

(Research Note)

A New Solar Power Driven TV Programs Receiving System via Communication Satellites
--To Support Education at Remote Regions in Developing Countries--

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ABSTRACT

A television (TV) broadcast receiving system through communication satellites for educational objectives has been developed. The system has solar modules to generate electric power and the electricity obtained will then be supplied to the receiving system of the TV programs. The TV programs were recorded on videotapes in Japan in March 2000 before the receiving experiment. The programs were sent from Japan through the satellite PanAmSat Pas 4 and they were received at the experimental site located in a remote place, Ban Nong Pha Jam Mai in Mae Hong Son Province, a hill-tribe village on the Thai side of the border area between Thailand and Myanmar. The experiments were carried out during two days on March 3 and 4, 2001 at 18:00 till 20:00 (Thai local time). The Thai TV programs were also received at the same site via the satellite Thaicom. The quality of the TV programs we have received at the experimental site has been very good in terms of picture, voice, and text characters. We have observed the expressions of the persons, both adults and children, who had watched the TV programs at the site during the experiment. After the receiving experiments we performed a hearing survey of the impression those who watched the TV programs formed of them. From the results of observation and hearings we have concluded that most of the persons who watched the TV programs formed good impressions of them. This TV receiving system is one of new approaches to getting the TV programs at the place where there is no commercial electricity supply, and this system will be expected as one of the procedures to solve the difficulties of the educational problems at remote regions in developing countries. The present system is not expensive, easy to install, and easy to

maintain.

Key words: distant education, education with the use of broadcast, television receiving system, international cooperation, education at remote region

1. INTRODUCTION

There are a lot of places or regions, where there exist many kinds of educational difficulties, in developing countries. A part of these difficulties originates from hard social circumstances or severe geological situations. For example, there are cases where the materials to construct school buildings are available, but there were no teacher and no electric supply. Without electricity it is not convenient either for teachers or for learners to spend their daily lives at school. In such places most newly developed information communication technologies cannot be used satisfactorily, because electricity is one of the most important infrastructures for both modern society in general and educational settings in particular.

Nowadays quite large numbers of communication satellites have been used in the area of digital data communication and broadcasting objectives all over the world. The Internet technology is on the other hand widely available in many places almost all over the world. Of course these technologies also use electric power. The electricity, therefore, is the most important factor to govern modern science and technology. In the present study, we will propose a new combination technique between the receiving system of the satellite TV broadcasting and electric power supply system with the use of solar energy. With this system we will try to get some basic data in relation to the possibility of making use of this system to mitigate the educational difficulties in developing countries. In the present broadcasting experiment we will use the PanAmSat Pas 4 as an international communication satellite. The cost of the system is a very important factor especially in the case of developing countries. This will be discussed in the present article. At this point it is clear that the present system would be excellent.

2. APPARATUS

The apparatus for the present receiving unit, in particular the planning of the electric supply and store system will be described.

2.1 Receiving apparatus

In order to receive the satellite TV programs, the following apparatus are necessary.

- 1) A TV receiving set
- 2) A DVB receiver
- 3) A video tape player/recorder

2.2 Electric power supply system

Electricity supply is necessary to watch the TV programs. Where there is no electric supply we will have to get electricity by our own system. Here, in order to generate the electric power, we propose a solar energy system.

2.2.1 Solar energy system

Solar energy from sunlight is converted into electric energy on the solar panel and the electricity obtained will then usually be stored in lead car battery cells. In order to watch the TV programs the electricity of the DC 12 V from car batteries will be inverted into AC 220 V.

The output power of the solar system will be estimated mainly by the two factors. That is,

- 1) Surface area of solar module, and
- 2) Time of sunlight (daylight hours).

We have no exact meteorological data at the installation site (Mae Hong Son province). In the present paper therefore to make a system planning, we have assumed the following two conditions.

- 1) Average daylight is five hours a day.
- 2) Average rainy and/or cloudy days are two in a week.

The procedure or steps of the system planning are as follows:

- 1) To estimate the electric consumption of the TV satellite receiving system in a day.

