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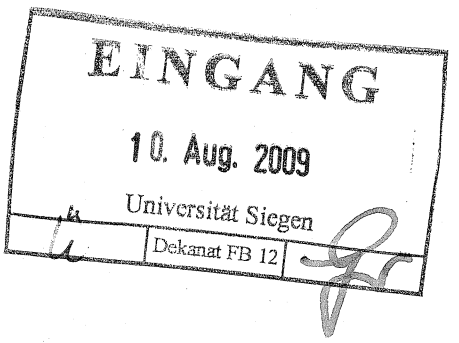

Date: Aug. 7th 2009

Prof. Dr. Elmar Griese
Dean of the Department for Electrical Engineering and Computer Science
University of Siegen
D-57068 Siegen

Dear Prof. Dr. Griese,

Please accept my application for the position of **Junior Professor for Sensorics and Sensor Data Processing**. My background and skills will prove to be an effective match for your qualifications.

I have a BSc in Electrical Engineering, an MSc in Computer Engineering and a PhD degree (Dr.-Ing.) in Electrical and Information Engineering. In the mean time, I am working as a Senior Research Scientist at the Institute of Flight Guidance, Dept. of Aerospace Engineering, TU Braunschweig. I am successfully applying my research skills in many ongoing projects, some of them in collaboration with the European Space Agency (ESA), German Aerospace Center (DLR), and other reputable institutions.

I am very interested in pursuing an academic career. Therefore, I would like to further develop my teaching skills while creating a strong and successful externally funded research program, and build-up and lead a research group in which I will supervise students at the MSc and PhD levels. Furthermore, I would also like to develop my management skills by participating in your institute's managerial and educational tasks. In addition, my experiences in supervising MSc theses, managing research projects, preparing proposals for new projects and obtaining external research funding would be an asset to your institution. I work well as a team member, am very reliable and organized, and willing to learn.

At present, I have an EU work permit, and will be awarded the German citizenship in the next few weeks.

I have attached the required material for your review. Thank you for considering my application. I would appreciate the opportunity to interview and look forward to hearing from you in the near future.

Yours sincerely,

M. Khalaf Allah

Mohamed Khalaf-Allah

Curriculum Vitae

Personal Data

Name	Mohamed Khalaf-Allah
Date / Place of Birth	25.06.1974 / Giza, Egypt
Maritial Status	Married, two daughters
Address	Plengestrasse 9 D-30459 Hannover, Germany
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Academic Degrees

Oct. 2008	Dr.-Ing. / PhD (magna cum laude) Electrical & Information Engineering, Univ. of Hannover, Germany
Sep. 2004	MSc Computer Engineering, Univ. of Hannover, Germany
Jul. 1998	BSc Electrical Engineering, Cairo Univ., Egypt

Language Skills

Arabic (mother tongue), English (fluent), German (fluent).

Recent Job Experiences

01.08.2007 – present	Senior research scientist at Inst. of Flight Guidance, Dept. of Aerospace Engineering, TU Braunschweig, Germany
01.01.2005 – 31.07.2007	Research scientist & PhD candidate at Inst. of Communication Technology, Univ. of Hannover, Germany
01.09.2005 – 28.02.2006	Part-time consulting engineer at Navman Automotive Competence Center, Hannover, Germany

Professional Activities

Session Chairing

[1] 6th Workshop on Positioning, Navigation and Communication 2009 (WPNC'09), Mar. 19, 2009, Hannover, Germany.

Invited Talks

[3] *Bayesian Filtering for Positioning Applications*, Freie Universität Berlin, Dept. of Computer Science, May 6th, 2008, Berlin, Germany.

[2] *Bayesian Mobile Location in Cellular Networks*, Università Politecnica delle Marche, Faculty of Engineering, Sep. 12th, 2006, Fermo, Italy.

[1] *Mobile location in wireless networks using the Bayesian filtering formulation*, Tampere Univ. of Technology, Dept. of Mathematics, Personal Positioning Algorithms Research Group, Aug. 8th, 2006, Tampere, Finland.

Theses Supervision

[2] Lei Shao, "Database Correlation for GSM/WLAN Indoor Localization," MSc thesis, Inst. of Communications Engineering, Univ. of Hannover, Germany, Aug. 2007.

[1] Ye Zhou, "Implementation and Evaluation of Probabilistic Algorithms for Mobile Terminal Positioning in Wireless Networks," Diploma thesis, Inst. of Communications Engineering, Univ. of Hannover, Hannover, Germany, May 2007.

Publications

Journal/Magazine Papers

[J3] **M. Khalaf-Allah**, "Nonparametric Bayesian Filtering for Location Estimation, Position Tracking, and Global Localization of Mobile Terminals in Outdoor Wireless Environments," *EURASIP Journal on Advances in Signal Processing*, vol. 2008, Article ID 317252, 14 pages, 2008. doi:10.1155/2008/317252.

