A new student-teacher mentoring algorithm for online feedback using statistical signal processing

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ABSTRACT. *The purpose of this work is to develop an online student-teacher mentoring algorithm using statistical data based signal processing. In this approach, it is assumed that teachers' data and attendances of the students are available in the online portal. Students will give mentoring feedback marks for the teachers according to their choices. This statistical information is transferred to discrete time signal by scaling and shifting operation. Performance of the algorithm is established by determining average mentoring feedback value, standard deviation, signal-to-noise ratio (SNR), coefficient variance and typical error. Statistical signal processing algorithm is used to compute the whole mentoring system and error in algorithm is calculated based on SNR. Here, 30 students are grouped under 5 teachers equally for mentoring and using the proposed algorithm achieved typical error varies from about 11% to 12.5%. The findings of this investigation will be useful for online student-mentoring system in educational organizations for the enhancement of quality of education.*

RÉSUMÉ. *Le but de ce travail est de développer un algorithme en ligne de mentorat étudiant-enseignant utilisant un traitement de signal basé sur des données statistiques. Dans cette approche, il est supposé que les données des enseignants et les présences des étudiants sont disponibles sur le portail en ligne. Les étudiants donneront des notes de mentorat aux enseignants en fonction de leurs choix. Cette information statistique est transférée au signal de temps discret par une opération de mise à l'échelle et de décalage. La performance de l'algorithme est établie en déterminant la valeur moyenne du retour d'information, l'écart type, le rapport signal sur bruit (SNR), la variance du coefficient et l'erreur type. Un algorithme de traitement statistique du signal est utilisé pour calculer l'ensemble du système de mentorat et une erreur dans l'algorithme est calculée sur la base du RSB. Ici, 30 étudiants sont regroupés de manière égale sur 5 enseignants pour un tutorat et en utilisant l'algorithme proposé, l'erreur typique varie d'environ 11% à 12,5%. Les résultats de cette enquête seront utiles pour le système de mentorat en ligne des étudiants dans les organisations éducatives afin d'améliorer la qualité de l'éducation.*

KEYWORDS: *online feedback, student-teacher mentoring, mentoring algorithm, statistical signal processing.*

MOTS-CLÉS: commentaires en ligne, mentorat élève-enseignant, algorithme de mentorat, traitement statistique du signal.

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1. Introduction

In order to increase day-to-day interaction with the teachers, student mentoring is an important component in an educational institute. A mentoring is a process in organizations which reduces the gap between mentees and mentor and built the bright career, better life style and will make society prosperous and peace. In this paper, a new statistical data based signal processing algorithm is used for online student-teacher mentoring system in educational organizations. In this approach, it is assumed that teachers' data and attendances of the students are available in the online portal. Total number of students is grouped under different tutor-mentors. Teachers will mentor the students for different activities, like, education, attendances in class, higher studies and other extra-curricular activities. Stream-wise all subjects name with code number, teachers' name subject-wise, semester-wise groups of students name and roll numbers with particular faculties are available in the data base system of the organization. Students will give online feedback for his/her mentor according to his/her choice, but student attendance will be considered to compute mentoring feedback as one of the parameters for marking system. This statistical information is transferred to discrete time signal by scaling and shifting operation. The algorithm is developed in such a manner that those who have less than (75-85) % attendances only 50% mentoring points will generate to give the mentoring feedback to their concern teacher, (86-95) % attendances only 75% mentoring points will generate to give the mentoring feedback to their concern teacher and equal and above 95% attendances 100% mentoring points will generate to give the mentoring feedback to their concern teacher respectively. Performance of the algorithm is established by determining average mentoring feedback value, standard deviation, signal-to-noise ratio (SNR), coefficient variance and typical error. Statistical signal processing algorithm is used to compute the whole mentoring system and error in algorithm is calculated based on SNR. Here, 30 students are grouped under 5 teachers (that is, 6 students under each teacher) for mentoring and using the proposed algorithm achieved typical error varies from about 11% to 12.5%. The findings of this investigation will be useful for online student-mentoring system in educational organizations for the enhancement of quality of education.

