PROCEEDINGS OF ISAP '96, CHIBA, JAPAN

ANTENNA SYSTEM FOR MOBILE VIDEO TRANSMISSION VIA SATELLITE

Ryuichi IWATA*, Yasunori YOSHINO*, Tsunehisa MARUMOTO*, Masaki MORITA*,
Makoto NAKAYAMA* and Toshiaki YAMASHITA**
* Microwave and Satellite Communications Division, NEC Corporation
4035 Ikebe-cho, Tsuzuki-ku, Yokohama, 224 JAPAN
** Functional Devices Research Laboratories, NEC Corporation
Kawasaki, Kanagawa, 226 JAPAN

1. Introduction

There increases the demand of real time mobile video transmission. For example, medical video information transmission from an ambulance car to the doctor in the hospital will decrease the ratio of DOA (Dead on Arrival) . Because relatively wide bandwidth is necessary for video transmission, the satellite communication is one solution for this purpose.

Although various mobile satellite communication systems and antennas has been developed so far, most of all these systems are for voice or message transmission, or for satellite broadcasting receive system (1) and report of video transmission from mobile terminal is very few.

Discrepancies of the video transmission from above conventional mobile communication systems are wideband usage and high power transmission with large antenna. For example, for analog video transmission via satellite, bandwidth of 27MHz, an antenna with 1.2m diameter and a power amplifier of 100W or more are necessary. This has been the obstacle of the development of the mobile video transmission system.

Recent digital video compression technologies, however, made it possible to transmit the video data using the narrower band width and smaller antenna with lower transmission power. For example, 4MHz band width, antenna with the gain of 30dB(equivalent diameter of 30cm) and antenna input power of 27W is enough for the transmission of 1.5Mbps digital compressed video data. (Decoded video picture from the 1.5Mbps compressed data has not enough quality for general broadcasting material, but enough for usual real time motion picture information, for example for the medial treatment information.)

In this paper, the antenna system which is able to be installed in the ordinary car for mobile video transmission via Ku band satellite is presented. The configuration, tracking system and experiment data are described.

2. Configuration

Figure 1 shows the image of the mobile video transmission system.

Figure 3 shows the block diagram of the antenna system. And Figure 4 shows the external view of the antenna. The transmit antenna is printed rectangular patch array with parastic elements (Figure 5). The elements are excited by magnetic coupled feeder line. The receive antenna is also printed rectangular array, but divided into four parts for tracking purpose as described later. The antennas are mechanically steered around azimuth and elevation axis by DC-servo motor. In azimuth axis, the waveguide/coaxial-cable hybrid rotary joint is installed, which facilitate both the transmission of high power from the HPA to the transmit antenna and the transmission of the received communication signal from the receive antenna to the down converter. The slip ring is also installed to supply the DC power source to antenna drive motor. The antenna has a 3-axis opticl fiber gyro.

3. Antenna Tracking

The antenna tracking is performed utilizing the RF tracking error signal and information from the sensors. Tracking has two modes. One is RF tracking mode, and the other is gyro sensor mode. Ordinarily the antenna tracking is in the RF tracking mode. And if the antenna tracking error exceeds the limit of RF tracking range, or if the antenna loses the satellite signal because of the blocking by the obstacles, antenna tracking transfers to the gyro sensor mode.

The antenna RF tracking principle is beam switching method (2) . The receive antenna is divided into four sub-antennas. Phase shifter is installed in each port of sub-antenna. The phase shifter has two status (on and off), and by driving the phase shifter, the beam is shifted by small amount in azimuth and elevation direction, that is the beam is shifted to four positions. If the antenna is accurately pointed to the satellite, the received pilot signal is unmodulated. On the other hand, if there is an difference between the antenna beam angle and the satellite direction, the received pilot signal is AM modulated. The tracking demodulator yield the tracking error signal from the received pilot signal. According to the tracking error signal the antenna control unit(ACU) control the drive motors with the AR model algorithm. The AR(Auto-regressive) model is a kind of filter algorithm (3) .