[J2] **M. Khalaf-Allah**, "A Novel GPS-free Method for Mobile Unit Global Positioning in Outdoor Wireless Environments," *Springer Wireless Personal Communications Journal*, Special Issue on *Towards Global & Seamless Personal Navigation*, Vol. 44, No. 3, Feb. 2008, pp. 311-322.

[J1] K. Kyamakya, **M. Khalaf-Allah**, A. Popovic, B. Lamprecht, (in German) "Ortungssysteme in der Transportlogistik: Schnell und sicher reagieren," ("Location Systems in the Transport Logistics: Reacting fast and reliably"), *MM Logistik*, Softwareführer 2006/2007, Special Issue, Sep. 2006, pp. 66-67.

Conference/Workshop/Symposium Papers

[C11] **M. Khalaf-Allah**, "Accuracy Assessment of the Position Tracking Filter," in *Proc. European Navigation Conference (ENC-GNSS 09)*, May 3-6, 2009, Naples, Italy.

[C10] **M. Khalaf-Allah**, K. Kyamakya, "Position Tracking and Global Localization of Mobile Terminals in Cellular Networks," in *Proc. 8th IEEE Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2007)*, Jun. 17-20, 2007, Helsinki, Finland.

[C9] **M. Khalaf-Allah**, K. Kyamakya, "Tracking Mobile Terminals in Wireless Networks," in *Proc. 3rd International Conference on Waveform Diversity and Design (WDD 2007)*, Jun. 4-8, 2007, Pisa, Italy, pp. 46-49.

[C8] **M. Khalaf-Allah**, K. Kyamakya, "Accurate GPS-free Positioning of Mobile Units in Wireless Networks," in *Proc. European Navigation Conference (ENC-GNSS 07)*, May 29 – Jun. 1, 2007, Geneva, Switzerland, pp. 45-54.

[C7] **M. Khalaf-Allah**, K. Kyamakya, "Bayesian Mobile Location in Cellular Networks," in *Proc. 14th European Signal Processing Conference (EUSIPCO2006)*, Sep. 4-8, 2006, Florence, Italy.

[C6] **M. Khalaf-Allah**, K. Kyamakya, "Mobile Location in GSM Networks using Database Correlation with Bayesian Estimation," in *Proc. IEEE Symposium on Computers and Communications (ISCC'06)*, Jun. 26-29, 2006, Pula-Cagliari, Sardinia, Italy, pp. 289-293.

[C5] **M. Khalaf-Allah**, K. Kyamakya, "Bayesian Filtering for Localization of Mobile Terminals," in *Proc. 6th International Workshop on Applications and Services in Wireless Networks (ASWN2006)*, May 29-31, 2006, Berlin, Germany, pp. 132-135.

[C4] **M. Khalaf-Allah**, K. Kyamakya, "Database Correlation using Bayes Filter for Mobile Terminal Localization in GSM Suburban Environments," in *Proc. 2006 IEEE 63rd Semi-Annual Vehicular Technology Conference (VTC2006-Spring)*, May 7-10, 2006, Melbourne, Australia, pp. 798-802.

[C3] **M. Khalaf-Allah**, K. Kyamakya, "Mobile Location using Database Correlation with Least-Squares and Bayes Filtering," in *Proc. 12th European Wireless Conference (EW2006)*, Apr. 2-5, 2006, Athens, Greece.

[C2] O. Wulf, **M. Khalaf-Allah**, B. Wagner, "Using 3D Data for Monte Carlo Localization in Complex Indoor Environments," in *Proc. 2nd Bi-Annual European Conference on Mobile Robots (ECMR'05)*, Sep. 7-10, 2005, Ancona, Italy, pp. 170-175.

[C1] C. M. Takenga, A. Waal, **M. Khalaf-Allah**, K. Kyamakya, S. P. Butsana, "Localization of a mobile system using predicted GSM radio signal strengths and neural networks," in *Proc. 9th International Applied Science Conference - Systems and Media of Information Transmission and Processing (SSPOI-2005)*, Sep. 5-10, 2005, Cherkassy, Ukrainia, pp. 112-117.

Theses

[Th3] **M. Khalaf-Allah**, "Bayesian Algorithms for Mobile Terminal Positioning in Outdoor Wireless Environments," PhD thesis, Inst. of Communications Engineering, Univ. of Hannover, Germany, Oct. 2008.

[Th2] **M. Khalaf-Allah**, "A Real-time Implementation of a Probabilistic Localization Method for Mobile Robots," MSc thesis, Inst. of Systems Engineering, Real-time Systems Group, Univ. of Hannover, Germany, Aug. 2004.

[Th1] **M. Khalaf-Allah** *et al.*, "Industrial Robot Programming and Controller Design," Joint BSc thesis, Electrical Power and Machines Dept., Cairo Univ., Egypt, Jun. 1998.

