

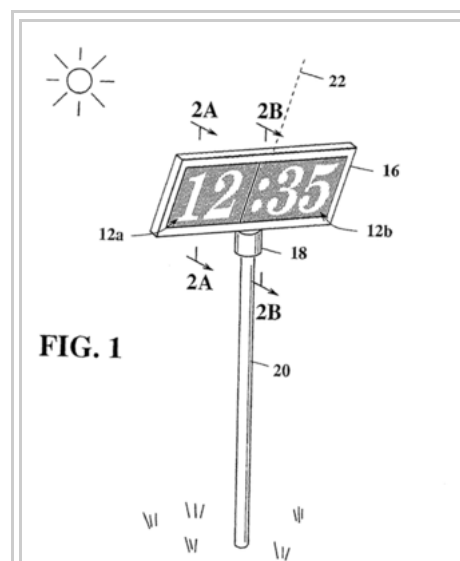
Digital sundial

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A **digital sundial** is a clock that indicates the current time with numerals formed by the sunlight striking it. Like a classical sundial, the device is purely passive and contains no moving parts. It uses no electricity nor other manufactured sources of energy. The digital display changes as the sun advances in its daily course.

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A patent illustration of a fractal digital sundial.

Technique

There are two basic types of digital sundials. One construction uses optical waveguides, while the other is inspired by fractal geometry.

Optical fiber sundial

Sunlight enters into the device through a slit and moves as the sun advances. The sun's rays shine on ten linearly distributed sockets of optical waveguides that transport the light to a seven-segment display. Each socket fiber is connected to a few segments forming the digit corresponding to the position of the sun.^[1]

Fractal sundial

The theoretical basis for the other construction comes from fractal geometry.^[2] For the sake of simplicity we describe a two-dimensional (planar) version. Let L_θ denote a straight line passing through the origin of a Cartesian coordinate system and making angle $\theta \in [0, \pi)$ with the x -axis. For any $F \subset \mathbb{R}^2$ define $\text{proj}_\theta F$ to be the perpendicular projection of F on the line L_θ .

Theorem

Let $G_\theta \subset L_\theta$, $\theta \in [0, \pi)$ be a family of any sets such that $\bigcup_\theta G_\theta$ is a measurable set in the plane. Then there exists a set $F \subset \mathbb{R}^2$ such that

- $G_\theta \subset \text{proj}_\theta F$;
- the measure of the set $\text{proj}_\theta F \setminus G_\theta$ is zero for almost all $\theta \in [0, \pi)$.

There exists a set with prescribed projections in *almost* all directions. This theorem can be generalized to three-dimensional space. For a non-trivial choice of the family G_θ , the set F described above is a fractal.

Application

Theoretically, it is possible to build a set of masks that produce shadows in the form of digits, such that the display changes as the sun moves. This is the fractal sundial.

The theorem was proved in 1987 by Kenneth Falconer. Four years later it was described in *Scientific American* by Ian Stewart.^[3] The first prototype of the device was constructed in 1994. In 1998 for the first time a fractal sundial was installed in a public place (Genk, Belgium).^[4] There exist window and tabletop versions as well.^[5] Jullozzer in Oct, 2015 published an Open Source 3d printed model sundial.^[6]

References

1. US patent belongs to HinesLab Inc. (USA) (<http://www.hineslab.com/digital-sundial/>)
2. Falconer, Kenneth (2003). *Fractal Geometry: Mathematical Foundations and Applications*. John Wiley & Sons, Ltd. xxv. ISBN 0-470-84862-6.
3. Ian Stewart, *Scientific American*, 1991, pages 104-106, *Mathematical Recreations -- What in heaven is a digital sundial?*.
4. Sundial park in Genk, Belgium (<http://www.fransmaes.nl/genk/welcome-e.htm>)
5. US and German patent belongs to Digital Sundials International (<http://www.digitalsundial.com/patent.html>)
6. Mojoptix 001: Digital Sundial (<http://www.mojoptix.com/2015/10/25/mojoptix-001-digital-sundial/>)

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Categories: Sundials



This sundial by *Digital sundials international* uses just two masks and a plexiglas layer.

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