

# Lav R. Khot

## CONTACT INFORMATION

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## EDUCATION

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<b>Ph.D.</b>	Agricultural and Biosystems Engineering	North Dakota State University	Aug-2009
<b>M.S.</b>	Agricultural and Biosystems Engineering	Iowa State University	Aug-2006
<b>M.E.</b>	Agricultural Systems and Engineering	Asian Institute of Technology, Thailand	Aug-2004
<b>D.A.C.</b>	Post Graduate Diploma in Advanced Computing	CDAC's Advanced Computer Training School, Ahmadabad (Ministry of IT, Govt. of India)	Jan-2002
<b>B.Tech.</b>	Agricultural Engineering	MPKV, Rahuri-India	June-2001

## AWARDS & RECOGNITIONS

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- **Outstanding Reviewer** for the Information & Electrical Technology (IET) division of ASABE journals (year-2010)
- **Frank Bain Dissertation Fellowship**, 2008-2009, NDSU, Fargo, ND
- **Non-Faculty Travel Awards** at NDSU: to present research at 2006 CSBE/ASABE conference, SK, Canada and at 2008 ASABE Annual International Meeting, Providence, RI
- **Special Partial Scholarship**, AIT, Thailand, 2003-2004
- **Brahad Bharti Merit-cum-Scholarship Awards** during B. Tech. for year 1999, 2000

## WORK EXPERIENCE

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**Assistant Research Professor**, Biological Systems Engineering, Washington State University  
(June 2013 –Present)

- *Research Interest: Agricultural Automation Engineering and Food Engineering with major focus towards applied sensor technologies in agricultural production and post-harvest handling and processing.*

*Agriculture Production: Sustainable Agricultural Production Technologies Development, Spray Technology, Low Altitude High Resolution Aerial Imaging, Precision Farming.*

*Food Quality and Safety: Chemical & Optical Sensor(s) Systems.*

**Postdoctoral Research Associate**, Citrus Research and Education Center, University of Florida (July 2009 –May 2013)

- *Sustainable agricultural production technologies: R&D on in-field thermal treatment system for economical reduction of inoculum in huanglongbing (HLB)-infected citrus trees, UAV based low altitude high resolution imaging for early HLB disease detection in citrus orchards.*
- *Variable rate spray technology: R&D on axial-fan airblast sprayer retrofit for precision citrus spraying, design and conduct field experiments, data analysis, reports and publications.*
- *Ultra-low volume and thermal foggers: design and conduct field experiments for efficacy evaluation of spraying equipment to be used to control sandfly in military environment, LiDAR based 3D spray plume visualization and*

*droplet dispersion assessment in stable and unstable micro-meteorological conditions, LiDAR data mining, feature extraction, statistical analysis, reports and publications.*

- *Citrus yield and fruit quality assessment: R&D on LiDAR based bulk fruit volume-mass estimation techniques, Photo-synthetically Active Radiation (PAR) sensors based citrus yield estimation, LiDAR and visible-near infrared spectroscopy based fruit quality monitoring systems development, field testing, reports and publications.*
- *Site specific nutrient estimation and plant stress detection: Characterizing oil palm leaf nutrients and 'Ganoderma' disease using optical sensors (GreenSeeker<sup>®</sup> 505, SPAD-502Plus, Multiplex<sup>®</sup> 3, ASD spectroradiometer, IR-spectroscopy, FTIR), develop decision support through soft computing (pattern recognition, feature extraction and classification).*

**Graduate Research Assistant**, Bio-imaging and Sensing Center, North Dakota State University (Jul 2006 - Jul 2009)

- *Polymer based chemometric and piezoelectric sensors R&D for monitoring volatile biomarkers (VOCs).*
- *R&D on custom e-nose systems for detecting low concentrations of VOCs specific to Salmonella contamination in packaged beef.*
- *Pattern recognition: Wavelet based feature extraction and artificial neural network based learning for packaged beef spoilage and contamination detection.*