The sensor mode is open loop control. The 3-axis optical-fiber gyro detects the yaw, pitch and roll angles of the vehicle's motion. And the ACU compensates the antenna azimuth and elevation angles by using the gyrosensor and the angle detectors..

4. Experiment

Table 1 shows the summary of the antenna performance.

Figure 6 shows the measured transmit antenna radiation pattern, it complies with the off-axis power emission regulation for Ku band mobile terminal in Japan. Figure 7 shows the receive antenna radiation pattern with beam switching. This data shows that a small amount of beam shift is created by driving the phase shifters.

Figure 8 shows the output voltage of tracking demodulator in azimuth and in elevation direction. Figure 9 and 10 shows examples of the data of tracking performance. Fig. 8 shows the receive level variation during the car traveling though S-curve. This data shows that the receive level variation is within 2.5dB except the miss tracking at the abrupt road gap. This receive level variation corresponds to the tracking error of 0.83 ° rms. Fig. 10 shows the tracking mode transition and receive level variation of driving under the condition of intermittent shadowing. This data shows that the antenna tracking is successfully performed by automatic tracking mode changeover even under the blocking condition.

The video transmission was actually performed using this antenna system and it was successful.

5. Conclusions

The antenna system for video transmission was studied and experimental model was made.

The experiment shows that the antenna radiation pattern is compliant with required off beam power emission. And antenna RF performance is enough for mobile video transmission. Using the antenna, actual video transmission is successfully performed. This experiment shows that the mobile video communication is possible via satellite.

The future technical subjects to be improved are to diminish the size of the antenna and to improve the tracking performance.

References

(1) Ito,Y.:"A mobile 12 GHz DBS television receiving system".IEEE Trans. on Broadcasting-35. 1, pp.56-61 (Mar.1989)

(2) Imafuku,H., Ogawa,S., Seki,K., Endo,N., Shimizu,R., Kaneko,Y. and Kuramoto,A.:"Mobile TV receiving antenna system of direct broadcasting satellite for train application". Proceedings of ISAP'89, 3A2-4, pp.545-548(1989)

(3) Yamashita,T., Tsujisawa,T., Iwazawa,N. and Yoshino,Y.:"Vehicle Antenna tracking-control using an AR model" Proc. of 2nd Int. Conf. on MOVIC, pp.623-627(1994)

