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Research Article

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Sports Field Simulation and Plotting - Use of The Innovative Tool Total Station

Tara Singh Thakur[1], Hazarath, K[2], Ibrahim Syed[3]*

[1]Physical Education Department, Anurag Group of Institutions, Venkatapur (V), Ghatkesar (M), Medchal Dist. Hyderabad, Telangana-500088, India.

[2]Civil Engineering, Anurag Group of Institutions, Venkatapur (V), Ghatkesar (M), Medchal Dist. Hyderabad, Telangana-500088, India.

[3]Prof. Department of Physical Education, King Fahd University of Petroleum & Minerals, Dhahran 34463, Saudi Arabia.

**Corresponding Author Email: sibrahim @ kfupm.edu .sa*

ABSTRACT

The main objective of this study was to examine the use of a new and innovative tool called electromagnetic total station in marking some sports fields and comparing it with the manual markings with time as measuring factor. For the study, the samples taken were 5 different sports fields and a total station consisting of a theodolite with a built-in distance meter to measure angles and distances at the same time were used. Initially the five fields were marked using manual method of measuring tape (M) and the time spent in marking each court was noted down. Later, the Total Station (TS) was used in the same field to mark the above 5 mentioned courts and the time was noted. Further, the third method used to measure was a combination of total station and measuring tape(C). The data obtained was analyzed using SPSS version 21 and ANOVA was computed through LSD method. The results indicated that there exists a significant difference in using M method and C method of plotting ($p = 0.02$) at 0.05. But no significant difference exists in other two cases of comparing M method with TS ($p = 0.294$) or TS with C method ($p = 0.186$). It is concluded that when the total station is available, its usage in combination with measuring tape will help in faster and accurate sports field plotting.

Key Words*: Field Marking, Total Station, Surveying.*

INTRODUCTION

Inter-disciplinary studies in sports and physical education are extremely basic and yet it remains unfocused. Engineering is a monster which is driving today's reality and has its contributions in every aspect of sports and physical education. This field has been contributing immensely in various ways including sports goods manufacturing, sports uniform, plotting and marking of sports fields. The application of Civil Engineering equipment in Sports Field Marking has taken its centre stage in the present day scenario. Total Station is a device which joins Electromagnetic Distance Measuring Instrument and Electronic Theodolite (pivoting telescope for assessing horizontal and vertical angles). Likewise, it is coordinated with Microprocessor, Electronic information gatherer and Storage framework. The gadget can be utilized to gauge horizontal and vertical angles as well as sloping expanse of item to the device.

Electronic equipment and field robotics go hand in hand and have confirmed consistency in several diverse expanses like recuperation and operation [8], endoscopic surgery [20], in health management [2], management and assemblage in cosmos and in engineering [18], subaquatic, building, and service atmospheres [25], in cultivation [17, 1], portable

cow milking [15], jungle fire observing [5], and in dangerous environs like soldering [10, 11] and in nuclear-powered business [3].

Innumerable management machineries, containing automatic regulation, photosensitive direction, radio course-plotting and ultrasonic control have been intensely explored [13, 21]. Extraordinary precision regulation schemes on global positioning systems (GPS) and real-time kinematic (RTK) have been established and probed [19, 12]. A novel peer group of paraphernalia centred on lesser, entirely independent technology is established [16]. The key successes of the said stages fall in the decline of soil compaction and power depletion. The main aim will be to improve minor, fewer insensitive, focussed [17] and collaborating self-directed portable electronic equipment & robots proficient in operating through a day, in peak climate and in tough soil environments [7]. To yield benefit of these certainties, the systems should be accurate to perform at reasonably great swiftness (from 1 to 5 m/s). Several tracing regulator algorithms are prepared prominently to monitor tracing faults [4, 22]. New observations validate that notwithstanding descending phenomena, the electronic equipment is capable to spontaneously and precisely accomplish an anticipated pass, with adjacent and angular faults, respectively, within ±10 cm and ±2 degree, whatsoever its form and whatever the topography or surroundings [4]. In uniform ground like football playing fields and other sports fields and courts, improved line tracing exactitudes can be effortlessly attained.

