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OPTIMAL LENGTH EXPLORATION FOR FIELD RNG OUTPUTS USING A HAAR WAVELET FILTER: TV AUDIENCE RATINGS FOR NEW YEAR'S 2012 IN JAPAN

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ABSTRACT: The current study examined the optimal period length using wavelet analysis assuming that TV audience ratings are indicators of field intensity that affects field random number generator (RNG) outputs. As TV programs around the New Year often have high ratings, we focused on these programs in 2012 in Japan. Using Psyleron, Rpg102, and Orion as physical RNG devices, the sum of squares of RNG outputs during 288 selected programs were decomposed into multiple levels from periods of 250 ms to 256 s through a Haar wavelet filter. Unexpectedly, the wavelet filter could not find sensitive periods, whereas an ANCOVA suggested that Rpg102 might detect audience rating effects over almost the whole range of wavelengths. Psyleron and Orion devices showed null results. These results suggest that RNG behavior cannot be described by physical signal modeling. There is a possibility of canceling effects in RNG outputs, and this may be a subject for a future study.

Keywords: Psyleron, Rpg102, Orion, Kohaku, TV audience rating

Field random number generator (RNG) studies have found that RNG outputs are significantly biased during periods in which many people focus on the same event at the same time, such as during the 911 terror attacks (Bancel, 2001; Nelson 2001; Nelson, Radin, Shoup, & Bancel, 2002). Devices seem to have the sensitivity to detect field signals even though the audience does not have any intention or knowledge of the existence of the RNG.

The most sensitive time scale or wavelength for RNG outputs during such events remains unclear. At present, 1 s trial generation is the methodological standard in field RNG studies. Bit sequences are generated by an RNG per trial t, creating a bit array (e.g., 0, 1, 0, 0, 1, . . . 0), whereas the sum of the 1 bits (ignoring 0s) is binomially distributed (e.g., 251, 267, 248, . . . 256, when a trial has a total of 512 bits), and the standardized z score for chance expectation is calculated as:

$$z_t = \left(X_t - N\pi\right) / \sqrt{N\pi\left(1-\pi\right)} = (X_t - \mu)/\sigma, \qquad (1)$$

where π is .50, the probability of obtaining a 1, and is the total number of bits per trial generated by the RNG, although trial quantities differ in field RNG studies. If N is large enough, the bit sequence can be converted into a variance measure reflecting the unsigned deviation of the bit sum from chance. The chi square values obtained for one trial t are given as $\chi^2_t = z^2_t$ and cumulative statistics are calculated as:

$$\chi^2_T = \sum_{t=1}^{T} z^2_t, df = T, \qquad (2)$$

where T is the total number of trials based on event length.

Compatible Period-Length Exploration

The method for computing RNG outputs is somewhat arbitrary because a 1 s interval is not necessarily natural for most people. Discovery of an optimal length would be advantageous for future micro-PK studies. Such micro-PK phenomena might not approximate physical modeling, but an assumption that RNGs can detect physical signals as waves would be helpful for understanding the characteristics of RNG behavior. In fact, several findings seem to support the possibility that RNGs have an optimally sensitive time scale, because RNG outputs show a significant autocorrelation during highly focused events such as 911 calls (Bancel, 2001; Nelson et al., 2002; Radin, 2006) or events such as workshops that have many participants (Radin & Atwater, 2009). These positive autocorrelations, or persistence effects, suggest that processing using a longer interval (e.g., 2 or 4 s) would show larger variances for these sequences than for sequences with an interval of 1 s.

For this purpose, in the current study we focused on effects of audience rating, because RNG biases may have positive correlations with audience rating during worldwide events and also during local events, such as sports games (Shimizu & Ishikawa, 2012a) and movies played in theaters (Shimizu & Ishikawa, 2010, 2013). These findings support the hypothesis that repeated events with variable audience ratings can reveal the most sensitive period length for detecting field consciousness. We focused on TV programs as variable audience-size events to examine associations between TV ratings and particular wavelengths (i.e., intervals) as time scales that show biases more clearly.

High variability in TV audience ratings was obtained by using New Year's Eve ratings. Many people in Japan return to their family home just before the New Year to celebrate the event with their family, and many people watch TV programs on New Year's Eve. The TV ratings represent the size of the audience watching the programs. As expected, the highest rated program in 2011 was a music program produced by NHK (a major broadcasting company in Japan) with a rating of more than 40%. Such a high rating is rarely observed throughout the year.