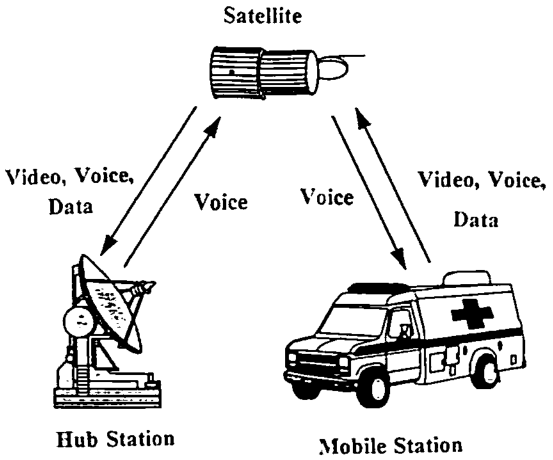


Fig. 1 Video transmission system

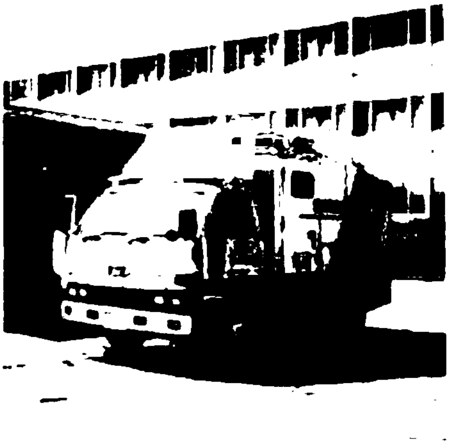


Fig. 2 Mobile sataion for experiment

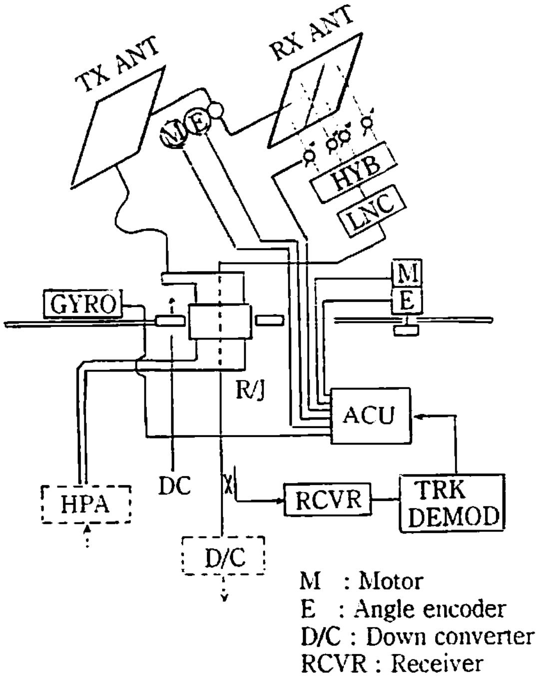
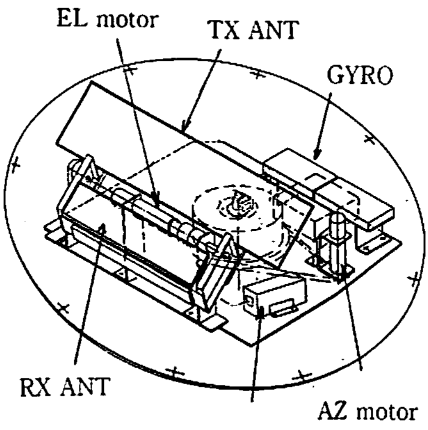


Fig. 3 Block diagram



ϕ 840 × 350(H) mm

Fig. 4 External view

Table 1 Antenna Performances

TX ant. gain (measured)	30.0 dB
RX ant. gain (measured)	24.5 dB
Ant. noise temp. (estimated)	192 K
XPD (measured)	28.5 dB
Tracking error (design target)	0.7 ° (rms)

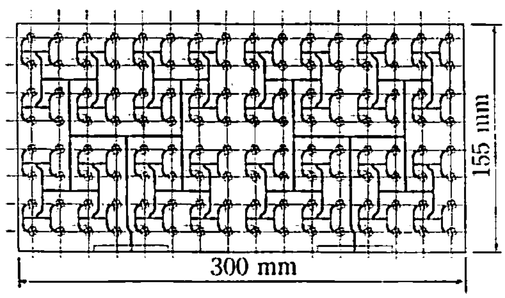


Fig. 5 Transmit antenna (half section)

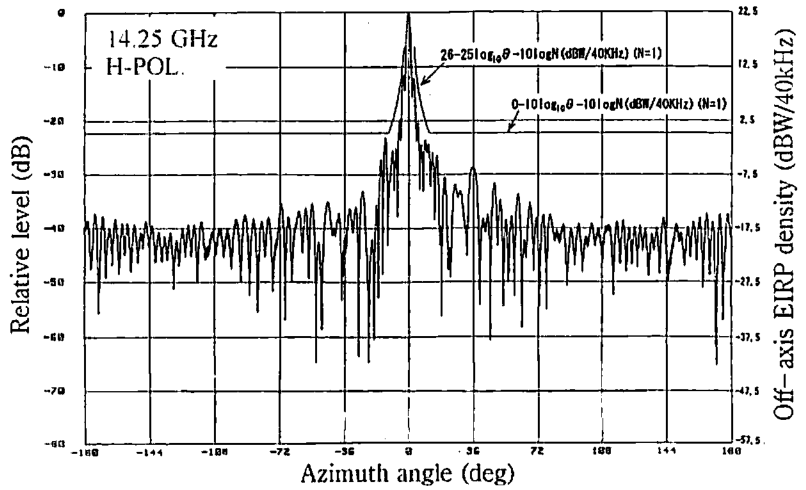
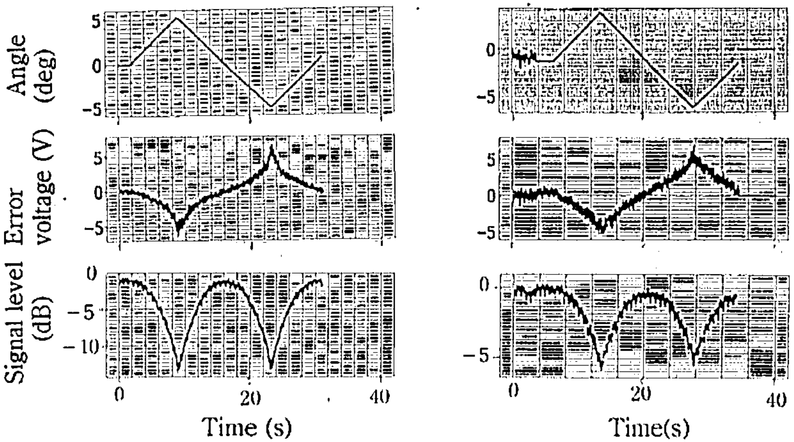


