Extended Student Quality Improvement Programs of Xiamen University

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Abstract— **This paper describes the recent educational activities and programs organized by the IEEE Engineering in Medicine and Biology Society (EMBS) Xiamen University Student Club. The educational programs covered the undergraduate student mentoring program, seminar series, the top-quality course project, and student scientific projects and contests. These activities have successfully cultivated our students strong interests in the field of biomedical engineering, and also trained our students the skills of solving real-world problems and experience of teamwork collaborations. Our initiatives provide a good example of well-organized education practice for IEEE EMBS student organizations.**

I. Introduction

Biomedical engineering is a rapid-growing field that applies diverse knowledge of biology, medicine, and engineering to study the complex physiological systems. Development of biomedical engineering and its related disciplines call for more advanced education programs to train students with interdisciplinary skills. Some curricula reforms have placed emphasis on how to teach students to complete practical projects using the knowledge they learn from textbooks [1], [2]. In addition to the regular biomedical engineering course teaching, IEEE Engineering in Medicine and Biology Society (EMBS) Xiamen University Student Club has recently organized a number of instructive activities as the supplementary education programs for student quality improvement. The activities contained the undergraduate student mentor program, the series of introductory seminars, the top-quality course teaching, and student scientific projects and design contests. The undergraduate student mentor program is established to provide students with appropriate guidelines of college study planning and future career choice. The seminar series may foster the extensive interests in the related fields of biomedical research. The top-quality course is designed for teaching students with solid knowledge in one or more particular research topics. In order to train the local students to solve real-world problems with teamwork spirit, we grouped the local students into different teams to participate in the innovation projects and design contests. Our programs are quite popular on campus. Most of undergraduate students who are involved in our activities become self-motivated in their postgraduate study. They are quite active in scientific research projects, and more likely to collaborate with others in teams to solve practical problems.

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II. Undergraduate Student Mentor Program

The undergraduate student mentor program has been supported by Xiamen University for more than eight years. Relative to graduate students who are mentored and supervised by their faculty advisors, undergraduate students need more curricula guideline, major choice advice, and future study plan mentoring. In response to student requests, Xiamen University launched the undergraduate student mentor program as an extended teaching model.

Every faculty member can mentor up to 6 undergraduate students. Mentors may make private conversations with an individual student at a coffee break, or have a brainstorm with a group of students in a lab panel discussion [3]. In addition to the regular face-to-face communications, teachers can also mentor student design projects, supervise student contests, or train student interns with industry experts [4]. The students of our EMBS student club join the tea party with the faculty advisor once a month. Such an one-hour conversation event focuses on the discussions of study planning, career choice, professional presentation skill training, and balancing study with social connections. As an example, the topics of student tea party in February 2014 are listed below:

- How to read a book effectively;
- How to make an informed career choice;
- Tips of mutual communications in an efficient team;
- How to make a study plan for short-term abroad exchanges;
- How to prepare a job interview;
- The benefits of industry internship.

With the student mentor program, our undergraduate students have greatly improved their decision making and communication skills. They are actively involved in the classroom teaching activities and collaborative learning projects, relative to other students who did not participate in our student mentoring events.

III. Seminar Series

Seminar series are the regular educational activities organized by our EMBS student club for years. The purpose of the interest-oriented seminars is to attract extensive attentions on campus and enhance the influence of biomedical engineering on campus. We expect to help student attendees generate broader interests about biomedical research, by means of introductory but not very abstruse seminars.

In July 2011, we invited IEEE Fellow Prof. Rangaraj M. Rangayyan to provide an IEEE Distinguished Lecture for local students. In the lecture entitled “Computer-Aided Diagnosis of Breast Cancer”, Prof. Rangayyan presented the

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history and recent advances of computational technologies for breast cancer diagnosis. More than 50 students joined our lecture and enjoyed the question-answer discussions. The lecture was also ranked in the Xiamen University Nanqiang Lecture Series with the highest honor, and supported by the IEEE EMBS, Xiamen University Academic Affairs Office, and the School of Information Science and Technology.

From July 18-19, 2012, we invited two IBM software engineers, Ms. Qien Jiang and Mr. Xiubin Yu, to give lecture series on campus. In six lectures, they demonstrated the comprehensive biomedical software development process, including software requirement investigation, system design, code integration, testing and delivery. Ms. Jiang also introduced the IBM Personalized Cancer Diagnosis and Treatment Project for our students. Most students felt very interested in the high-performance data mining and biomedical big data projects supported by the IBM company.

So far, our EMBS student club has organized more than 10 diverse seminars on campus, and 5 technical tutorials to support the interdisciplinary curricula study and scientific research. All of our student activities received sufficient financial supports from Xiamen University and IEEE Engineering in Medicine and Biology Society.