One reason why this optimal wavelength issue has not been widely discussed is the methodology of data processing. We use calculation of a wavelet as a method to decompose a signal wave into multiple levels of energy, which is defined as variance, allowing examination of the duration (length) of the signal from field consciousness. Wavelet transformation can decompose original chi squares from RNG outputs into comparable statistics for periods of different lengths (Shimizu, Kokubo, & Ishikawa, 2013).

Method

TV Ratings

We predicted that higher TV ratings should produce more bias in RNG outputs of an optimal length. We sought the optimal wavelength to detect signals from field consciousness.

Information on TV audience ratings was provided by Video Research Corporation in Japan, covering the Kanto Area from 5:00 a.m. (in Japan) on December 28, 2011 to 5:00 a.m. January 4, 2012; that is, 3 days before and 3 days after New Year's Eve. This period corresponds to December 27, 2011 at 15:00 to January 3, 2012 at 9:00 UTC. Some long programs were divided into subprograms with a short break for a weathercast (Table 1). The TV audience ratings were based on the population of about 30 million people who live in the Kanto area. However, as most TV programs were broadcast on a national network and ratings in other areas were similar to those in the Kanto Area, the TV audience population is estimated at about 120 million nationwide. Seven major broadcasters provided a total of 1,618 programs. Audience TV ratings ranged from 0.0 to 41.6%, and the lengths of the programs ranged from 1 to 388 min.

To identify the higher rated programs, all 1,618 programs were sorted by audience ratings before being registered as events, unless the program's time range overlapped that of a previously registered program. When a higher rated TV program overlapped another program, only the higher rated program was analyzed (Table 1). A total of 228 programs were finally selected. The analyzed week had a total of 9,468 minutes of program time, which accounted for 93.93% of the week (10,080 min = 1,440 min × 7 days).

Table 1
Examples of TV Programs Around New Year's 2012

	Ratings	Start	End	TV	Programs
1	41.6	12/31/2011 21:00	12/31/2011 23:45	NHK	62th Kohaku Music Festival (2nd)
2	35.2	12/31/2011 19:15	12/31/2011 20:55	NHK	62th Kohaku Music Festival (1st)
3	33.6	12/31/2011 20:55	12/31/2011 21:00	NHK	News Weather Bulletin
4	28.5	1/3/2012 07:50	1/3/2012 14:18	NipponTV	The 88th Ekiden Race Backhaul (2nd)
5	27.9	1/2/2012 07:50	1/2/2012 14:05	NipponTV	The 88th Ekiden Race Approach route (2nd)
6	25.4	12/31/2011 23:45	1/1/2012 00:15	NHK	Old year and new year
7	21.0	12/29/2011 19:00	12/29/2011 20:54	NipponTV	Gurunai Final (2nd)
excluded	18.7	12/31/2011 18:30	12/31/2011 21:00	NipponTV	DownTown's Gakitsuka New Year's Eve Special (1st)
8	18.6	12/28/2011 21:00	12/28/2011 23:30	NipponTV	Documentary of Big Family Ishida 2011
9	17.7	1/2/2012 09:00	1/2/2012 23:30	TV Asahi	Tonnels Sports King - 5 hour special (2nd)
228	0.6	12/29/2011 04:25	12/29/2011 04:45	TBS	Kaimono Lab

Note. The time zone is based on Tokyo. Orion device data were analyzed after translation into UTC. One program produced by Nippon TV was excluded because it partly overlapped with a higher rated program (2nd).

Random Number Generation

A total of 11 devices were used as true RNGs (four Psyleron, four Rpg102, and three Orion devices). The Psyleron and Rpg102 devices were connected to four personal computers via a USB port (Acer Aspire One, VAIO Type-G, Type-X, and Dell Dimension 4600). All three Orion devices were registered in the Global Consciousness Project (GCP) and were associated with the following identification numbers: Tokyo (1101), Tsukuba (2201), and Tokorozawa (2202). The four Psyleron, four Rpg102, and one Orion (2201) devices were located within a 1 m circle of the first author's home in Tsukuba before and after the 2012 New Year. They were run continuously in parallel for about one week.