Through this study, examination has been made to calculate the time taken for marking 5 distinct sports fields which are: 1. Badminton Court, 2. Basketball Court, 3. Football Field, 4. Kabaddi Court and 5. Volleyball Court manually, then by utilizing Total Station and finally a combination of both.

MATERIALS AND METHODS

Sample

The aim of this research was to compare the time taken for marking Sports fields manually using a measuring tape and technically using Total Station. The samples taken were 5 different sports fields namely 1. Badminton Court, 2. Basketball Court, 3. Football Field, 4. Kabaddi Court and 5. Volleyball Court.

A total station comprises of a theodolite with an integrated distance meter (distancer), so that it can quantify angles and spaces at the same time. All the electronic total stations in vogue has an opt-electronic distance meter (EMD) and electronic angle scanning. The coded scales of the horizontal and vertical circles are scanned electronically and later angles and circles are exhibited digitally. The horizontal distance, height difference and the coordinates of a point are finely measured automatically and all dimensions and supplementary statistics can be documented. The total station apparatus is fixed on a tripod and is flattened by operating levelling screws. Within a small variation, the device is adept of altering itself to the level position. Then vertical and horizontal reference directions are indexed via on-board

keys. It is likely to set required entities for distance, temperature and pressure (FPS or SI). When target (Prism pole) is seen horizontal and vertical angles as well as sloping distances are quantified and by pressing suitable keys, they are documented along with point number. Heights of device and targets can be keyed in after assessing them with tapes. The processor figures different dimensions about the point and exhibits the information on screen. This data is also retained in the electronic notebook. At the conclusion of the day or each time electronic note book is complete, the data stored is transferred to computers.

In order to establish and prove the aim of this research, a big open field measuring 4 Acres at Anurag Group of Institutions, Hyderabad was used. Initially, the five fields namely 1. Badminton Court, 2. Basketball Court, 3. Football Field, 4. Kabaddi Court and 5. Volleyball Court were marked using manual method by measuring tape and 3 staff members. The time consumed in marking each court was noted down. Later, Total Station was used in the same field to mark the above mentioned five courts with the help of 2 professionals who are experts in using the equipment and the time taken was noted down in marking each court. The following data was used for marking with Total Station followed by offset technique for internal marking.

Table 1: Dimensions (L, W, D) and angles (ϖ) used for plotting using Total Station

Court/Field	Length (M) L	Width (M) W	Diagonal (M) D	Sinϖ = L/D	ϖ= Sin-1L/D
Volleyball	18	9	20.1246	0.8944	63° 25' 53.28"
Kabaddi	12.5	10	16.0078	0.7809	51° 20' 34.99"
Badminton	13.4112	6.096	14.7316	0.9104	65° 33' 38.47"
Basketball	28.7512	15.3416	32.5875	0.8828	61° 58' 55.17"
Football	100	60	116.619	0.8575	59° 2' 13.31"

After plotting all the five courts manually and using Total Station on the ground, a combination of Total Station and Measuring Tape was used in such a way that the basic outline of each court i.e. the boundary line of every court was plotted using Total Station by angles as mentioned above and all the subsequent internal markings were done using a simple measuring tape.