- 2) To estimate the surface area of solar panels to produce enough electricity for the receiving unit.
- 3) To estimate the amount of charge storage and the necessary number of batteries.

2.2.2 Estimation of electric consumption of the receiving system

Table 1 shows the consumption of electric power for the present receiving system. It is assumed that we will use these apparatus at the same time for almost three hours a day, $210 \times 3 = 630$ Wh. We will have to apply two corrections for this value; the first the inverter efficiency from DC to AC (90%), the coefficient 1.1 will be used and the second the battery loss (80%), the coefficient 1.25 will be used. Taking into account these corrections to the original value, we will obtain the value of electric consumption for this system as ca. 870 Wh.

Table 1 . Electric consumption of the TV programs receiving system

Apparatus	Number	Consumption power(W)	Watching hours/day	Quantity of electric consumption(W h)/day	Corrected(Wh)/day ^{a)}
TV	1	150	3	450	495
DVB tuner	1	30	3	90	99
Video tape player/recorder	1	30	3	90	99
Total				630	693
Corrected ^{b)}					870

^{a)} DC/AC inverter efficiency (90%) from DC12 V to AC200V, correction coefficient 1.1 was used (<http://www.naturalgoods.com/guide.html>).

^{b)} Battery loss (80%), correction coefficient 1.25 was used (<http://www.naturalgoods.com/guide.html>).

Table 2 . Output power of solar module

		Descriptions
Electric consumption/day (Wh/day)	870	after correction
Daylight (h)	5 ^{a)}	
Necessary output power(W)	174	before correction
Efficiency (Modification) ^{b)}	1.15	correction
Necessary output power of solar module(W)	200	after correction

Output power of one solar module (W)	75	
Necessary number of modules	3	theoretical
Actual number of modules	5	after correction

- a) Assumed average hours of daylight.
- b) Efficiency (modification) coefficient of output power.

2.2.3 The estimation of an output power of the solar module

The proper output power of the solar module will then be estimated. Table 2 shows the procedure to estimate the number of solar modules. We will obtain the basic value of the output power of solar module. The consumption of electric power per day 870 Wh was divided by the average hours of daylight 5, to obtain the value 174 W. The value will then be corrected by the coefficient 1.15, to obtain 200 W. The value 200 W is divided by 75 W, and we obtain integer number 3. This value however will not have taken into account the rainy and/or cloudy days. If we had two rainy and/or cloudy days in a week, the proper value will be obtained multiplying by the value $7/5 (=1.4)$. If the number 3 is multiplied by 1.4, we obtain integer number 5. Finally we obtain the proper number of 75 W solar modules as to be 5.

2.2.4 The estimation of the proper battery volume

Table 3 shows the steps of the estimation of the proper battery volumes. The consumption of the electric power corrected is estimated as ca. 870 W per a day. When the value 870 W is divided by the voltage of the battery 12 V, we obtain the value 73 Ah of current load during a day. In order to estimate the charge volume of the battery, the current load 73 Ah will be multiplied by the average number of rainy and/or cloudy days 2 in a week. The value 145 will then be obtained. After the correction of battery maintenance efficiency 80%, i.e., the correction coefficient 1.25 will be used; we obtain the value 181 Ah. Moreover if possible the batteries will be used within less than the 50% of the whole discharge from the original volume of the storage power. Then the value 145 Ah will be tripled for example in the case of 30%; we will obtain the value of ca. 450 Ah. When the value 450 Ah is divided by 150 Ah, we obtain integer 3. Finally therefore we will propose three batteries of the value of 150 Ah for the present system.

Table 3 . Estimation of proper battery volume

Voltage of battery (V)	12
Electric load per day (Ah/day)	73
Rainy/cloudy days(days/week)	2 ^{a)}
Storage volume (Ah/day)	145
Maintenance efficiency (factor)	0.8 ^{b)}
Total storage volume (Ah)	181 ^{c)}
Total storage volume (Ah) desired	450

a) In Japan the coefficient 3-4 will usually be used (<http://www.naturalgoods.com/guide.html>).

b) This shows the degree of discharge (Less than 50 % should be desired (Takahashi, 1997)).

c) Actually, 1.5-3 times of batteries in storage volumes against the theoretical value are desired.