All the RNG devices, except Orion, collected 64 random bits per trial, which consumed 125 ms. Then, they collected random bits at a sampling rate of 512 bits/s. A software application was developed using Visual Studio 2010 to control the Psyleron and Rpg102 devices simultaneously. All the RNG outputs were recorded in a CSV file. GCP RNGs produce more than 8,000 (maximally 16,000) bits/s, and the GCP trials were sums of 200 bits. Data files for Orion were downloaded from the GCP website.

Procedure

The current analysis used two procedures: (a) sum of squares decomposition of the standard deviation of the bit sum from chance expectation into wavelets and (b) regression analysis using audience TV ratings.

Wavelet decomposition. Discrete wavelet transformation is a method to process real data in which the signal is known only at sampling points, with the spacing dependent on the sampling rates of outputs (Capilla, 2006) such as those from a field RNG. We used the Haar filter (Haar, 1910) to decompose the sum of squares of RNG outputs into multiple levels, each level representing a period length. The procedure is described mathematically in the Appendix. Two of the results of these analyses, *dZ* and Stouffer's *Z*, were incorporated in subsequent analyses; *dZ* represents the output variance for each period length. Stouffer's *Z* is a single value representing the output variance for all the period lengths combined.

Note that the lengths of the analyzed events (programs) ranged from 1 to 388 min, resulting in different maximum levels for different programs. The longer periods have fewer degrees of freedom, resulting in a worse approximation to the normal distribution. Thus, sums of squares with $df < 60$ were excluded.

Table 2 shows the number of samples for each RNG in the analysis of the programs.

Table 2
Number of Samples for Each RNG Device Based on the Wavelet Decomposition

	Psyleron		Rpg102		Orion	
	Analyzed	Base	Analyzed	Base	Analyzed	Base
Stouffer's Z	912	912	912	912	684	684
250 ms	912	912	912	912		
500 ms	912	912	912	912		
1 s	912	912				
2 s	908	912	908	912	681	684
4 s	863	912	863	912	647	684
8 s	636	912	636	912	477	684
16 s	408	912	408	912	306	684
32 s	264	912	264	912	198	684
64 s	168	912	168	912	126	684
128 s	92	908	92	908	69	681
256 s	16	876	16	876	12	657
512 s		840		840		630
1024 s		636		636		477
2048 s		408		408		306
4096 s		264		264		198
8192 s		164		164		123
16834 s		88		88		66
32768 s		12		12		9
N	7003	13316	7003	13316	3200	7935

Note. There were a total of 228 TV programs. Four machines were used, giving a simultaneous sample of 912 (2287 x 4) for the Psyleron and Rpg102 devices, and 684 (228 x 3) for the Orion device. Sample sizes are smaller for longer periods because of the short TV program length. Very short programs did not provide any samples for longer periods. Analyzed samples have sufficient *df* (< 60) for calculating the standardized *dZ* scores.

ANCOVA. Using *dZ* values as the dependent variable, we conducted an ANCOVA with fixed factors of Period Length (12 levels) and RNG Type (three levels: Psyleron, Rpg102, and Orion), and Audience Rating (continuous variable, $N = 228$) as a covariate. There also were two interaction terms involving Audience Rating: Period Length x Audience Rating, and RNG Type x Audience Rating. There was no Period Length x RNG Type interaction because the outputs of the Orion device didn't have periods < 1 s. The intercept in the ANCOVA model was excluded because of parameter redundancy. Second, after the ANCOVA model yielded significance, ANCOVAs were conducted for each RNG device separately, including Period Length, Audience Rating, and their interaction. The ANCOVAs were analyzed using JMP 11.0 (SAS Institute).

A significant main effect for Audience Rating would mean that audience size had an influence across all periods. A significant interaction would suggest that the RNGs were more sensitive at some period lengths than at others. A main effect for Period Length would simply reflect bias in the RNGs.

Results

Using 228 TV programs with audience ratings, we tested the hypothesis that peaks would be found for highly sensitive wavelengths, if these exist. There were no undue outliers. Figure 1 shows the Pearson correlations between audience ratings and *dZ*.