IV. Top-Quality Course

The top-quality course is an in-depth extension of the seminar series. Rather than fostering the general biomedical interests in seminars, the top-quality course aims at preparing our students with solid knowledge background and scientific research skills. In July 2011, Prof. Rangayyan offered our students a short course "Biomedical Signal Analysis" on Xiamen University Zhangzhou campus. Over 20 students attended the short course and enjoyed the interactive teaching-learning style. During the 2013 fall semester, our EMBS student club provided the course "Data Mining Theory and Practice", which covered the state-of-the-art biomedical data mining topics. The syllabus included the classroom teaching and computer experiments. The target of this top-quality course is to train undergraduate students the primary research abilities of bibliography searching, experiment design, data analysis, professional presentation, and scientific writing by means of a few biomedical data mining projects. Until the course ending, three elite undergraduate students had published the first journal papers of their own. The student feedbacks were quite positive. Our course "Data Mining Theory and Practice" has been ranked in the national top-quality course list of China's Ministry of Education, and also begins to receive the IBM Enterprise Collaboration Excellent Course funding from 2014.

V. Student Scientific Projects and Contests

The scientific projects and student contests can reward the experience of applying the textbook knowledge in solving real-world problems [5], [6]. Students may also train their practical skills to rise to the hardware and software challenges toward a final solution [7]. Compared with the students who only worked individually, the students who worked in teams with teamwork spirit are more likely to offer necessary assistance for their teammates [8]. Our EMBS student club positively encourages the local students to participate in scientific design projects and contests. We have set up a web-based system to support students to perform effective collaborative learning for teamwork projects [9]. With the wiki features provided by the powerful system, students can carry out their projects with sufficient online interactions such as data sharing and interpersonal communications [10].

Students commonly work with their teammates using the field-independent or field-dependent collaboration styles [11]. Those students who are excellent problem solvers themselves can work with each other with the field-independent style. The whole project will be divided into different small tasks which are expected to be privately completed by each student. For a field-dependent team, students will clarify ideas and final solutions together with their teammates to solve the problem. The success of the project depends on the excellent collaborative interactions between students. In every team, one student would be assigned as principal investigator who plays a pivotal role in the team-based collaborations. The principal investigator student is responsible for the project schedule and budget management, and also helps defuse any conflict that may occur in the project completion process [12].

From 2010, our students have been involved with several student innovation projects in the area of biomedical signal processing, biomechanics, and rehabilitation engineering. The previous research projects covered the topics on knee joint vibroarthrographic signal analysis [13]–[17], neurodegenerative diseases [18]–[20], and human motion analysis [19], [21]–[23]. These student projects were supported by the research grants from Xiamen University and China's Ministry of Education. Our students also actively participated in different paper and design contests. The previous student contests included Chinese Undergraduate Electrical Engineering Mathematical Modeling Contest, Mathematical Contest in Modeling, and IEEE Industry Application Society Student Design Contest. The local students won multiple prizes in these contests, which have significantly enhanced their self-confidence and sense of accomplishment.

VI. Outcomes

Our educational activities have expedited plenty of student achievements. The local self-motivated students conducted efficient teamwork and online collaborations. There were 3 student projects supported by the Xiamen University student innovation research grants. Our students have published 7 peer-reviewed international journal papers [14]–[17], [20], [22], [24] and 7 conference papers [25]–[31]. From 2011 to 2013, there were 20 student teams participated in the Chinese Undergraduate Mathematical Contest in Modeling (CUMCM), Chinese Undergraduate Electrical Engineering Mathematical Modeling Contest (EEMCM), and the U.S. Mathematical Contest in Modeling (MCM). Students won 8 national contest awards and 11 Fujian provincial awards

in total. The outstanding students received a total of 23 university scholarships and 2 national scholarships. The IEEE EMBS Xiamen University Student Club was recognized by the 2011 IEEE EMBS Best New Student Club Award. The faculty advisor Prof. Yunfeng Wu was also acknowledged with the 2012 university teaching excellence award.

VII. Summary and Perspective

Since founded in 2010, the IEEE EMBS Xiamen University Student Club has organized plenty of activities to provide our students more opportunities for curricula study and biomedical research. Our recent initiatives benefited the local students with a remarkable improvement in practical skills of project management, design collaboration, conflict resolution, verbal presentation, and technical writing. The web-based infrastructure of the EMBS student club provides a community-centered collaborative learning platform for our students. The students actively made teams to effectively complete design projects to earn problem-solving and teamwork experience.

In the next step, our student volunteers plan to keep close communications with research fellows in Taiwan. Taiwan and mainland students have so many similar folkways and customs, even the same dialect, but we are not able to communicate with each other frequently due to the political obstacle. We hope to establish the student exchange programs with National Taiwan University and National Chiao Tung University, for further research collaborations and cultural interactions.

