

A new Decimal System for the Unit of Time Measurement

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Abstract

Till today time is measured in duodecimal and sexagesimal units, whereas all other modern measurements like length, weight, volume etc are made in decimal units. For ease of calculation, decimal system is considered to be better. In history, there were a few attempts to convert time measurement in decimal system, but they could not succeed. Here a proposal is made to convert time measurement in a new decimal system.

1. Introduction

Decimal system is mostly used today for measurement of various physical parameters like length, weight, volume etc. This system was developed because it made easy for ancient people to count using their fingers. Ancient civilisations, however used different systems, particularly duodecimal of base 12 and sexagesimal of base 60 for dividing the day time into smaller parts.

Egyptians [1] divided the time between sunrise and sunset into 12 parts. This reflected their use of duodecimal system. The number 12 might have been used because there are 12 finger joints in each hand excluding the thumb making it possible to count to 12 with the thumb.

Greek civilisation [2] used the sexagesimal system of base 60 for astronomical calculations. They have inherited it from Babylonians, who developed it during 2000 B.C. Most probably the number 60 was considered, because it is convenient for expressing fractions, since 60 is the number divisible by first six numbers 1 to 6 as well as by 10, 12, 15, 20 and 30.

Sexagesimal system is used till today to measure angles, geographical coordinates and time, but for other measurements it is no longer used. Greek astronomers devised a system of

longitude lines that covered 360 degrees from north to south and from pole to pole. Each 360 degrees circle was subdivided into smaller segments. Each degree was subdivided into 60 segments which was further subdivided into 60 smaller parts. The first division became known as 'minute' and the second partition became known as 'second'.

Ancient civilisations used the similar concept for the division of time as a day of 24 hours, an hour of 60 minutes and a minute of 60 seconds. The same system is followed in modern time. As the science of timekeeping progressed, the definitions of these units have changed with time. With the International System of Units (SI), second was defined as a fraction of the mean solar day consisting of 86400 seconds (24 hour x 60 minutes x 60 seconds). This is also known as ephemeris second. This definition of the duration of the second as the 86400th part of the mean solar day was arbitrary. There has never been a formal definition of the second as a binding measure of time in the sense of the International System of Units (SI). The mean solar time related to the zero meridian is referred to as *Universal Time (UT)*, and the original name is still popular today as *Greenwich Mean Time (GMT)*.

Later on the definition of second was technically redefined in 1967 as the duration of 9192631770 periods of the radiation corresponding to the energy transition between the two hyperfine levels of the ground state of the Caesium (¹³³Cs) atom [3]. In 1997, this definition was made more specific with the stipulation that this refers to a Caesium atom at rest at a temperature of 0° K. This specification is followed in the era of atomic timekeeping and is called *Coordinated Universal Time (UTC)*. This ensured that the duration of the new second was close that of the ephemeris second.

The measurement of time is unique in SI in the sense that while the second is the base unit, and measurements of time smaller than a second use prefixed units smaller than a second (e.g. microsecond, nanosecond, etc.), measurements larger than a second instead use traditional divisions, including the sexagesimal based minute and hour as well as the less regular day and year units.

There have been a few proposals for use of decimal time system most of which were based on the day as the base unit, such that the number of units between any two events that happen at the same time of day would be equal to the number of days between them multiplied by some integer power of ten. In dynastic China, the 'ke' was a unit that represented $\frac{1}{100}$ of a day (it has since been refined to $\frac{1}{96}$ of a day, or 15 minutes). In France, a decimal time system in place from 1793 to 1805 divided the day into 10 hours, each divided into 100 minutes, in turn each divided into 100 seconds. The French Republican Calendar further extended this by assembling days into ten-day "weeks".

SI allows for the use of larger prefixed units based on the second, a system known as metric time but this is seldom used, since the number of seconds in a day (86,400) negate one of the metric system's primary advantages, such as easy conversion by multiplying or dividing by powers of ten.

Here one new decimal time system is proposed which can be used as a metric system by using some different units. This may help in making time calculation easy using decimal system.

2. Proposed new decimal system for time measurement

The proposed new basic unit of time is Nimesa, instead of Second. The term Nimesa [4] has been used as an unit of time in Sanskrit language in ancient India, but it had a different meaning than the current proposed definition. The definition of Nimesa here is as follows.