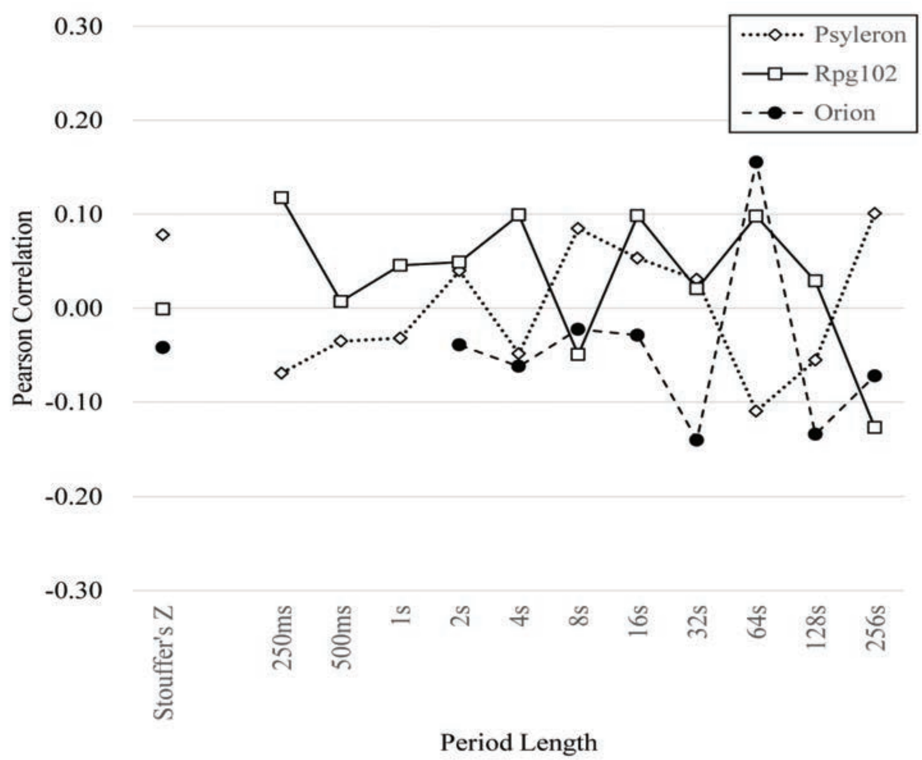

Figure 1. Pearson correlations between audience ratings and *dZ* as a function of period length and RNG type. Stouffer's *Z* has no relation to period length. It is included in the figure because it is a "scale" value needed for application of the Haar filter (see Appendix).

The global ANCOVA yielded a significant main effect for RNG Type, $F(2, 17179) = 4.68$, $p = .0009$, and significant interaction of RNG Type with Audience Rating, $F(2, 17179) = 8.72$, $p = .0002$. Table 3 shows results from three ANCOVAs conducted independently for each RNG. Only the ANCOVA using Rpg102 was significant after adjusting the significance level ($\alpha = .05 / 3$), $F(23,6980) = 2.16$, $p = .001$, permitting us to examine the Rpg102 ANCOVA model in more detail. There was a significant main effect for Audience Rating, $F(1,6980) = 13.62$, $p = .0002$, meaning that the variance (i.e., bias) in the output of the Rpg102 devices was positively correlated with audience size. The main effect for Period Length was nonsignificant, but the interaction between Period Length and Audience Rating was significant, $F(11,6980) = 1.92$, $p = .032$. Although the Psyleron device had a peak period length of 8 s and the ANCOVA gave a small p value, it was not significant. The Orion device results were also nonsignificant.

Table 3
ANCOVA Models and Effects on dZ Values Using Rpg102

1. Models

		SS	*df*	*MS*	*F*	*p*
Psyleron	model	31.6	23	1.37	1.402	.096
	error	6842.1	6980	0.98		
Rpg102	model	48.9	23	2.12	2.164	.001
	error	6851.5	6980	0.98		
Orion	model	23.1	17	1.36	1.390	.131
	error	3112.3	3183	.98		

2. Detailed analysis for Rpg102

	SS	*df*	*MS*	*F*	*p*
Audience Rating	13.35	1	13.36	13.62	.0002
Period Length	6.06	11	.55	.56	.862
AR x Period Length	20.76	11	1.89	1.92	.032
Error		6980			

Discussion

In this study, we examined the optimal wavelength as a time interval for RNG outputs, using information on TV programs and audience ratings around New Year's 2012. Outputs of 11 RNG devices were evaluated using Haar wavelet decomposed sums of squares (chi squares).