Fakultät für Elektrotechnik und Informatik

Leibniz Universität Hannover

DIE GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER

VERLEIHT MIT DIESER URKUNDE DURCH DIE

FAKULTÄT FÜR ELEKTROTECHNIK UND INFORMATIK

HERRN MASTER OF SCIENCE

MOHAMED KHALAF-ALLAH

GEBOREN AM 25. JUNI 1974 IN ELGIZA / ÄGYPTEN

DEN AKADEMISCHEN GRAD

DOKTOR-INGENIEUR (DR.-ING.)

NACHDEM ER IN EINEM ORDNUNGSGEMÄSSEN PROMOTIONSVERFAHREN DURCH EINE DISSERTATION MIT DEM THEMA

BAYESIAN ALGORITHMS FOR MOBILE TERMINAL POSITIONING IN OUTDOOR WIRELESS ENVIRONMENTS

SOWIE DURCH EINEN VORTRAG UND EINE MÜNDLICHE PRÜFUNG SEINE WISSENSCHAFTLICHE BEFÄHIGUNG ERWIESEN UND DABEI DAS PRÄDIKAT

SEHR GUT BESTANDEN

ERHALTEN HAT.

HANNOVER, DEN 20. OKTOBER 2008

DER PRÄSIDENT
DER GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER

E. Barke

Prof. Dr.-Ing. E. Barke

DER DEKAN
DER FAKULTÄT FÜR ELEKTROTECHNIK UND INFORMATIK

Prof. Dr. sc. nat. H. J. Osten

Research project proposal

Mohamed Khalaf-Allah

My research interests belong to several fields I have been working in during my studies and my current research work: from theoretical areas, e.g. estimation and filtering theory (especially the Bayesian paradigm), to applied areas, e.g. positioning and navigation in many fields (especially mobile robots, land, marine, and air vehicles, mobile terminals in wireless systems and personal navigation).

1 Current projects

InLite (in German) "Indoor-Navigation für Einsätze von Sicherheitskräften auf Pseudolite Basis," "Indoor navigation for employments of security forces based on pseudolites" in collaboration with ESA (European Space Agency).

GOPort (in German) "GALILEO basierte Ortungsverfahren zur Verbesserung von Prozessabläufen auf dem Airport," "GALILEO based location methods for the improvement of process cycles at airports" in collaboration with DLR[1] (Deutsches Zentrum für Luft- und Raumfahrt).

ANASTASIA "Airborne New Advanced Satellite Techniques and Technologies in A System Integrated Approach". EU project.

UniTaS (in German) "Unterstützungsprogramm industrieller Aktivitäten und Technologietransfer auf dem Gebiet der angewandten Satellitennavigation für die Luftfahrt," "Support program of industrial activities and technology transfer in the area of the applied satellite navigation for aviation" in collaboration with DLR.

My research work is mainly focused on designing and developing positioning and navigation algorithms. I do sensor fusion of different sensor data (GNSS, pseudolites, INS, wireless, etc.) using different filtering approaches (particle, Kalman, Bayesian, etc.) and assessing the achievable accuracy of techniques by theoretical performance bounds, e.g. the Cramér-Rao inequality.

2 Future research

There is no widely accepted standard formulation of the "sensor data fusion and processing problem". Also, and to an even larger extent, there is no standard formulation of how sensor data fusion problems should be solved. Instead, there exists an abundance of methods and algorithms for solving various well-defined tasks, where the methods often are very task specific and seldom can be generalized over a wide range of applications. Many of the methods and applications are still in the state of basic research, but more and more methods have found their way into commercial products, where they often constitute a part of a larger

[1] German Aerospace Center.

system which can solve complex tasks. In most practical sensor data fusion applications, the dedicated platforms are pre-programmed to solve a particular task, but methods based on learning are now becoming increasingly common.

The fields, in which sensor data fusion algorithms are widely applied, include e.g. surveillance and security, intelligent transportation systems, robotics, aerospace and automobile applications. There is a significant overlap in terms of what techniques and applications they cover. This implies that the basic techniques that are used and developed in these fields are more or less identical, something which can be interpreted as there is only one field with different names. On the other hand, it appears to be necessary for research groups, scientific journals, conferences and companies to present or market themselves as belonging specifically to one of these fields and, hence, various characterizations which distinguish each of the fields from the others have been presented. A consequence of this state of affairs is that you can be working in a lab related to one of these fields, apply methods from a second field to solve a problem in a third field and present the result at a conference related to a fourth field! Each of the application fields employ a range of sensor data fusion tasks; more or less well-defined measurement problems or processing problems, which can be solved using a variety of methods.