3. INSTALLATION OF THE RECEIVING APPARATUS

Receiving experiment was at first planned at the site Ban Pha Puak (See Figure 1). There were some conflict between the Thai and Myanmar armies around the border just before the experiment in February 2001. We therefore changed the experimental site to Ban Nong Pha Jam Mai. Pictures 1-8 show the scenery of Ban Nong Pha Jam Mai and installation of the apparatus there.

3.1 Receiving system

We have installed two kinds of antenna, i.e., for receiving the Ku and C bands. With the Ku band we have used the steel dish antenna which is about 70-80 cm in long diameter. With the C band this is a mesh dish antenna and it has a diameter of about 3 meters. The TV receiving set, video player/recorder, and DVB receiver are each installed. With the C band a special receiver is temporally installed during the receiving experiment.

3.2 Electric power supply system

Table 4 summarizes installed apparatus for the experiment. We actually have arranged five solar modules of 75 W in a parallel form on the steel cell structure. The whole steel frame was then fixed on the four concrete poles of about one meter high (See Picture 7). For inversion from DC 12 V to AC 220 V, we have installed a 1,500 W inverter.

Table 4 . Actually Installed apparatus used in the experiment

Descriptions	Model	Quantity
Receiving system		
Satellite television system	DSTV	1
Television (29")	LG29	1
Video tape player/recorder		1
Television shelf		1
Solar power system		
Mono-crystalline solar module (75W)	BP275	5
Charge regulator (12V 30A)	GCR2000M	1
Inverter (12V 1,500W)	PW1500	1
Battery (12V , DC150 Ah)	GS150GH	3
Support cell structure 5	T-5	1

4. EXPERIMENTAL BROADCASTING

The receiving experiment was performed on March 3 and 4, 2001, with the use of two kinds of bands, the Ku and C bands.

-Ku band

We will here mention first the TV programs which used Thai domestic bands. The TV programs in Thai are summarized (Ohnishi, 2000). The satellite used was Thaicom. We could watch the programs of the channels, 3, 5, 7, 9, 10, and 11. In addition to these channels the programs of the DLTV (Distance Learning TeleVision) station from Hua Hin, located at three-hour drive to south west direction from Bangkok, could also be received. Quality of the observed picture, voice, and text characters was excellent.

Table 5 . Schedule of experimental broadcasting and the TV programs

Date	Tape number	Program (M:S)	Running time (M:S)	Contents
March 3		10:00	10:00	test pattern (inserted by NHK)
March 3	2	13:19	23:19	meals, fruits
March 3	1	18:45	42:04	ginger, carrot, aloe
March 3	3	20:27	62:31	vermifuge (comics)
March 3	4 ^{a)}	16:07	78:38	injury, decoction of herb

March 4		10:00	10:00	test pattern (inserted by NHK)
March 4	5	14:09	24:09	sick, mosquito, malaria
March 4	6	9:40	33:49	sick (puppet show)
March 4	7	19:01	52:50	old Thai, tiredness, patient medicine, massage
March 4	8	18:47	71:37	bones, therapeutic point, massage

^{a)} Actually the fourth program of the first day "injury, decoction of herb" was replaced by the program (ca. 25 minutes) that was produced by Indonesian PUSTEKKOM (Center for Communication Technology for Education and Culture). All of the programs except the Indonesian program were produced in Japan together with Thai researchers.

Table 6 . Channel structures of Nippon Hosokai (NHK-JN(Japan))^{a)}

Channel	Format	Voice	Scramble	Contents
11	NTSC	Main (Japanese)	No	NHK World TV
12	NTSC	Sub (English)	No	NHK World TV
21	PAL	Main (Japanese)	No	NHK World TV
22	PAL	Sub (English)	No	NHK World TV
31	—		Yes	Radio Japan
51	NTSC	Main • Sub(L/R)	Yes	NHK World Premium
61	NTSC	Main • Sub(L/R)	No	Channel J
71	NTSC	Main • Sub(L/R)	Yes	JN Feed Transmittance

^{a)}This table shows the case of PanAmSat Pas8, 4060(MHz). Situations are the same to those of Pas4 (See Appendix).