We hypothesized that a large audience size would increase the variance of X_t for a particular period length that would be optimal for picking up signals. The results showed that the output from the Rpg102 device might be sensitive enough to detect field consciousness. Audience rating effects were observed, as expected, but no optimal period lengths were identified. The significant results with Rpg102 for most period lengths suggest that RPg102 is sensitive to audience size at all the sampled period lengths, from shortest to longest. This is a characteristic of fractal-shaped waves in bit sequences, as was also reported in a field RNG experiment using music that was listened to repeatedly (Shimizu et al., 2013). It is perhaps worthy of note that there was a marked dropoff of the correlation between audience ratings and *dZ* after 64 s for Rpg102 and the opposite for Psyleron (see Figure 1).

The results also showed device differences in susceptibility to influence by field consciousness. These tendencies have been found in previous reports showing that the Rpg102 device repeatedly shows high sensitivity (Shimizu & Ishikawa, 2010; 2012a, 2012b), whereas Psyleron does not (Shimizu & Ishikawa, 2013). Because these kinds of anomalies are not considered to be influenced by such physical factors, it might appear odd that only a particular RNG, Rpg102 in the current case, showed sensitivity to audience size. We cannot yet conclude that thermal noise, the source of Rpg102 output, was the cause of the sensitivity. Further exploration is needed to determine if this was a unique event or if Rpg102 always has high sensitivity. For this purpose, there is a need to examine the measurement reliability of RNG devices. Good reliability is needed to differentiate individual true (universal) scores from measurement errors. This reliability issue is often discussed in relation to generalizability theory (Cronbach, Gleser, Nanda, & Rajaratnam, 1972).

The results we obtained for wavelets depended on the application of the Haar filter. The current Haar filter is the simplest to use and the best suited for the short period lengths used in this study, but it has relatively low resolution. In contrast, the general filters developed by Daubechies (1992) are better suited for longer lengths, which probably explains their better resolution. Bit generation speed defines the maximum resolution in wavelet analysis, and more bits with a higher resolution can be obtained than was the case in the present study.

It is unlikely that the anomalous RNG behavior we found can be explained exclusively by physical wave modeling in the framework of signal detection, because it appears that the bit stream continues to be generated between trials. This means that the RNG biases were not derived only from wave-like signals, but also from some kind of entanglement of quantum particles.

Cancellation Effects

We had hypothesized that audience size would increase bias in the RNG outputs, but we didn't predict that different RNG devices would have different effects. However, we found that waves coming from one kind of device interfered with waves coming from the other kinds of devices. Thus, as a post hoc test, we evaluated the reliability of the regression coefficients using intraclass correlation (ICC). Excluding the three missing short periods of data for the Orion ($N = 9 = 12 - 3$), the ICC (1, 3) was estimated to be -2.24, $F(8, 18) = 0.31$, $p = .95$, which is significantly low reliability by a one-tailed test, suggesting that the coefficients for these devices canceled each other out for all period lengths. Such low reliability may keep results from being statistically significant in an analysis that combines data from different types of RNGs.

Cancellation effects between devices have been reported for baseball games (Shimizu & Ishikawa, 2012a) and in reliability analyses of control conditions in field RNG experiments (Shimizu & Ishikawa, 2012b). Fundamental "cancellation pressure" could explain large biases in the variance of RNG outputs during events. For instance, if for a given period length an RNG generates the strongly biased bit array 0, 0, 0, 0, 0, . . . 0 following the strongly biased bit array 1, 1, 1, 1, 1, . . . 1, the mean of the bit sequence would be the null expected value of 0, increasing the value of the corresponding chi square. Then, to keep the variance at the null expected value of 1, the RNGs would work cooperatively with one another as well as independently. It is premature to discuss such mechanisms as a new hypothesis, and a future task is to examine the possibilities of such cancellation mechanisms.

