INNOVATIONS

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GHOST CANCELLING

AN ARTICLE BY REJI MATHEWS FOR THE FACTS SPECIALIST GROUP STUDYING GHOST CANCELLING TECHNOLOGY

When viewing television pictures it is often possible to make out faint but shifted versions of the same picture appearing on the screen. These shifted versions of the original television picture are often referred to as ghosts. Ghosting interference can dramatically reduce the quality of a received television picture and in some cases severe ghosting can make television pictures unwatchable.

This paper examines the problem of ghosting and discusses current ghost cancelling technologies that are available for improving television reception. Recent Australian developments in adopting a ghost cancelling system are also discussed.

Figure 1: A ghosted TV picture

But wait there's more! Ghosting gives you one, two, three or more shifted images in the television picture.

GHOSTING

An example of a ghosting situation is illustrated in Figure 1, where a number of unwanted shifted or 'ghosted' images are easily visible in the television picture.

Ghosting is caused by reflections of transmitted signals. Objects such as high-rise buildings or hills can cause reflections of the original transmitted television signal. A television set may receive a direct television signal as well as multiple reflected signals. It is the reception of these reflected signals that cause the 'ghosted' images to be displayed on the screen. An example of a direct signal and an unwanted reflected signal reaching a television antenna is illustrated in Figure 2. Since the direct and reflected signals travel a different path from the transmitting tower to the receive antenna the two signals will arrive at the television receiver at slightly different times. It is this time difference that determines the amount of shift or displacement of the 'ghosted' image from the original wanted image.

The level of picture degradation that ghosting can cause depends on a number of factors, the main ones being the: number of received reflected signals; relative delay of reflected signals in relation to the wanted direct signal; and relative strength of the reflected signals. Weak reflected signals with short time delays may only cause a blurring (and sometimes an enhancement) of the edges of the television picture. High-level reflections with large time delays can cause multiple easily visible 'ghosted' images to appear.

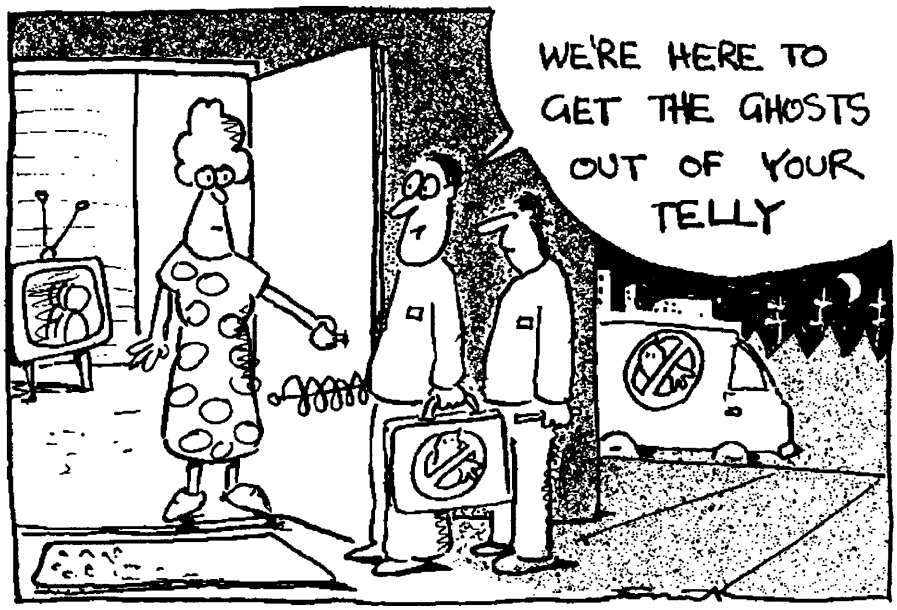
ANTENNA SYSTEMS

Traditional approaches for reducing ghosting interference have been to make appropriate modifications to the receiving television antenna system. This approach however has been shown to have limited success and works best for simple ghosting cases where the 'ghost' signals arrive at the rear of the receiving antenna, where the antenna has the maximum rejection.