**Graduate Research Assistant**, Iowa State University (Jan 2005 - May 2006)

- *Sensors fusion: Development of Extended Kalman filter based sensor fusion algorithm using various navigational sensors for agricultural vehicles localization.*
- *Modeling of 4WS/4WD AgRV platform for dynamic behaviour and stability assessment using Matlab<sup>®</sup> Simulink and SimMechanics toolboxes.*

**Graduate Research Assistant & Research Associate**, Asian Institute of Technology, Thailand (Jan 2003 – Dec 2004)

- *R & D on simulation models of wheel-soil interaction using Discrete Element Method (DEM), model implementation in VB6.0 and SQL server, validation using laboratory experiments, data analysis, reports and publications.*

**Project Facilitation Team Member**, NGO (Grass Roots Action for Social Participation) (June 2002 – Dec 2002)

- *Worked on World Bank project to evaluate poverty in 40 villages (of rural central India) and developing sustainable co-operative projects to improve the livelihood of the farmers via. team building and self-help-groups formation.*
- *Management of project funds, coordinating between government, NGO, and villagers.*

**Programmer**, I-Gen Software Pvt. Ltd., Maharashtra, India (Jan 2002 – May 2002)

- *Development of user-friendly software (using VB 6.0 and SQL server) for co-operative sugarcane factory for centralized database management of famers' sugarcane quantity and their billing cycles.*

## **EXTENSION ACTIVITIES/ARTICLES**

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- José I. Reyes De Corcuera, R. Ehsani, L. Khot. 2012. Understanding the potential of thermal treatments in combatting HLB. *Citrus Industry*, Sept, 2013 (*In Press*).
- Ehsani, R., L. Khot. 2012. Over-the-row mechanical harvesting machine for dwarf and young citrus trees. *Citrus Industry*, Sept, 2012 pp. 10-11.
- Demonstrated variable rate sprayer developed as part of USDA-SCRI project for citrus during 'International Symposium on Mechanical Harvesting & Handling Systems of Fruits and Nuts' field day held on 4 April, 2012 at Lykes Bros., Ft. Basinger, FL.
- Presented a poster on 'Intelligent artificial nose for food safety' as a part of 61<sup>st</sup> Annual Agricultural Technology Expo, held at North Dakota State University, Fargo, ND on Feb 14, 2009. The expo provides an opportunity to present the research work to the public.
- Presented two posters 'An enhanced variable rate axial-fan airblast sprayer for citrus' and 'In-field thermal treatment of Huanglongbing (HLB) infected trees' at 2013 Posters and Pastries Research Gallery, Poster nos. 27-28.

## **TRAINING PROGRAMS**

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- Participant of International course on New Technologies of Agricultural Engineering (in year 2002), held at Beijing, China, organized by Chinese Academy of Agricultural Mechanization Science (CAAMS).

- Training on Design, Fabrication and Quality control of Agricultural Implements (in year 2000) conducted by Popular Steel Works Pvt. Ltd., Maharashtra, India.
- Training on Tractors, Agricultural Machinery Operation and Testing (in year 1999) held at Tractor Training and Testing Center, Madhya Pradesh, India.
- Participant of a semester long advanced leadership program “Masters of Success” in Spring 2008 at North Dakota State University, Fargo, ND. Have participated in life changing ‘Unleash Power Within’ program by Tony Robbins in Orlando, FL in October 2008 as a part of leadership program.