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Appendix

A wavelet is a function $\psi(t) \in \boldsymbol{L}^2(\mathbb{R})$, which is the space of square integral functions and t is time, with the following properties:

$$\int_{-\infty}^{\infty} \psi(t)dt = 0, \tag{3}$$

as well as $\|\psi\| = 1$, where $\|.\|$ is the $\boldsymbol{L}^2$ norm. The mother wavelet function $\psi(t) \in \boldsymbol{L}^2(\mathbb{R})$, which is dilated/scaled by a, and translated by b, and denoted by $\psi_{a,b}(t)$, is given as

$$\psi_{a,b}(t) = \frac{1}{\sqrt{a}}\psi\left(\frac{t-b}{a}\right), \tag{4}$$

where a is the scale factor determining the extent the wavelet is stretched or compressed, and b is the extent of the shift with which the wavelet is moved along the time or space scale (Dong & Li, 2008); $1/\sqrt{a}$ is the normalization factor. The continuous wavelet transform (CWT) of a function
$f(t) \in \boldsymbol{L}^2(\mathbb{R})$ is given as

$$W_{\psi}f(a,b) = \int_{-\infty}^{\infty} \frac{1}{\sqrt{a}} \overline{\psi\left(\frac{t-b}{a}\right)} f(t)dt \tag{5}$$

where the ψ term represents the complex conjugate (Daubechies, 1992).

To analyze these one dimensional outputs we again assume that time series X_t is the sum of the 1 (not 0) bits in trial t (e.g., 38, 27, 36, 35, 29, 27, . . . 34 when a trial has a total of 64 bits generated), and its standardized score (z_t), where $t = 1, 2, \ldots T$, with $T = 2^L$ = the number of trials with some positive integer. Wavelet transforms are defined under the restriction that $a = 2^j$ and $b = ak$ ($j, k \in \mathbb{Z}$), where k is the index ranging from 1 to $T / 2^j$ (the number of trials within a level j), and j is the scale parameter or transform level ranging from 1 to L ($1 \leq j \leq L$).

The Haar filter decomposes a sequence of length 2^L (raw sequence) into coefficients of *details* (information as differences between outputs at a given level) and *scales* (information as averages, approximations of the level outputs), as shown below. The mother wavelet of the Haar filter is expressed simply as

$$\psi(t) = \begin{cases} 1 & 0 \leq t < 0.5, \\ -1 & 0.5 \leq t < 1, \\ 0 & \text{otherwise.} \end{cases} \tag{6}$$

Then, the computation of the wavelet (or detail) coefficients using the Haar basis is performed from the scaling coefficients c_j at scale level

$$d_{j+1,k} = \frac{1}{\sqrt{2}}\left(c_{j,2k-1} - c_{j,2k}\right). \tag{7}$$

This means that a detail coefficient consists of the difference between two neighbor scales. The value is the deviation and its sums of squares becomes the wavelet variance.

On the other hand, its father wavelet or scaling function is defined as

$$\phi(t) = \begin{cases} 1 & 0 \leq t < 1, \\ 0 & \text{otherwise.} \end{cases} \tag{8}$$

The purpose of the scaling is to approximate the sequences. Note that scaling (approximation) coefficients can be expressed

$$c_{j+1,k} = \frac{1}{\sqrt{2}}\left(c_{j,2k-1} + c_{j,2k}\right) \tag{9}$$

Because these scales become the inputs at the next level, the Haar filter process allows recursive calculation of the "differences" and "sums" of the scale coefficients.

Therefore, this analysis can break down original sequences into scale levels from 1 to L, creating 2^L - 1 detail coefficients and one approximation.

These structures become very simple when it is assumed that all original time series (X_t) are standardized (z_t) from RNG outputs. Both wavelets and scaling coefficients become standardized, that is, Equation (8) and Equation (10) standardize values in the same way.

The original sequences are available when $j = 0$ and $a = 2^j$, whereas the coarsest scale $c_{l,k}$ corresponds to a single data point $c_{L,1}$, representing the signal average, which is

$$c_{L,1} = \frac{1}{\sqrt{2}}\left(c_{L-1,1} + c_{L-1,2}\right) = \frac{1}{\sqrt{4}}\left(c_{L-2,1} + c_{L-2,2} + c_{L-2,3} + c_{L-2,4}\right) = \cdots = \frac{1}{\sqrt{2^L}}\left(c_{0,1} + c_{0,2} + \cdots + c_{0,T}\right) = \frac{1}{\sqrt{T}}\sum_{t=1}^{T} c_{0,t,} \tag{10}$$

showing that the final approximation value is actually equal to Stouffer's Z, which is

$$\text{Stouffer's } Z = \frac{1}{\sqrt{T}}\sum_{t=1}^{T} z_t \tag{11}$$

suggesting that using Haar wavelets fits well with previous RNG methodology.