Mentoring is nowadays very important in education area of organization to interactions between the teachers (mentors) and the students (mentees) built students' future carrier, life and minimize un-civilian works in society. A mentoring is a process in organizations which reduces the gap between mentees and mentor and built the bright career, better life style and will make society prosperous and peace. Mentoring programs can be valuable for mentor in education organization and commercial purpose to encourage the mentees in self-confidence to life-long positive professional impacts, such as learning and understanding by accepting feedback from mentors. So mentors have an opportunity to share their knowledge, strengthen their interpersonal technique skills to make the mentees a good social person in society.

Overall learning and attitude of a student are very much dependent on effective mentoring of teachers (Anderson, 1991; Wortmann *et al.*, 2008; Deans *et al.*, 2009; Wanberg *et al.*, 2006; Block and Georgiadis, 2012; Xiao, 2013). Because of advancement of information and communication technology, online mentoring is gaining much more attention worldwide (Sohn *et al.*, 2012; Srivichai *et al.*, 2012; Quintana and Zambrano, 2014; Rhodes and Spencer, 2010), though face-to-face communication cannot be denied for mentor-mentee communication. The models for mentor-mentee communications, reported earlier might not be useful for online mentoring. Therefore, some common basics of mentor-mentee communication for online mentoring is discussed in (Nuankaew and Temdee, 2015). Positive impacts on teaching quality, teachers' morality and teacher-student interactions are observed by using a computer joystick (Pennings *et al.*, 2014). The principles (Hendrickxa *et al.*, 2015) underpinning efficacious inclusive teacher education, research project and recommended for the context of an organizations including experience of teachers. The teacher (Sedova *et al.* 2016) should be dialogic teaching, classroom discourse parameters was identified, the amount of talk with reasoning increased and other indicators of dialogic teaching. From qualitative statistical data on teachers' career it is found that teacher attrition should be more complex and non-linear phenomenon (Lindqvist *et al.*, 2014). The quality of student-teacher interaction is related to teacher and student based on instructional support, positive emotional relationship with students during the education (Krstić, 2015).

There are several methods for the assessment of different aspects of teacher-student social-emotional relationship, interaction inside and outside the class room but very few literatures are available on online student-mentoring system. In this paper, based on the literature review, a perfect and automatic feedback mentoring system is developed, which is applicable for average weighted based attendance of mentees. This will give the desired feedback marks to their concern mentors according their average weighted based attendance. Feedback mentoring improvement based on average weighted attendance of mentees is adapted from several related scales and factor from several research papers. Also according to their mentoring feedback, the mentoring marks will be entered against the respective mentors and the proposed method takes care that only after completion of mentees feedback admit card will generate to appear in the final examination. For the implementation of this mentoring feedback system, a signal processing algorithm is used based on statistical data for the mentors. Using statistical data, mean, standard deviation, signal-to-noise ratio (SNR), typical error and coefficient variance are computed by using signal processing. MATLAB is used for simulation.

The rest of the paper is organized as: Section 2 is the proposed online mentoring algorithm, Section 3 describes the implementation of the proposed statistical data based signal processing algorithm for online mentoring including performance of proposed algorithm, Section 4 is conclusion and future work and last section is references.

2. Proposed online mentoring algorithm

The algorithm, proposed for online mentoring feedback system, is described in detail below.

Input in Institute Portal: Insert semesters; Insert branch names; Teachers' names group wise roll nos.;

Input in Institute Portal: Subjects name with subject codes; Admit card format;

Input in Institute Portal: Roll numbers of students with percentage of attendance;

Input in Institute Portal: Feedback points [For each mentoring point answer bits have, (a) = 0.0 mark, (b) = 0.25 mark, (c) = 0.75 mark and (d) =1.0 mark];

Input by Students: Student's ID number and Password

Estimation of Mentoring: Statistical data-based signal processing algorithm will estimate mentoring marks and teacher's-name wise

Output: Sum of all mentoring marks teacher's-name wise.

