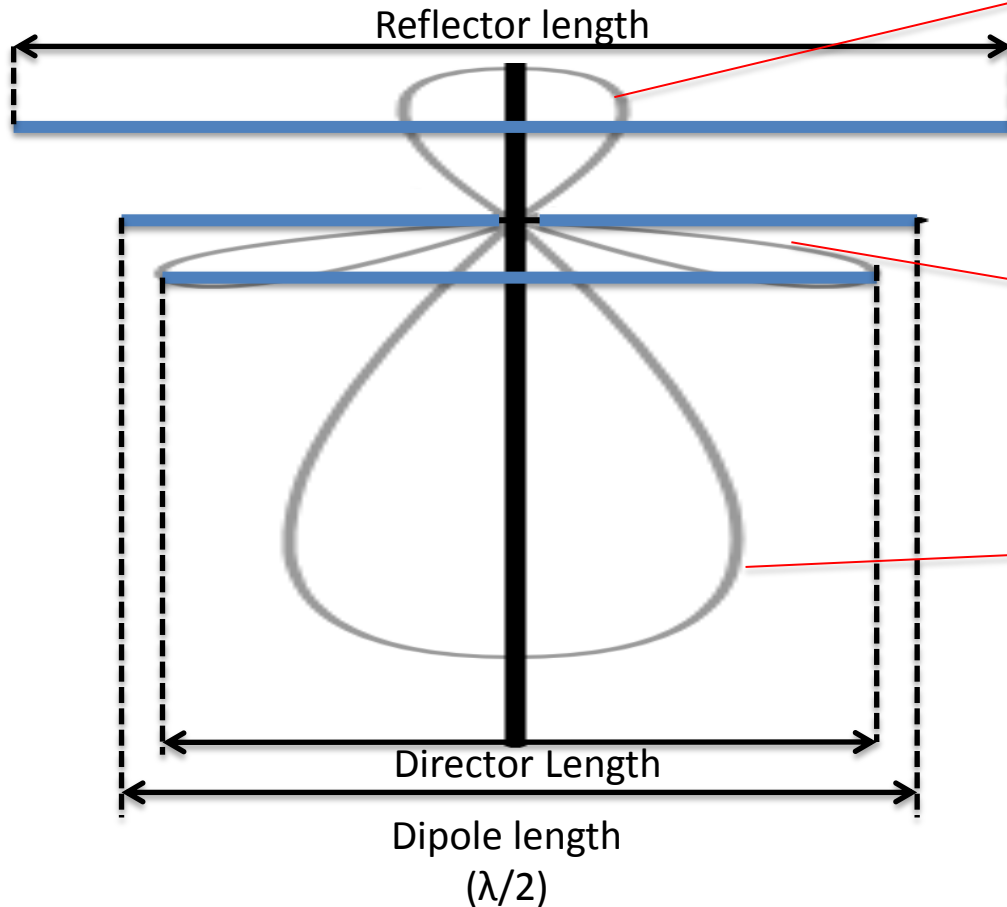
Director

- Retransmitted the signal collected from front side towards dipole
- It attenuates the signal coming from sides and back side



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Radiation Pattern



Back lobe
(Minimum directivity)

Side Lobes
(Very small directivity)

Main lobe
(Maximum directivity)



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Characteristic of Yagi-Uda

Charateristic 3 Elements: one reflector, one driven and one or more directors

Fixed frequency operated

The Bandwidth of 2% and 3% can be easily achieved (if spacing between the elements is between 0.1 to 1.5λ)

Gain of Yagi-Uda is about 7 to 8dB and F/B ration is 20dB

Light weight, low cost, and simple feeding.

To get greater directivity more number of director are used. (range from 2 to 40)

It also called as superdirective or super gain antennas



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Yagi-Uda Calculations

$$\lambda = \frac{c}{f}$$

Length of dipole (driven)

$$\frac{\lambda}{2} = \frac{150}{f(\text{MHz})}$$

In practice, the antenna elements should be 5% and 7% shorter than obtained using formula

Therefore, Length of dipole (driven), D_r

$$\frac{143}{f(\text{MHz})}$$

Length of Reflector, R

$$\frac{152}{f(\text{MHz})}$$

Length of 1st Director, D_1

$$\frac{137}{f(\text{MHz})}$$

More number of directors, length of subsequent director shortens by 2.5%

Spacing between R and D_r :

$$0.25\lambda = \frac{75}{f(\text{MHz})}$$

Spacing between D_r and D_1 :

$$0.13\lambda = \frac{40}{f(\text{MHz})}$$

Spacing between D_1 and D_2 :

$$\frac{38}{f(\text{MHz})}$$



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Advantages and Disadvantages

Advantages

- Excellent sensitivity
- F/B ratio is excellent
- Useful as transmitting antenna at HF for TV reception
- Almost unidirectional radiation pattern
- By using of folded dipole: the antenna is broadband

Disadvantages

- Gain limited
- Bandwidth limited
- The gain of antenna increases with reflector and director



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- [2] Stutzman and Thiele, *Antenna Theory and Design*, John Wiley, 2012.
- [3] T. A. Milligan, "Modern Antenna Design" John Wiley, 2nd edition, 2005.



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Author Information

Nor Hadzfizah Binti Mohd Radi

Lecturer

FKEE, UMP

email

hadzfizah@ump.edu.my



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