-C bands

The TV programs of the C bands were sent from Japan and these are summarized in Table 5. Channel structures of the NHK world are shown in Table 6. The satellite we have used in the experiment was the PanAmSat Pas 4. The quality we have had at the receiving site was very good at pictures, colors, voice, and text characters.

4.1 Observation of the persons who watched the TV programs

We observed the expressions of those who watched the TV programs during the two days of the receiving experiment. There were about 20 adults and ten children. On the first day it seemed that most of the female adults did not express a strong interest in the programs.

On the other hand the male adults and children appeared to watch the TV programs with moderate interest. On the second day some of the TV programs were replaced by the Thai domestic programs with the use of Ku bands. These Thai programs were dramas. With these programs, it seems that most of the viewers, female, male, and children, watched with strong interest.

4.2 A hearing survey

After watching the experimental TV programs, we performed a hearing survey for the persons, about fifteen of adults and five of children, who watched the TV programs.

-Adults

There were several persons who have never watched the TV programs before. The rest had experienced watching television more than once before our experiment. The location is Soppong, a very small town located along the main road between Mae Hong Son and Chiang Mai (See Figure 1). There is an electric supply there. In this small town a person can watch the TV programs, e.g., in a small restaurant.

-Children

Some of children who visited the school had experienced watching television. There is a secondary school in Panma Pa and there is an elementary school in Soppong. There are TV sets at the schools. It takes about one hour on foot or ten minutes by car to the schools from the village Ban Nong Pha Jam Mai.

4.3 The possibility to use this system for educational objectives

-Installation cost

A TV set including a video tape player/recorder, an electric power supply system, transportation and the cost of installation totaled about 1,000,000 yen (about 8,000 dollars at the rate of March 2001). This does not seem so expensive. For the software, that is the preparation of the TV programs for education is needed and the cost of broadcasting including the satellite use is additionally necessary. It takes about a week to install and adjust all the apparatus including transportation from Bangkok. The present system is very easy to install and very simple to maintain. With reference to these affairs the present TV

receiving unit will be used as hardware for the educational objectives in the developing countries.

5. CONCLUSIONS

This paper describes an actual example of planning and installation of the receiving procedure of satellite TV system, where there is no electric power supply. We conclude that this system will be used in the field of education especially at the remote site. The present article will help us in cases to take into consideration international cooperation in which electricity supply is needed in many fields. This system seems on the other hand one of the types of the distance education. This can also be used in the developed countries.

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7. NOTE AND REFERENCES

The present manuscript is fundamentally based on our Japanese papers opened before (Ohsaku et al, 2000, 2001) .

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Takahashi, M. (1997) Hikari Hatsuden, No.20, 19-23.

Ohnishi, Y. (2000) Kyoikumediakenkyu, Media Survey in Vientiane: Education and Media in Laos, in Comparison with Those in Thailand (in Japanese), Japanese J. Educational Media Research, Vol.7, 39-53.

Appendix

Related URL

- Solar module
- Nippondenchi

<http://www.nippondenchi.co.jp/nippondenchi/top.html>

- Sharp Amenity System

<http://sdswww1.3sweb.ne.jp/sas/>

- Kyocera Solar Corporation

<http://www.kc-solar.co.jp/>

- Sanyo Electric

<http://www.sanyo.co.jp/solar/>

- Sekisui Housing

http://www.sekisuihouse.co.jp/product/ss/direct/ce_so_f.html

- Showa Shell Petroleum

<http://www.showa-shell.co.jp/products/prod03.html>

- British Petroleum

<http://www.bpsolarex.com/>

- Calculation for Output Power of Solar Cell

<http://www.naturalgoods.com/guide.html>

- Price of Solar Module

http://www.windsun.com/PV_Stuff/pv_pricing.html

- Satellites

PanAmSat Pas4

68.5 degree of East Longitude

<http://www.lyngsat.com/pas4.shtml>

PanAmSat Pas8

166.0 degree of East Longitude

<http://www.lyngsat.com/pas8.shtml>

Thaicom (related URL)