In the near future, our EMBS student club plans to prepare for a student conference to expand the local influence of biomedical professions. The student conference will be fully managed by our students, leaving only consultation and evaluation for faculty members. The paper reviewing process and venue preparation will operated by student volunteers. They will also have to learn how to obtain financial support from the university and local industry. We expect our students to gain more program management and problem handling experience.

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References

[1] T. R. Harris, "Recent adavnaces and directions in biomedical engineering education," *IEEE Engineering in Medicine and Biology Magazine*, vol. 22, no. 4, pp. 30–31, 2003.

[2] R. A. Linsenmeier, "What makes a biomedical engineer?" *IEEE Engineering in Medicine and Biology Magazine*, vol. 22, no. 4, pp. 32–38, 2003.

[3] Y. Wu, N. Tao, L. Tang, X. Ma, G. A. Garcia, and M. Mitsui, "Maxi program at IEEE EMBS student club of Beijing University of Posts and Telecommunications," in *Proceedings of the 26th Annual International Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2004)*, San Francisco, CA, USA, 2004, pp. 5192–5195.

[4] Y. Wu and J. He, "Biomedical industry skills education program at IEEE EMBS student club of Beijing University of Posts and Telecommunications," in *Proceedings of the 30th IEEE Annual Northeast Bioengineering Conference (NEBC 2004)*, Springfield, MA, USA, 2004, pp. 226–227.

[5] Y. Wu and M. Mitsui, "BME education program at the EMBS student club of Beijing University of Posts and Telecommunications," in *Proceedings of the 25th Annual International Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2003)*, Cancun, Mexico, 2003, pp. 3479–3482.

[6] Y. Wu and J. Wang, "Collaborative learning program of IEEE EMBS student branch chapter at BUPT," in *Proceedings of the 31st IEEE Annual Northeast Bioengineering Conference (NEBC 2005)*, Hoboken, NJ, USA, 2005, pp. 123–124.

[7] J. D. Enderle, W. Pruehsner, J. Macione, and B. Hallowell, "Using a multidisciplinary team approach in biomedical engineering senior design," *Biomedical Sciences Instrumentation*, vol. 36, pp. 63–68, 2000.

[8] B. A. Oakley, D. M. Hanna, Z. Kuzmyn, and R. M. Felder, "Best practices involving teamwork in the classroom: results from a survey of 6435 engineering student respondents," *IEEE Transactions on Education*, vol. 50, no. 3, pp. 63–68, 2007.

[9] Y. Wu, F. Zheng, S. Cai, N. Xiang, Z. Zhong, J. He, and F. Xu, "Effective collaborative learning in biomedical education using a web-based infrastructure," in *Proceedings of the 34th Annual International Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2012)*, San Diego, CA, USA, 2012, pp. 5070–5073.

[10] Y. Wu, S. C. Ng, and R. Kwan, "Effective mentoring of undergraduate final year projects: using a wiki-based environment," in *Hybrid Learning: The New Frontier*, Hong Kong, 2009, pp. 177–185.

[11] J. D. Enderle, K. M. Ropella, D. M. Kelsa, and B. Hallowell, "Ensuring that biomedical engineers are ready for the real world," *IEEE Engineering in Medicine and Biology Magazine*, vol. 21, no. 2, pp. 59–66, 2002.

[12] Y. Wu, B. Xu, and S. C. Ng, "Manufacturing student leaders and cultivating six ingredients for success of an EMBS student organization," in *Proceedings of the 27th Annual International Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2005)*, Shanghai, China, 2005, pp. 2395–2398.

[13] Y. Wu and S. Krishnan, "Combining least-squares support vector machines for classification of biomedical signals: a case study with knee-joint vibroarthrographic signals," *Journal of Experimental and Theoretical Artificial Intelligence*, vol. 23, no. 1, pp. 63–77, 2011.

[14] R. M. Rangayyan, F. Oloumi, Y. Wu, and S. Cai, "Fractal analysis of knee-joint vibroarthrographic signals via power spectral analysis," *Biomedical Signal Processing and Control*, vol. 8, no. 1, pp. 26–29, 2013.

[15] Y. Wu, S. Cai, S. Yang, F. Zheng, and N. Xiang, "Classification of knee joint vibration signals using bivariate feature distribution estimation and maximal posterior probability decision criterion," *Entropy*, vol. 15, no. 4, pp. 1375–1387, 2013.

[16] Y. Wu, S. Yang, F. Zheng, S. Cai, M. Lu, and M. Wu, "Removal of artifacts in knee joint vibroarthrographic signals using ensemble empirical mode decomposition and detrended fluctuation analysis," *Physiological Measurement*, vol. 35, no. 3, pp. 429–439, 2014.