According to Percival (1995), the energy preservation characteristic of the wavelet transform can be expressed in discrete cases as

$$\sum_{t=1}^{T} f(t)^2 = \sum_{j=1}^{L}\sum_{k=1}^{T/2^j} d_{j,k}^2 \tag{12}$$

suggesting that the sum of squared wavelet coefficients over scales provides an orthogonal decomposition of the total sample sum of squares. The energy contained in scale j can be computed from the wavelet coefficient as

$$\sum_{k=1}^{T/2^j} d_{j,k}^2 \tag{13}$$

Energies at different levels are theoretically independent of one another.

Note that whole energy defined by the above equation is based on the sample mean:

$$\bar{c}_0 = \sum c_0/T\,,\ \sum_{j=1}^{L}\sum_{k=1}^{T/2^j} d_{j,k}^2 = \sum_{k=1}^{T}\left(c_{0,k} - \bar{c}_0\right)^2 \tag{14}$$

whereas field RNG studies usually compute sum of squares from expectation $\mu = 0$, as

$$\sum_{k=1}^{T}\left(c_{0,k} - \mu\right)^2 = \sum_{k=1}^{T} c_{0,k}^2 \tag{15}$$

Then, the decomposition is given as

$$\sum_{k=1}^{T} c_{0,k}^2 = \sum_{k=1}^{T/2^j} d_{j,k}^2 + c_{L,1}^2 = \sum_{k=1}^{T/2^j} d_{j,k}^2 + \text{Stouffer's } Z^2 \tag{16}$$

Zero Padding

One unsolved issue is the restriction of event lengths, because the wavelet decomposition (Shimizu et al., 2013) assumes a dyadic time series with sample size $T = 2^L$, where L is a positive integer. To moderate it, we used zero padding (Shimizu & Ishikawa, 2014). Suppose that we have an original time series of length T, and a minimum positive integer L, which fulfills $T \leq 2^L$, where all the points in which the number is more than T are filled with 0 values. The degrees of freedom (df) of the wavelet variance correspond to the number of coefficients, defined as

$$df_{0,k} = \begin{cases} 1 & k \leq T \\ 0 & k > T, \end{cases} \tag{17}$$

At level $j = 0$ (original); df at the next level, $j + 1$, then becomes

$$df_{j+1,k} = \left(df_{j,2k-1} + df_{j,2k}\right)/2 \tag{18}$$

As an example, assume an original data set with the values 1.0, 2.0, 3.0, 4.0, and 5.0 ($T = 5$). The corresponding zero padded values are 1.0, 2.0, 3.0, 4.0, 5.0, 0.0, 0.0, and 0.0 ($T = 8$, $L = 3$). For the next level, $df_{1,k}$ = 1.0, 1.0, 0.5, and 0.0 ($T / 2 = 4$), next level $df_{2,k}$ = 1.0, 0.25 ($T / 4 = 2$), and finally $df_{3,1}$= 0.625 ($T/8 = 1$). The sum of squares for all the levels are calculated as

$$SS_j = \sum d_{j,k}^2 \tag{19}$$

And standardized as

$$dZ_j = \sqrt{2 \times \sum d_{jk}^2} - \sqrt{2df_j - 1} \tag{20}$$

Abstracts in Other Languages

Spanish

EXPLORACIÓN LONGITUDINAL ÓPTIMA PARA PRODUCTOS DE RNG DE CAMPO UTILIZANDO UN FILTRO WAVELET HAAR: ÍNDICES DE AUDIENCIA DE TELEVISIÓN PARA EL AÑO NUEVO 2012 EN JAPÓN