GHOST CANCELLING DECODERS

With the advent of digital signal processing and the falling costs of manufacturing electronic chips it is now possible to produce economically viable electronic processors that can cancel or at least reduce ghosting interference. The ghost cancelling decoders process the incoming television signal digitally to rectify ghosted images. Important performance factors of such ghost cancelling decoders are the number and severity of ghosts that can be successfully removed and in an associated processing time.

A number of ghost cancelling techniques using digital signal processing have been investigated by various research institutions. The Japananese Broadcast Technology Association and ▷



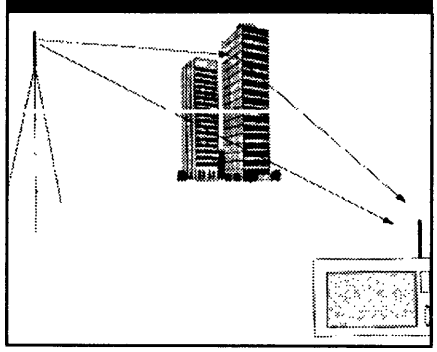
American Philips, Sarnoff and AT&T corporations have carried out major investigations into ghost cancelling technology. Certain organisations in South Korea have also been involved in developing ghost cancelling systems.

Ghost cancelling reference

The basic principles of most proposed ghost cancelling schemes are similar. They involve transmitting a reference signal with the television picture information. This reference signal is often termed a Ghost Cancelling Reference (GCR) signal.

Upon reception of television signals, a ghost cancelling decoder will examine the received GCR signal. If ghosting has occurred the received GCR signal will be quite different in shape to the original GCR signal that was transmitted. For a ghost cancelling system proposed by Philips, the original transmitted GCR signal and an example of a received GCR signal under ghosting conditions are shown in Figures 3 and 4 respectively[1]. To correct any ghosting effects, a ghost cancelling decoder compares the received GCR signal with a stored copy of the original GCR signal. The difference (in both amplitude and time) between the received and the stored original GCR signal provides information on the type of ghosting that has occurred. This information can then be used by the decoder to provide opposite ghosts to cancel the ghosts in the television picture. All comparisons and cancellations are performed in the digital domain.

Figure 2
Direct and reflected signals causing TV picture ghosts



Much of the success of ghost cancelling schemes using GCR signal technology depends on the received GCR signal being able provide a 'signature' of ghosting problems that have occurred.

In May 1993 the US Federal Communications Commission (FCC) approved a standard for the transmission of GCR signals for implementing ghost cancelling technology for television. The adopted system was developed by Philips New York with an engineering team headed by David Koo.

The standard approved by FCC relates to the American NTSC television standard. Australia and certain European and Asian countries use a different television standard called PAL. Philips New York in co-operation with groups from New Zealand and Europe have been working together to adopt the ghost cancelling system for PAL TV standard environments.

Australian developments

A specialist group co-ordinated by the Federation of Australian Commercial Television Stations (FACTS) has been studying developments in ghost cancelling technology. Members of this specialist group include representatives from ABA, ABC, Philips Australia and New York, Sony, Tektronix, Department of Communications and the Arts and commercial television stations Channel 10, Channel 9 and Channel 7.

The FACTS specialist group has completed the evaluation of a ghost cancelling system developed by Philips for PAL television standards. The evaluation process has involved laboratory tests and field trials. Laboratory tests of the proposed system were carried out by the Communications Laboratory of the Department of Communications and the Arts in Canberra. The field trials were carried out for a period of two weeks for certain VHF and UHF television services in Sydney.

The specialist group is also closely monitoring similar field trials of ghost cancelling systems being conducted in England by the Independent Television Commission and in New Zealand by Broadcast Communications Ltd (BCL).

Test results

Laboratory and field tests of the Philips ghost cancelling technology have shown that for the majority of cases a ghost cancelling decoder can improve the received television picture quality.