Fig. 6 Transmit radiation pattern (measured)



(a) Deviation in azimuth (b) Deviation in elevation

Fig. 8 Tracking demodulator output voltage

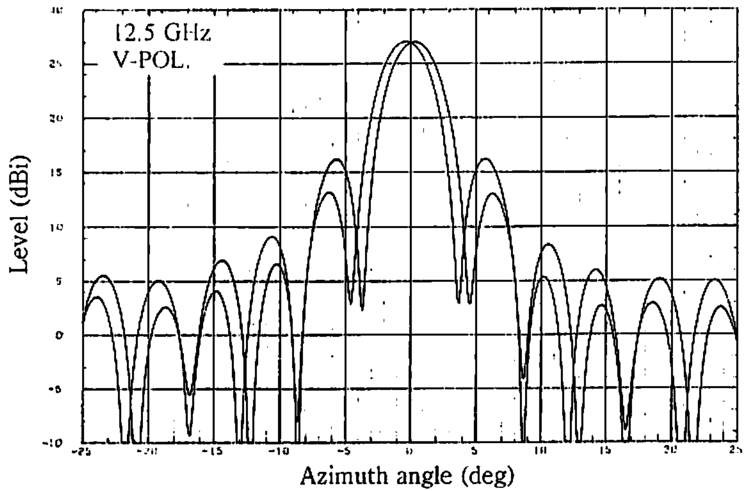


Fig. 7 Receive radiation pattern with beam switching (measured)

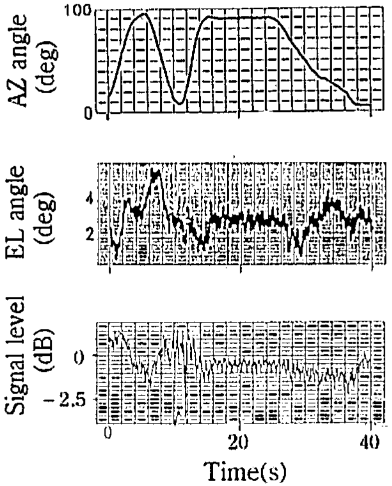
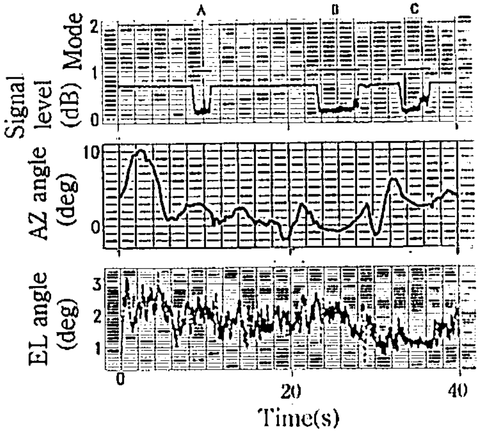


Fig. 9 Tracking in S-curve driving



Mode 1: RF sensor tracking
Mode 2: Gyro tracking

Fig. 10 Tracking under intermittent shadowing