RESUMEN: Este estudio examinó la duración óptima de longitud de periodo usando un análisis wavelet suponiendo que los índices de audiencia de televisión son indicadores de la intensidad de campo que afecta al producto de un generador de números aleatorios de campo (RNG). Ya que los programas de televisión de Año Nuevo a menudo tienen altos índices de audiencia, nos centramos en estos programas en 2012 en Japón. Usando Psyleron, Rpg102, y Orión como dispositivos RNG físicos, la suma de los cuadrados de los resultados de RNG durante 288 programas seleccionados fueron descompuestos en múltiples niveles de periodos de 250 ms a 256 s a través de un filtro de wavelets Haar. Inesperadamente, el filtro de wavelets no pudo encontrar períodos sensibles, mientras que un ANCOVA sugirió que el Rpg102 pudo detectar los efectos de la audiencia en casi toda la gama de longitudes de onda. Los dispositivos Psyleron y Orion mostraron resultados nulos. Estos resultados sugieren que el comportamiento RNG no puede ser descrito como modelamiento de la señal física. Hay la posibilidad de efectos de cancelación en resultados RNG, lo que puede ser un tema para un estudio futuro.

French

EXPLORATION DE LA LONGUEUR OPTIMALE DES DONNÉES SORTANTES POUR DES GNA DE CHAMP EN UTILISANT UN FILTRE D'ONDELETTE DE HAAR : LES TAUX D'AUDIENCE TÉLÉVISUELLE POUR LE NOUVEL AN 2012 AU JAPON

RÉSUMÉ : La présente étude examine la longueur de la période optimale en utilisant l'analyse par ondelette en faisant l'hypothèse que les taux d'audience télévisuelle sont des indicateurs de l'intensité du champ qui affecte les données sortantes d'un générateur de champ aléatoire de champ (GNA). Comme les programmes télé autour du Nouvel an engrangent souvent des audiences élevées, nous nous sommes focalisés sur ces programmes en 2012 au Japon. En employant un Psyléron, un Rpg102, et un Orion en tant que dispositifs GNA, la somme des carrés des données GNA durant les 288 programmes sélectionnés fut décomposée en de multiples niveaux pour des périodes de 250 ms à 256 s, à travers un filtre d'ondelette de Haar. De façon inattendue, le filtre à ondelette ne parvint pas à trouver des périodes sensibles, tandis qu'une ANCOVA a suggéré que le Rpg102 pourrait avoir détecté des effets de taux d'audience sur presque toute la gamme des longueurs d'onde. Les dispositifs Psyléron et Orion montrèrent des résultats nuls. Ces résultats suggèrent que le comportement du GNA ne peut pas être décrit par une modélisation en signal physique. Il y a une possibilité d'effets d'annulation dans les données GNA, et cela pourrait être le sujet d'une étude future.

German

DIE VERWENDUNG EINES HAAR-WAVELET-FILTERS: DIE EINSCHALTQUOTEN JAPANISCHER FERNSEHZUSCHAUER FUER DAS NEUE JAHR 2012

ZUSAMMENFASSUNG: Die vorliegende Studie untersuchte mit Hilfe einer Wavelet-Analyse die optimale Periodenlänge unter der Annahme, dass TV-Einschaltquoten Indikatoren für die Intensität eines Feldes sind, das sich auf den Output tragbarer Zufallszahlengeneratoren (RNG) auswirkt. Da TV-Programme zum Jahreswechsel oft hohe Einschaltquoten haben, haben wir uns 2012 auf diese japanischen Programme konzentriert. Unter Verwendung von Psyleron, Rpg102 und Orion als physikalische RNG-Geräte wurden die Quadratsummen der RNG-Daten während 288 ausgewählter Programme in mehreren Stufen in Perioden von 250 ms bis 256 sec mittels eines Haar-Wavelet-Filters zerlegt. Wider Erwarten konnte der Wavelet-Filter keine sensitiven Perioden entdecken, wohingegen eine ANCOVA anzeigte, dass der Rpg 102 Effekte bei Publikums-Einschaltquoten praktisch über das gesamte Spektrum der Wellenlängen hinweg entdeckt haben könnte. Psyleron und Orion zeigten keine Resultate. Diese Ergebnisse deuten darauf hin, dass sich das RNG-Verhalten nicht mittels physikalischer Signalmodellierung beschreiben lässt. Es besteht die Möglichkeit auslöschender Effekte bei RNG-Outputs, und dies könnte Gegenstand einer zukünftigen Studie sein.