Output: Admit card will be generating for eligible students (attendance ≥75%) after inserting their mentoring feedback on the portal. No admit card will be generated for the eligible students who have not completed online feedback process.

The step-wise procedure of the proposed algorithm for online mentoring is described below:

Step-1: Stream-wise all subjects name with code number, teachers' name subject-wise, semester-wise groups of students name and roll numbers with particular faculties are available in the data base system of the organization. Mentees roll nos. (1- 6) for Prof. A, roll nos. (7- 12) for Prof. B, roll nos. (13-18) for Prof. C, roll nos. (19-24) for Prof. D and roll nos. (25-30) for Prof. E. 20 numbers of mentoring points with multiple choices as (a) = 0.0 mark, (b) = 0.25 mark, (c) = 0.75mark and (d) = 1.0 mark are uploaded in organization database.

Step-2: Teachers will update attendance in the organization data base system immediately after taking the classes. After completion of course total attendance of the students will be stored in the data based system. The students roll nos. are divided in three tier such as less than (75-85) % attendances, (86-95) % attendances and equal and above 95% attendances to give the feedback about the mentoring to their concern teacher respectively. Those who have less than 75% attendances, their roll numbers will not be available in the data base of organization.

Step-3: After giving online mentoring feedback for their concern mentoring teacher by the students and feedback marks about the mentoring will be entered automatically against the respective mentor's name -wise.

Step-4: The algorithm is developed in such a manner that those who have less than (75-85) % attendances only 50% mentoring points will generate to give the mentoring feedback to their concern teacher, (86-95) % attendances only 75% mentoring points will generate to give the mentoring feedback to their concern teacher and equal and above 95% attendances 100% mentoring points will generate to give the mentoring feedback to their concern teacher respectively.

Step-5: After completion of the process of mentoring feedback by the students, desired mentoring feedback marks will be enrolled in respective teachers format and admit card will be generated for the student to appear in the examination. In this process the concern teachers will be evaluated correctly by the eligible students.

Step-6: Then such statistical information will be transferred to discrete time signal by scaling and shifting operation and will be simulated by statistical signal processing to get accurate information. From the statistical information the average mentoring feedback value, standard deviation, signal to noise ratio (SNR), coefficient variance and typical error will be determined.

3. Online mentoring using statistical signal processing

Good statistical signal representations (e.g. time-frequency or time-scale) are required for many engineering applications (Smith, 1997). Signal is described how can one parameter is related to another parameter. In feedback system, feed marks of different teachers are collected which are represented in Y-axis and roll numbers of different students are represented in X-axis. These parameters are also designated in Y-axis and X-axis as amplitude and time of signal respectively. So, the horizontal axis represented the other parameter of the signal which is the independent variable. Time is a common parameter which is represented in horizontal axis. In generally, the horizontals axis represented as sampler number. The parameters in Y-axis (dependent variable) are represented as function of the parameter on the X-axis (the independent variable). This independent variable represents, how and where each samples is considered, while the dependent variable is actual measurement, like a two-terminal source emitting mutually correlated signals in X & Y axis respectively (Amari and Han, 1989). Mathematical models serve as tools in the analysis and designing signal from statistical data analysis of mentoring feedback marks into delta function. Discrete continuous signals can be decomposed into scaled and shifted delta functions comparing with mentoring feed marks of teachers given by students as well as students roll numbers. Statistical data (Rosen and Porat, 1989) were sensitive to deviations of the data from the ideal model as measurement of noise, temporary deviation from stationary (change in amplitude etc) & outliers. Depending on the specify application, the algorithm may also have to be adaptive to changing signal and noise environments.

The mean is designated as "μ" in statistics for the average value of a signal. If there are X(n) numbers of signal with N numbers of discrete times, then mean is calculated as (Rosen and Porat, 1989)

$$\mu=\frac{1}{N}\sum_{n=0}^{N-1} X(n) \quad (1)$$

where X (n) represents the mentoring value of the signal at particular time & N represent the total sum of times where n=0,1,2......N. The calculation is completed by dividing the sum by N.