2.2.1 First research direction

Therefore, a future activity I would like to conduct is to contribute to the theoretical unification of the field of sensor data fusion by, e.g. expanding the potential uses of the Bayesian estimation paradigm and theoretical bounds for performance assessment. Bayesian algorithms should prove a seamless behaviour in sensor data fusion problems. They should have mechanisms for early detection of faults and failures in order to easily counteract and handle them. Theoretical performance bounds can be extended to account for false measurements or missed detections and imposed system restrictions. Thus, building a benchmark for objective performance comparison of different approaches and algorithms could be feasible.

A unified approach would help to develop sensor data fusion into an independent interdisciplinary curriculum. This will prove to have a significant impact on designing and facilitating future commercial products demanded by an expanding market of interested consumers and thus more public and society benefits can be obtained.

In spite of the effective use of theoretical performance bounds in many data fusion problems, their applicability to a broader spectrum is restricted by some limitations and shortcomings that may render them useless in real-world situations. Some of these limitations are listed below:

1. They must be evaluated at true state values, which is often not available. Moreover, the use of estimated state values does not result in meaningful performance bounds.
2. Calculation of these bounds involves high computational complexity.
3. They cannot easily handle many data fusion issues, such as correlation, feedback and data incest.
4. They cannot easily handle distributed, networked, hierarchical architectures without approximations.

In view of these shortcomings, the following list can be suggested as possible challenges that need to be overcome in order to make theoretical performance bounds useful in realistic sensor data fusion problems:

1. Computationally efficient bounds in large-scale real-world problems.
2. Bounds that efficiently handle discrete and continuous uncertainties.
3. Bounds for common fusion architectures.
4. Bounds for higher levels of fusion, e.g. classification, intent.
5. Bounds for common data association mechanism, e.g. assignment, multiframe.
6. Breaking points of bounds, e.g. detection of threshold region.

Furthermore, there is still a significant amount of work to be done in applying the results of the theory of global recursive Bayesian bounds to realistic sensor data fusion problems, and taking into consideration the challenges mentioned above. Further promising areas of research are the recursive versions of other covariance inequality bounds.

Whilst considerable effort has been expended by the research community on approaches for state estimation, relatively little attention has been paid to approaches that concentrate on the data association problem. Such techniques as Viterbi and EM algorithms show potential that merits further study in this context. In contrast to the large number of papers on multiple-scan assignment algorithms, other techniques from operations research and combinatorial optimisation (e.g. network theory, integer and linear programming) are somewhat underrepresented in the literature. Fundamental questions remain as to the effectiveness of so-called non-enumerative or *soft association* approaches when compared with conventional *hard association* methods that use a single measurement per track assumption.

2.2.2. Second research direction

Since systems or terminals that perform sensor data fusion tasks might have limited battery resources, energy consumption should be minimized. An important factor in achieving this is to minimize and simplify the computational burden in the data processing and fusion processes. Conventional algorithms use computation-intensive methods that are usually implemented in software and need relatively long execution time. Yet, the very fast growth of modern Very-large-scale integration (VLSI) technology offers a hardware realization of an ever-growing share of mathematical means. New algorithms are needed which satisfy VLSI technology requirements. Moreover, for any kind of application, whether the implementation is done in hardware and/or software, a simpler and faster algorithm always reduces the complexity in terms of time, chip area, and power consumption, by inference. If the system involves automatic control processing, a faster algorithm will improve the quality of the processing by achieving less response times. The above arguments motivate the proposal and development of new simple algorithms for sensor data fusion and processing which can be implemented in hardware using, e.g. a simple field programmable gate array (FPGA) chip. Only simple add, subtract, and shift operations are needed in such algorithms.

2.2.3 General considerations

The equivalence of certain research problems can be recognized and used to apply results from one research area to the other and vice versa. For instance, in 1992 it was made clear that using a significantly larger bandwidth combined with much closer spacing of the early and late reference codes would dramatically improve the ranging accuracy both with and

without multipath. It is somewhat surprising that these facts were not recognized earlier by the GPS community, given that they had been well known in radar circles for many decades.

The future research activities would be at the service of the international sensor data fusion and processing community with the ever-expanding technical expertise and scientific networks. These research activities also would promote the following issues with particular emphasis:

1. Link to major international research labs, university research groups and industry partners in the field of sensor data fusion. These links can be extended to help organize, e.g. joint conferences/workshops/symposia, expert meetings and lecture series.
2. Link to the German sensor data fusion community by establishing, e.g. an annual workshop series and developing it into a dynamic platform where many research activities in Germany on sensor data fusion applications are presented and discussed. Benefits include, e.g. improving direct linking of the national sensor data fusion community.
3. Encourage exchange of PhD students which has been proven as an excellent means for fostering cross-fertilization and flow of ideas in the common and expanding fields of research. This is certainly an interesting possibility for enhancing technical qualification, international competence, and future job opportunities of our graduates.