Some constructions of truncated Gold codes for GNSS

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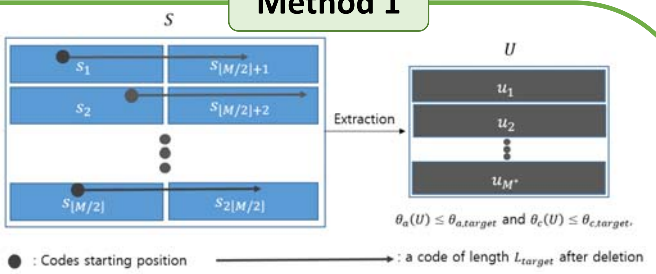
Introduction

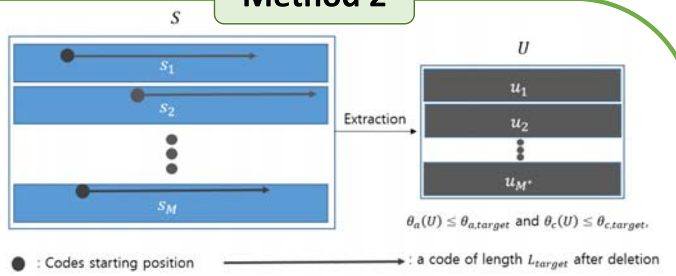
- GNSS systems usually use the spreading codes of length 10,230.
- Those Spreading codes are generated from the mother codes whose maximum correlation values are optimal or sub-optimal such as gold, kasami, weil codes.
- Those mother codes' lengths are not equal to 10,230. In gold code case, possible lengths are far from 10,230.
- We propose some truncated gold code families of length 10,230 to minimize non-trivial correlation maximum.
- Proposed truncated gold codes performance far surpass current GNSS truncated gold codes'

Method 1



- **Step1.** Using $2\lfloor M/2 \rfloor$ codes without overlapping in S, randomly make $\lfloor M/2 \rfloor$ pairs and connect two codes in each pair to make one code.
- **Step2.** From $2\lfloor M/2 \rfloor$ codes generated by **Step 1**, randomly set the starting point of each code and cut it to length L_{target}. From this step, we get $\lfloor M/2 \rfloor$ codes of period L_{target}.
- **Step3.** Among the $\lfloor M/2 \rfloor$ codes from **Step2**, choose M^* codes such that all non-zero phase even/odd correlations are bounded by $[-\theta_{a,target}, \theta_{a,target}]$ and $[-\hat{\theta}_{a,target}, \hat{\theta}_{a,target}]$, repectively. If the number of such codes is smaller than M^*, reset $\theta_{a,target}$ and $\hat{\theta}_{a,target}$ to larger values than now and go to **Step1**.
- **Step4.** Let U be the family of M^* codes generated by **Step3**, And then, calculate $\theta_a(U)$, $\hat{\theta}_a(U), \theta_c(U)$ and $\hat{\theta}_c(U)$.
- **Step5.** Repeat **Step1-4** N times, and determine spreading code family U which has minimum $\max\{\theta_c(U), \hat{\theta}_c(U)\}$ among N code families.

Method 2



- **Step1.** From M codes in S, randomly set randomly set the starting point of each code and cut it to length L_{target}. From this step, we get M codes of period L_{target}.
- **Step2.** Among the M codes from **Step1**, choose M^* codes such that all non-zero phase even/odd correlations are bounded by $[-\theta_{a,target}, \theta_{a,target}]$ and $[-\hat{\theta}_{a,target}, \hat{\theta}_{a,target}]$, repectively. If the number of such codes is smaller than M^*, reset $\theta_{a,target}$ and $\hat{\theta}_{a,target}$ to larger values than now and go to **Step1**.
- **Step3.** Let U be the family of M^* codes generated by **Step2**, And then, calculate $\theta_a(U)$, $\hat{\theta}_a(U), \theta_c(U)$ and $\hat{\theta}_c(U)$.
- **Step4.** Repeat **Step1-3** N times, then determine spreading code family U which has minimum $\max\{\theta_c(U), \hat{\theta}_c(U)\}$ among N code families.

$\theta_a(U)$, $\hat{\theta}_a(U)$: nontrivial even/odd autocorrelation maximum

$\theta_c(U)$, $\hat{\theta}_c(U)$.: even/odd cross correlation maximum

Results

Name	Period	Family size	$\theta_a(U)$ (dB)	$\hat{\theta}_a(U)$ (dB)	$\theta_c(U)$ (dB)	$\hat{\theta}_c(U)$ (dB)
GPS L5 data	10,230	74	-29.02	-26.86	-26.35	-25.32
GPS L5 pilot		420	-28.55	-26.21	-26.35	-25.20
Galileo E5a		100	-28.55	-28.64	-25.67	-25.87
Galileo E5b		100	-28.74	-28.51	-25.20	-25.04
Method1		100	-29.42	-29.42	-27.17	-26.83
Method2		100	29.32	-29.27	-26.50	-26.35

- **Mother code:** gold codes of length 16,383(for Method1), 8,192(for Method2)
- **Target period:** 10,230, which is usually used in GNSS systems.