Signals may be represented as discrete versions or repetitive wave forms as sine or square with peak to peak amplitude. But such type of signals is referred as in random nature. Deviation of N sample from mean value is described by standard deviation (σ). The average deviation of a signal is found by summing the deviations of all the individual samples and then divided by the number of samples N. The average deviation gives a single number representing the typical distance which samples are mean, while the average deviation is almost never used in statistics. So it is not well fit with physics that how can the signals operated. When random noise signal (Hero, 2008) combine in an electric circuit & the resultant noise is equal to the combined power of individual signals. The standard deviation is the average deviation with its power, but not in amplitude, which is done by taking the squaring each of the deviation before taking the average. Then standard deviation (σ) is represented as

$$\sigma = \sqrt{[\tfrac{1}{N}\textstyle\sum_{n=0}^{N-1}\{\mathrm{X(n)} - \mu\}]} \qquad (2)$$

A signal without any DC component, its r.m.s. value is same as its standard deviation (σ). Here the mean is measured while the standard deviation represented noise and other interferences. Stochastic process (Claus, 1993) of homogeneous trees aimed to process the multi scale statistical signal & gave signal level of resolution in terms of signal to noise ratio (SNR) which is (Johnson, 2013)

$$SNR(\rho) = (\mu/\sigma) \qquad (3)$$

Coefficient of variance CV(ϑ) is defined as (Johnson, 2013)

$$CV(\vartheta) = 100(\sigma/\mu) \qquad (4)$$

The random signal and typical error (Ɛ) [TE] between mean and the N points, and mean of the process is given by

$$\mathcal{E} = \sigma/\sqrt{N} \qquad (5)$$

Table 1. Conversion of mentoring feedback marks to discrete time signal

Mentors	Mentor-wise Representation of Discrete Time Signal
Prof. A	$X_1(n)=3.75\delta(n)+3.0\delta(n-1)+2.5\delta(n-2)+2.75\delta(n-3)+2.5\delta(n-4)+2.5\delta(n-5)$
Prof. B	$X_2(n)=2.5\delta(n-6)+3.0\delta(n-7)+4.0\delta(n-8)+2.5\delta(n-9)+2.0\delta(n-10)+3.0\delta(n-11)$
Prof. C	$X_3(n)= 2.25\delta(n-12)+2.5\delta(n-13)+3.5\delta(n-14)+ 3.0\ \delta(n-15) + 2.5\ \delta(n-16)+3.0\delta(n-17)$
Prof. D	$X_4(n)= 1.5\delta(n-18)+3.0\ \delta(n-19)+3.25\delta(n-20)+3.0\ \delta(n-21)+3.0\delta(n-22)+1.5\delta(n-23)$
Prof. E	$X_5(n)= 2.75\ \delta(n-24)+2.75\delta(n-25)+ 2.25\delta(n-26)+ 2.5\delta(n-27)+ 3.0\delta(n-28)+1.5\ \delta(n-29)$

Statistical data based signal processing is performed by representing discrete time signal for each feedback mentoring values as $w_1\delta(n)+w_2\delta(n-1)+w_3\delta(n-2)+ \ldots\ldots\ldots\ldots+w_N\ \delta[n-(N-1)]$. Where, N is the number of students, taken into consideration, $\delta(n)$ is the impulse delta function whose value is 1 for all integer values of ‘n’ and w_N is the weight of the signal as described in the Table 1.

The mentoring feedback marks in analog and digital forms for all the 5 professors are shown in Fig.1-Fig.5.

For online feedback of 30 students different statistical parameters, estimated from statistical signal processing for different subjects are tabulated in Table 2.