Although not able to remove all ghosts, the ghost cancelling decoder improved television picture quality even in complicated ghosting environments.[2] Certain pictures made unwatchable by ghosting were able to be improved to at least a low quality watchable picture.

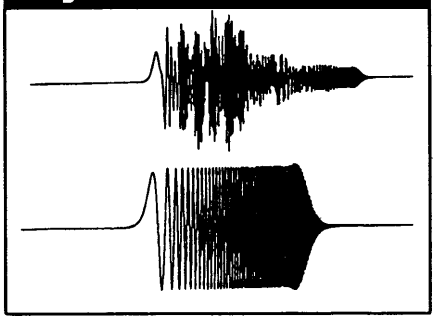
The Sydney field trial also showed that the ghost cancelling system in many cases restored corrupted teletext information.[3] Teletext is especially sensitive to ghosting problems.

The field and laboratory tests were overseen by a Philips engineering team from New York led by David Koo, the chief designer of the system.

Future directions

The GCR signal, as demonstrated by the field trials, can be successfully incorporated into existing television broadcast signals. To reduce ghosting problems tel-

Figure 3 and 4
Ghosted and original GCR signal



evision receivers will need to incorporate a built in ghost cancelling decoder. However, it is most likely that the decoder will take the form of a black box to sit on top of television sets.

Before Australia accepts a standard for ghost cancelling, further field and laboratory tests will need to take place. Australia, through its involvement with the International Telecommunications Union (ITU), is encouraging the formulation of ghost cancelling standards that will incorporate Australian requirements.[3] With success in this forum Australia is well on the way to achieving an Australian standard for ghost cancellation.

Conclusion

Reflected television signals arriving at the television receiver cause ghosting problems and reduce television picture quality.

Recent field and laboratory tests have shown that in many cases received television picture quality can be dramatically improved by using a ghost cancelling scheme.

References

1. C Greenberg, 1993, 'Ghost Cancellation System for the US Standard GCR', *IEEE Transactions on Consumer Electronics*, vol. 39, no. 4, November 1993.
2. Communications Laboratory, *Assessment of the Phillips Prototype Ghost Cancelling Receiver*, August 1994.
3. Australian Input Document to ITU-R WP11C, *Proposed Modification to Recommendation ITU-R BT.1124 on Reference Signals for Ghost Cancelling*, September 1994.

Maintaining French Culture

▷ *p. 15*

tored by way of sample surveys. The assessment of compliance with the content quotas is done by computer. The Conseil also assesses the financial records of broadcasters and issues annual reports on each broadcaster as part of its monitoring role. Monthly reviews of programs and content quotas are also undertaken.

The Conseil can issue formal notices to broadcasters and also has an administrative sanctioning power. The range of sanctions it has includes the:

- power to suspend a licence;
- reduction of the duration of a licence;
- ability to fine a broadcaster; and
- authority to withdraw a licence in the most serious of cases.

In 1989, a broadcaster, found to be in breach of the rules concerning the protection of young people, received a fine of approximately $A1.5 million. The broadcaster showed various violent American movies at 8.30pm.

The Conseil can also require the broadcast of its findings by the broadcaster found to be in breach of the regulations. The Conseil required such a broadcast in relation to the screening of violent scenes in youth programs, specifically US and Japanese cartoons. The Conseil directed that its finding be broadcast at 8pm to coincide with a peak viewing period, just before the evening news.

Broadcasters now have a greater understanding of the objectives of the Conseil's directive and the community's standards as they relate to the portrayal of violence. French broadcasters are now less likely to infringe the Conseil's directive.

French programming laws are more demanding than those of other European countries, especially in terms of quotas, advertising time and the power given to the Conseil to enforce those regulations. Such a regime was the reason why France now has a 'reasonable' proportion of French-produced programs in prime time and a 'great number' of independent producers.

France is nonetheless confronted by problems of financing program production, particularly drama programs, despite established systems of funding and reinvestment for producers.

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