RESULTS

Five courts/fields namely 1. Badminton, 2. Basketball, 3. Football, 4. Kabaddi and 5. Volleyball were plotted using 3 different methods and the time was noted

i) Manual Plotting time using measuring tape & arc intersection method (M)

ii) Total Station (T)

iii) Plotting time using combination of Total Station & Measuring Tape (C)

Table 2: List of times taken for plotting various Sports Fields using 3 methods

S.No	Court/Field	Manual Plotting Time M(Sec)	Plotting Time Using Total Station T (Sec)	Plotting time by Time(Sec)
1	Badminton	414 (6 Min 54 Sec)	388 (6 Min 28 Sec)	249 (4 Min 09 Sec)

2	Basketball	1188(19Min48Sec)	1033(17Min13Sec)	872 (14Min 32Sec)
3	Football	808 (13Min 28Sec)	654 (10Min 54Sec)	541 (9 Min 01 Sec)
4	Kabaddi	410 (6 Min 50 Sec)	343 (5 Min 43 Sec)	216 (3 Min 36 Sec)
5	Volleyball	378 (6 Min 18 Sec)	287 (4 Min 47 Sec)	205 (3 Min 25 Sec)

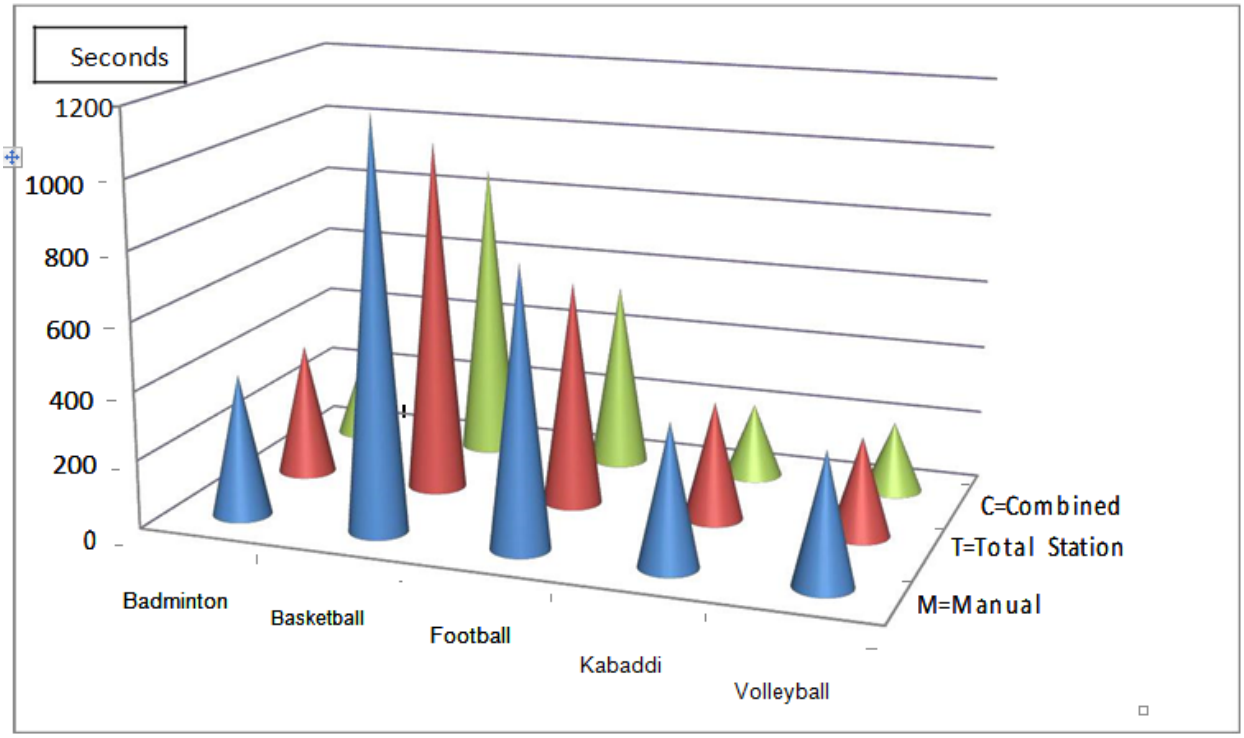

Figure 1: Graphical representation of times taken in plotting fields using 3 methods

The figures obtained were evaluated using SPSS (Statistical Package for the Social Sciences) Version 21 to determine the most effective and fastest method to be used for plotting sports fields.