One Nimesa is defined as (1/100000) of the duration of mean solar day.

By this definition, one Nimesa will be equivalent to 0.864 ephemeris seconds. So it will be slightly less than standard ‘Second’ unit. In terms of the other specific definition of second, Nimesa can also be defined as 7942433850 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of ¹³³Cs atom. On the basis of this basic definition of Nimesa, higher order units are proposed as follows.

1 Pal = 10 Nimesas (8.64 s)

1 Muhurt = 10 Pals (86.4 s or 1 min 26.4 s)

1 Ghadi = 10 Muhurts (864 s or 14 min 24s)

1 Prahar = 10 Ghadis (8640 s or 2 hr 24 min)

1 Diwas = 10 Prahars (86400 s or 1 day)

Many of the above proposed units like Muhurt and Prahar were also used in ancient India [4], but they had different values than the currently proposed values.

3. Discussion

On the basis of this new proposed system various universal constants have to be changed accordingly. For example, the speed of light in vacuum will be 259020683.712 m/Nimesa. As people are already habituated with the sexagecimal system, it will be difficult initially to change to new system, but the new decimal system will be easy for calculation purpose. The inverse conversion will be approximately as follows.

1 second ~ 1.157 nimesa

1 minute ~ 6.942 pal

1 hour ~ 0.41652 prahar

Some of the new proposed units are similar to some unusual units of time used in history. For example, the term ‘moment’ has been used as a mediaval unit of time. The duration of a moment in modern seconds was not fixed, but on average, a moment considered to be approximately 90 seconds. Here ‘muhurt’ is equal to 86.4 seconds, which is close to a ‘moment’.

In the middle ages, one of the simplest device to keep time was an Indian water-clock called a ghurry. It comprised a large metal or wooden bowl, pierced with several holes, which would be placed in a basin full of water, and as the water poured into the bowl through the holes in its sides, it would slowly sink to the bottom of the tank. The entire process from start to finish took a fixed amount of time, which was usually precisely 24 minutes. Ultimately, there were once considered to be 60 ghurries in a day. In the present proposal, one ghadi is 14 minutes and 24 seconds. KerMetric time is a concept that divides the day into 100 equal parts called Kermits. Each Kermit is equivalent to 14.4 minutes. This is similar to ghadi in the present proposal.

According to the present proposal, there are 10 prahars in a day and 5 prahars from midnight to noon. So, if a clock has to be designed in this decimal system, it will look like in Fig.1.

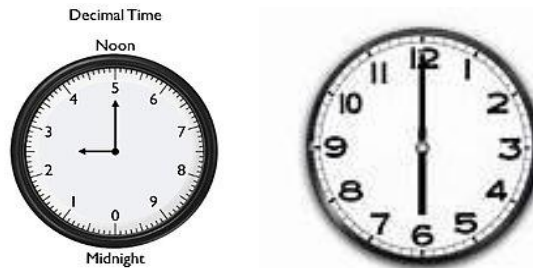


Figure.1 Decimal Time clock reading 2.50 Prahars (left) corresponds to 6 AM (right) [3]

The above decimal clock is showing only 2 arms representing prahar (small) and ghadi (large) units. The new decimal clock may have 3 or 4 arms depending on the scale of measurements. A 24 hours clock may be represented as a 10 prahars clock like in Fig.2.



Figure.2 Decimal clock with 10 prahars in a day (24 hours)

Now let us look into a time sequence data which has to be plotted in a graph in the new proposed system. Here a sample data set of temperature measured at 10 minutes interval by some Automatic Weather Station (AWS) is considered. If the data set is plotted in the modern standard system, it will look like in Fig.3.