http://www.mpt.go.jp/policyreports/japanese/misc/BS_Manual/status/current_status_4.2.html

http://www.nasda.go.jp/Home/Int_Coop/bangkok/index.html

<http://www.lib.u-ryukyu.ac.jp/biblio/bib31-4/bib31-4-4.htm>

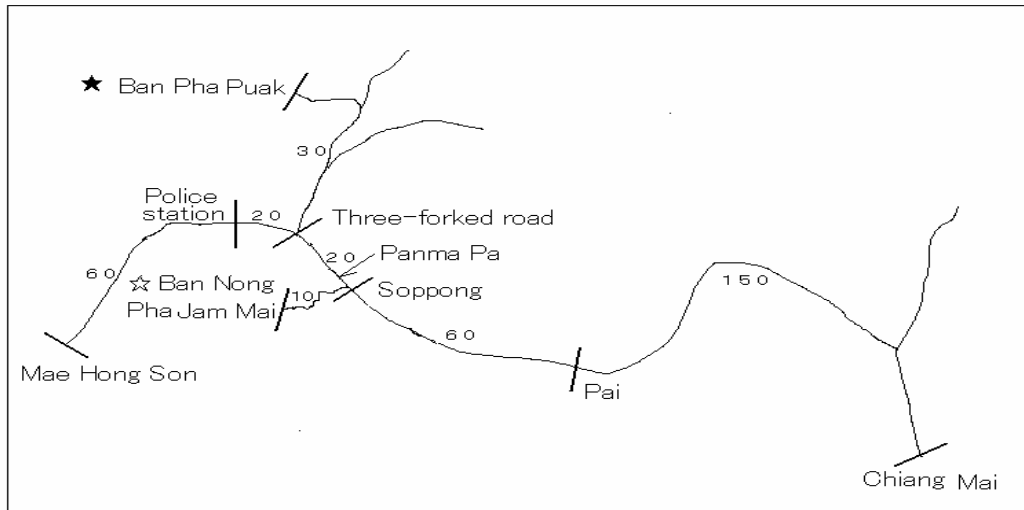


Figure 1 . The access time to the experimental site (figures are travel minutes by car in a dry season). At first planned site(Ban Pha Puak)and finally decided site where the receiving experiment was carried out on March 3 and 4, 2001 (Ban Nong Pha Jam Mai)

Pictures



Picture 1. Ban Nong Pha Jam Mai



Picture 2. Ban Nong Pha Jam Mai



Picture 3. Elementary school (under contraction);
Now this construction is used as a kindergarten
(private communication from Yoshida M.).



Picture 4. Installation of a Ku band antenna



Picture 5. Installation of a C band antenna



Picture 6. Installation of a TV set



Picture 7. Installation of solar modules



Picture 8. Installed charge controller, inverter, and batteries

通信衛星を経由する太陽光発電装置を備えた教育テレビ番組受信システムの開発

- 開発途上国における僻地教育を支援する -

大作 勝(安田女子大学・文学部・人間科学科; 現在、長崎大学アドミッションセンター)
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太陽光発電システムを電源とする、通信衛星を用いた教育用テレビ放送受信システムの設計開発と放送実験について論じた。ビデオテープ上に録画した放送番組を日本から発信し、タイ国のミャンマー国境近くに位置する山岳少数民族集落で受信し、そこに居住する成人ほかに視聴してもらった。番組は「薬草」と「衛生」に関するものである。実験は2001年3月3日、4日の両日、現地時刻18:00~20:00で実施した。放送番組は実験サイトにおいて、極めて高品質で受信できた。放送中の視聴者たちの表情を観察した。放送後、受信サイトの成人と子供に対しテレビ視聴の経験と番組の視聴について簡単なヒアリングを実施した。本研究で用いた受信システムは開発途上国における僻地教育の支援、国際間の教育支援に有効な手段の一つとなりうるであろうと結論した。

キーワード:遠隔教育、放送教育、教育機器開発、テレビ放送受信システム、国際協力、僻地教育