Table 3: Shown below are results from Statistical Analysis of three methods used in plotting 5 different sports fields in the study by ANOVA through LSD (Least Significant Difference) method**.**

Method (I)	Method Compared (J)	Mean difference (I-J)	Std. Error	Sig.
Manual	Technical	98.6000	93.0075	.294
Manual	Combination	223.0000*	93.0075	.020
Technical	Combination	124.4000	93.0075	.186

P value (significance) obtained on comparison of Manual and Technical methods was 0.294 (> 0.05), P value (significance) obtained on comparison of Manual and Combined methods was 0.020 (< 0.05) and P value (significance) obtained on comparison of Technical and Combined methods was 0.186 (> 0.05).

The values of significance which are obtained from the analysis in this study using three methods of plotting the 5 different courts reveal that there exists a significant difference in using Manual method of plotting (M) and Combined method of plotting (C) the play fields (p=0.02) at 0.05 level of confidence. There exists no significant difference in the other two cases i.e. either comparing Manual method with Technical Method (p=0.294) or Technical Method with Combined method of plotting (p=0.186).

DISCUSSION

The main aim of this investigation was to observe the use of a new and innovative tool called electromagnetic total station in marking different sports fields and comparing it with the manual markings with time as measuring factor.

Advancement is persistently accomplished and novel applications are regularly accessible in the field of electronics and engineering. Automation and remote control are the hall mark of this millennium as manual works are no more preferred by the younger generation. Skilled labor has become rare and expensive which has necessitated finding ways and means to invent new and innovative modalities which are inexpensive and faster replacing traditional equipment [24]. Total station is one of the rare and unique electronic machines which help in marking different sports fields. The result of the study indicated that the time taken to mark different sports fields utilizing combination of Total Station and tape was amazing and very noteworthy and profoundly exact when compared with the time taken to mark similar sports fields physically utilizing a Measuring Tape or technically using Total Station alone. Thus, it is prescribed to utilize Total Station in combination of measuring tape in marking Sports fields to spare time, labour and to make markings brisk and exact without blunders. The above result is in line with the studies made by [9] who used an algorithmic method for producing the way points essential for the management of a GPS-based field robotic over a football playing field to automatically convey periodical effort like cutting the grass field, pitch and line marking graphics and meadow striping is epitomized. They also concluded that this device was able to execute regular manoeuvres which are currently being completed physically in regular basis in football stadiums. They also concluded that this methodology is not restricted to football playing fields; however, the instrument could be utilized for various sports like hockey, tennis, etc. This apart a patent developed by [6] on the modular marking for Athletic field is also corroborated to our study as this system is particularly useful for permanently marking different fields on some athletic field.

[23] used reference beam generator, for guiding a field marker movable relative to the reference beam generator and intended for producing ground markings, comprising: a positional and fixable support element defined relative to the Earth's surface, the support element having geometry with two limbs arranged at right angles, which also is in with the outcomes of present observation. [14] in his patent used a line marking system for installing permanent field lines in natural grass fields which comprises a line fixed to a backing sheet which is installed under the grass sod. The backing sheet is preferably a mesh which allows the grass to grow through the backing sheet thereby anchoring the line to the ground thereby also confirming the results of our study. There many more investigations carried out and converted to patent with regard to the marking of the sports field and all have used a variety of electronic and other mechanical devices in this area confirming that use of electronic equipment is worthwhile. The unique method of utilizing combination of Total Station and tape was amazing and very noteworthy and profound in marking the sports field quickly, easily and precisely.

CONCLUSION

It is concluded that:

i) There exists a significant difference of time consumed in plotting sports fields manually using a measuring tape when compared with the utilization of Total Station in marking the outlines/boundary lines in combination with usage of measuring tape for internal markings.

ii) When a Total Station is available, its usage in combination with measuring tape will help in a faster and an accurate sports field plotting/marking.

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