Typical error in the Table 2 varies from about 11% to about 12.5%. This typical error is high in this case because error is calculated based on mean of the signal in this paper. Beyond the mean the signal noise is present over the span of standard deviation. Subject-wise teacher-wise SNRs calculated from the algorithm are much higher than the coefficient variance and also from the typical error. These estimation parameters are tabulated in Table 3. In this table SNR is of the order of 5 in all the cases. If number of data is large SNR is also large.

In Table 3, SNR/CV is less than SNR/TE, that is, it shows that noise of CV is more than noise of TE. Therefore, the online feedback estimation using the proposed statistical data based signal processing is very effective for evaluation of mentoring points of teachers in an institute.

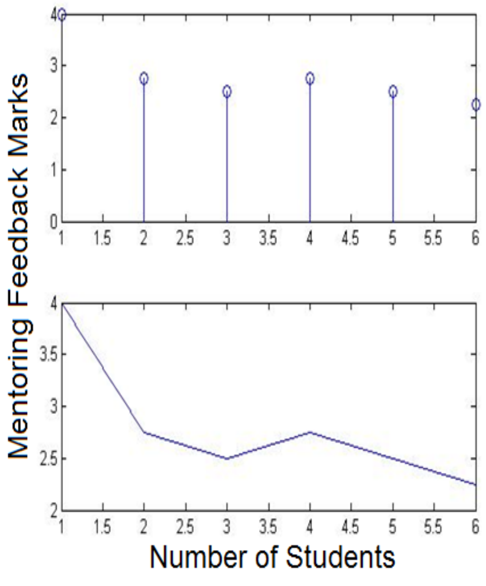

Figure 1. Mentoring feedback marks for Prof. A

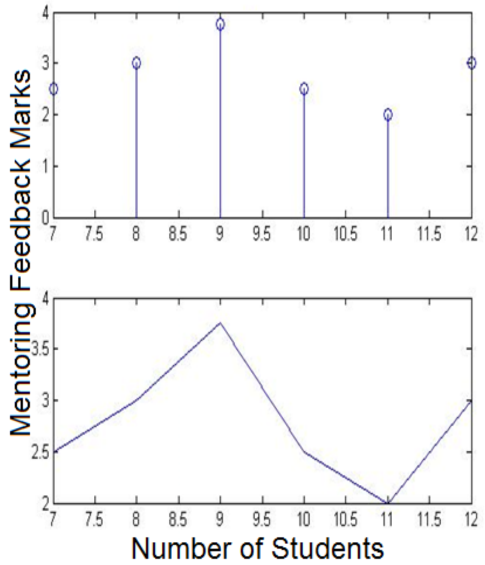

Figure 2. Mentoring feedback marks for Prof. B

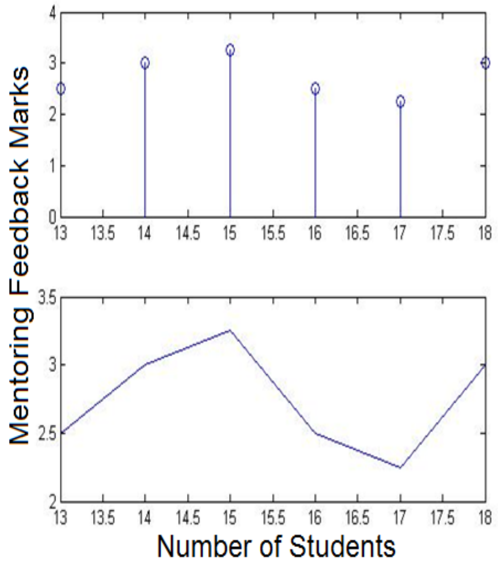

Figure 3. Mentoring feedback marks for Prof. C

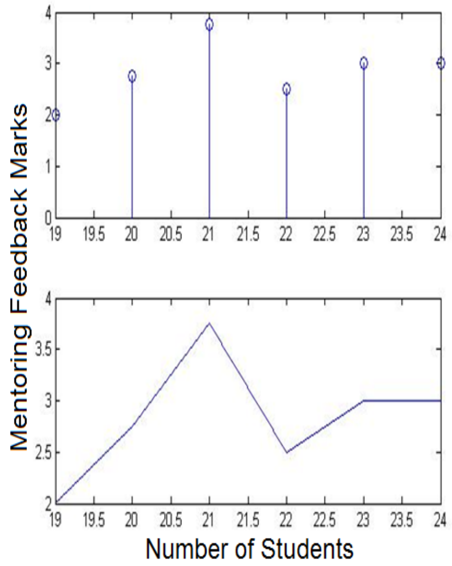

Figure 4. Mentoring feedback marks for Prof. D

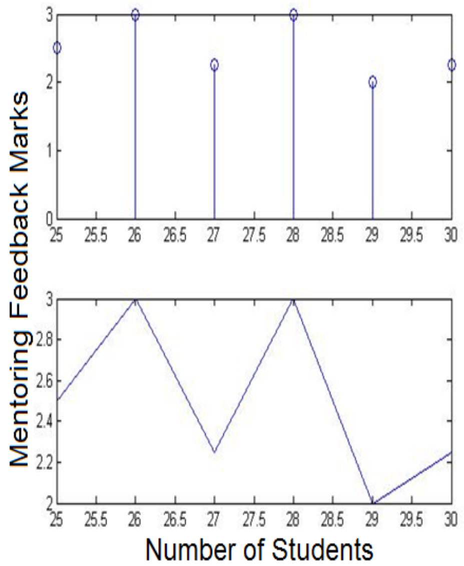

Figure 5. Mentoring feedback marks for Prof. E

Table 2. Estimated parameters for 30 students using statistical signal processing

Roll. No.	Average Attendance In all subjects	Ment. Feedback marks	Mean (μ)	Std Deviation (σ)	SNR (ρ)	SNR/CV	SNR/TE	Mentors
01	97.2	3.75	2.8	0.62	4.5	0.2	17.74	Prof. A
02	87.8	3.0						
03	87.8	2.5						
04	86.8	2.75						
05	94.2	2.5						
06	87.8	2.5						
07	87.4	2.5	2.8	0.60	4.65	0.22	19.0	Prof. B
08	88.6	3.0						
09	97.4	4.0						
10	87.4	2.5						
11	80.0	2.0						