[17] S. Cai, S. Yang, F. Zheng, M. Lu, Y. Wu, and S. Krishnan, "Knee joint vibration signal analysis with matching pursuit decomposition and dynamic weighted classifier fusion," *Computational and Mathematical Methods in Medicine*, vol. 2013, Article ID: 904267, 2013.

[18] Y. Wu and S. Krishnan, "Analysis of gait rhythm variability in patients with amyotrophic lateral sclerosis," in *IFMBE Proceedings of 2009 World Congress on Medical Physics and Biomedical Engineering (WC 2009)*, Munich, Germany, Sep. 2009, vol. 25, pp. 36-39.

[19] Y. Wu and L. Shi, "Analysis of altered gait rhythm in amyotrophic lateral sclerosis based on nonparametric probability density function estimation," *Medical Engineering and Physics*, vol. 33, no. 3, pp. 347–355, 2011.

[20] S. Yang, F. Zheng, X. Luo, S. Cai, Y. Wu, K. Liu, M. Wu, J. Chen, and S. Krishnan, "Effective dysphonia detection using feature dimension reduction and kernel density estimation for patients with Parkinson's disease," *PLOS ONE*, vol. 9, no. 2, Article ID: e88825, 2014.

[21] Y. Wu and S. Krishnan, "Computer-aided analysis of gait rhythm fluctuations in amyotrophic lateral sclerosis," *Medical and Biological Engineering and Computing*, vol. 47, no. 11, pp. 1165–1171, 2009.

[22] N. Xiang, S. Cai, S. Yang, Z. Zhong, F. Zheng, J. He, and Y. Wu, "Statistical analysis of gait maturation in children using nonparametric probability density function modeling," *Entropy*, vol. 15, no. 3, pp. 753–766, 2013.

[23] Y. Wu and S. Krishnan, "Statistical analysis of gait rhythm in patients with Parkinson's disease," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 18, no. 2, pp. 150–158, 2010.

[24] Y. Wu, X. Luo, F. Zheng, S. Yang, S. Cai, and S. C. Ng, "Adaptive linear and normalized combination of radial basis function networks for function approximation and regression," *Mathematical Problems in Engineering*, vol. 2014, Article ID: 913897, 2014.

[25] Y. Wu, Z. Zhong, M. Lu, and J. He, "Statistical analysis of gait maturation in children based on probability density functions," in *Proceedings of the 33rd Annual International Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2011)*, Boston, MA, USA, 2011, pp. 1652–1655.

[26] Y. Wu, S. Cai, M. Lu, and S. Krishnan, "An artificial-neural-network-based multiple classifier system for knee-joint vibration signal classification," *Advances in Computer, Communication, Control and Automation, LNEE 121*, Zhuhai, China, 2011, pp. 235–242.

[27] Y. Wu, S. Cai, M. Lu, Z. Zhang, J. He, F. Zheng, F. Xu, L. Shi, and C. Xia, "A gait cadence measurement method based on match filter and turns detection for human locomotion monitoring," in *Proceedings of 2012 IEEE EMBS International Conference on Biomedical and Health Informatics (BHI 2012)*, Shenzhen, China, 2012, pp. 530–533.

[28] Y. Wu, S. Cai, F. Xu, L. Shi, and S. Krishnan, "Chondromalacia patellae detection by analysis of intrinsic mode functions in knee joint vibration signals," in *IFMBE Proceedings of 2012 World Congress on Medical Physics and Biomedical Engineering (WC 2012)*, vol. 39, Beijing, China, 2012, pp. 493–496.

[29] S. Cai, Y. Wu, N. Xiang, Z. Zhong, J. He, L. Shi, and F. Xu, "Detrending knee joint vibration signals with a cascade moving average filter," in *Proceedings of the 34th Annual International Conference of IEEE Engineering in Medicine and Biology Society (EMBC 2012)*, San Diego, CA, USA, 2012, pp. 4357–4360.

[30] M. Lu, S. Cai, F. Zheng, S. Yang, N. Xiang, and Y. Wu, "Adaptive noise removal of knee joint vibration signals using a signal power error minimization method," in *Proceedings of the 7th International Conference on Computing and Convergence Technology (ICCCT 2012)*, Seoul, Korea, 2012, pp. 1193–1196.

[31] K. Liu, X. Luo, F. Zheng, S. Yang, S. Cai, and Y. Wu, "Classification of knee joint vibroarthrographic signals using k-nearest neighbor algorithm," in *Proceedings of the 27th Canadian Conference on Electrical and Computer Engineering (CCECE 2014)*, Toronto, ON, Canada, 2014, pp. 150–153.