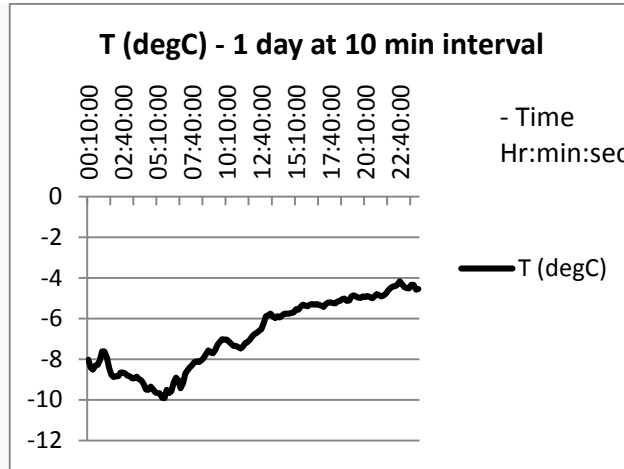


Figure.3 One day sample AWS data of temperature with 10 min interval

If the same data set is plotted in new proposed system, it will look like in Fig.4.

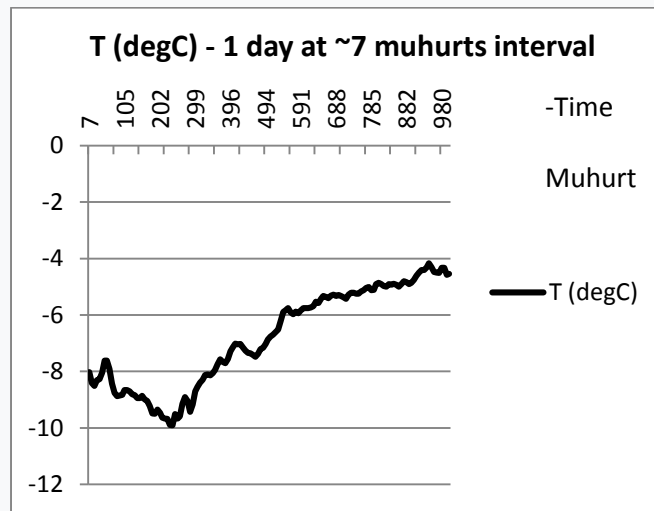


Figure.4 One day sample AWS data of temperature plotted in decimal system

If in future, the new decimal system is adopted, the measurements by AWS can be made at 10 muhurt interval and then the line plot will look like in Fig.5.

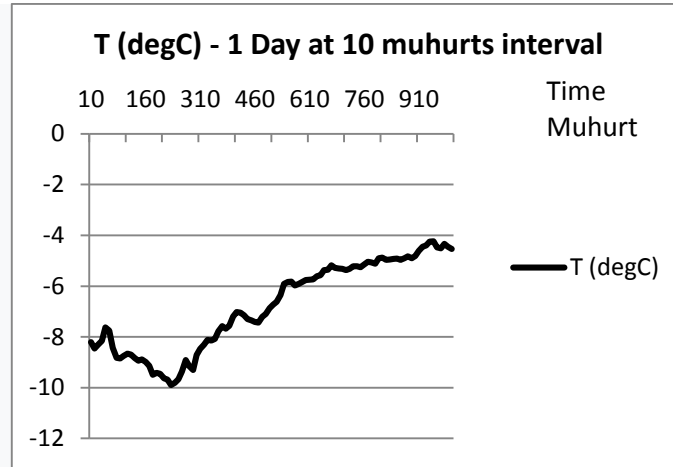


Figure.5 One day sample AWS data of temperature measured in decimal system

It may be noted that the time axis in the new proposed system will be 1000 muhurts for one day.

Initially all measurements in current standard system have to be converted to new proposed decimal system, but later on the measurements can be made directly in the new proposed decimal system.

4. Conclusion

A new decimal system for the unit of time measurement has been proposed for ease of calculation in decimal system. In modern day many other measurement units have been already converted to metric system. For example, it took a long time to change fps system to cgs system. Similarly, there were a few attempts to change the time measurement system to metric system, but it has not succeeded. Here is one more attempt is made with new definitions of the unit of time measurement. Actually there is no strict or robust definition of time, so this new definition will change the system to metric system. Once the decimal system of time measurement is adopted, then the measurements can be made directly in the currently proposed decimal system.

5. References

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- [2] History of the Hour. Gerhard Dohrn-van Rossum. University of Chicago Press, 1996.
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- [4] The Units of Time in Ancient and Mediaval India, Takao Hayashi, History of Science in South Asia, 51, 2017, p.1-116