12	91.4	3.0						
13	93.0	2.25	2.75	0.39	7.1	0.50	44.91	Prof. C
14	94.4	2.5						
15	97.6	3.5						
16	93.4	3.0						
17	91.6	2.5						
18	85.0	3.0						
19	80.4	1.5	2.83	0.58	4.85	0.24	20.32	Prof. D
20	89.0	3.0						
21	96.8	3.25						
22	92.2	3.0						
23	95.6	3.0						
24	93.0	1.5						
25	91.6	2.75	2.5	0.42	5.98	0.36	35.01	Prof. E
26	93.0	2.75						
27	90.8	2.25						
28	87.2	2.5						
29	91.0	3.0						
30	94.6	1.75						

Table 3. Estimation parameters for online feedback

Estimation Parameter	Prof. A	Prof. B	Prof. C	Prof. D	Prof. E
SNR / CV	25.577	29.300	26.656	22.647	23.431
SNR / TE	44.987	47.059	44.396	38.280	39.103

4. Conclusion

Online mentoring feedback system proposed here is more transparent for evaluation of mentoring of a particular faculty and it will help the learning and professional development of students in the institute. In this process the eligible students will get admit card to appear the examination and also mentors will get proper justice from the students, because the feedback points are generated according the average attendance based by the students. The information will be useful to the teacher(s) as well as to the organization in the ongoing efforts to enhance the quality of education. In statistical signal processing, processing of signal is treated as stochastic processes, dealing with their statistical properties (e.g., mean, standard deviation, SNR and coefficient of variance, etc.). From the research work it is found that the better data is obtained for higher SNR and for lower value for the coefficient variance. Signal processing using Bi-spectrum to determine the better data for online mentoring may be the future work on this topic.

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