### TEACHING EXPERIENCE/TRAINING

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- North Dakota State University:
  - CFS 471-Food processing laboratory (Teaching Assistant, Fall-2008).
  - “Expanding the Horizon” program volunteer (2007).
- Asian Institute Technology-Thailand: Graduate course curriculum and teaching material preparation for following courses in Agricultural Systems Engineering program
  - ED70.04 : Ergonomics
  - ED70.13 : Agricultural soil mechanics
  - ED70.16 : Controlled environment agriculture

### PROFESSIONAL MEMBERSHIPS/ACTIVITIES

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- *Invited Member of Alpha Epsilon Honour Society*
- *Member of American Society of Agricultural and Biological Engineers since 2005*
- *Member of International Society of Precision Agriculture since 2012*
- *Life Member of Indian Society of Agricultural Engineers since 2004*
- *Active Member of Toastmasters International*
- Reviewer USDA-NIFA (SBIR).
- Reviewer for internationally recognized journals such as: Transactions of ASABE, Applied Engineering in Agriculture, Sensing and Instrumentation for Food Quality and Safety, Journal of Terramechanics, etc.
- Exhibited the research work of our research group during 2009 Agricultural Expo & 2008 Engineers week at Fargo, ND.
- A promotional talk on “NDSU graduate program and opportunities in USA” at Dr. DY Patil College of Agricultural Engineering and Technology, Talsande, Kolhapur (December, 2008) as NDSU student ambassador.
- Participated in an International Conference on, “Biological Sensorics: Critical Technologies for Future Biosystems”, June 15-17, 2007 organized by ASABE in Minneapolis, MN.
- Served as President of Indian Student Association at Asian Institute of Technology, Thailand.

### GRANTS WRITING EXPERIENCE

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#### 2012-13

Automated stress and disease detection in vegetable and tree crops using a cooperative ground and aerial vehicle network and optical sensors (Key Personnel) <b>(Funded)</b>	National Robotics Initiative (NRI-small)
Developing and implementing an aerial remote sensing system for monitoring and characterization of woody perennial plants for improved profitability’ (Co-PI)	USDA-SCRI
Mechanical harvesting and abscission machine enhancement (Key Personnel) <b>(Funded)</b>	IFAS Citrus Initiative

#### 2011-12

Low-cost solar thermal treatment for in-grove reduction of CLas inoculums (Key Personnel) <b>(Funded: \$ 237, 559)</b>	Citrus Research and Development Foundation
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### BOOK CHAPTER

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S. Sankaran, **L. R. Khot**, R. Ehsani. 2013. Mid- and far-infrared spectroscopy. In “Alahakoon et al., Imaging with Electromagnetic Spectrum: Applications in Food and Agriculture”. *Springer (In preparation)*.

## REFEREED PUBLICATIONS

### Precision agriculture and spray technology

- ◆ **Khot, L. R.**, S. Sankaran, J. M. Maja, R. Ehsani, and E. W. Schuster. 2012. Applications of nanomaterials in agricultural production and crop protection: a review. *Crop Protection*, 35: 64-70. [**Most downloaded crop production article from SciVerse ScienceDirect May-2012- July-2013**]. <http://www.journals.elsevier.com/crop-protection/most-downloaded-articles/>
- ◆ **Khot, L. R.**, R. Ehsani, G. Albrigo, P. A. Larbi, A. Landers, J. Campoy, and C. Wellington. 2012. Air-assisted sprayer adapted for precision horticulture: Spray patterns and deposition assessments in small-sized citrus canopies. *Biosystems Engineering*, 113(1): 76-85.
- ◆ Miller, D. R., **L. R. Khot**, A. L. Hiscox, M. Salyani, T. W. Walker and M. Farooq. 2012. Effect of atmospheric conditions on coverage of fogger applications in a desert surface boundary layer. *Transactions of ASABE*, 55(2): 1-11.
- ◆ **Khot, L. R.**, R. Ehsani, G. Albrigo, P. A. Larbi, and A. J. Landers. 2012. Spray pattern investigation of an axial-fan airblast precision sprayer using a modified vertical patternator. *Applied Engineering in Agriculture*, 28(5): 647-654.
- ◆ Yamakawa, M., **L. R. Khot**, R. Ehsani, N. Kondo. 2012. Real-time nondestructive citrus fruit quality monitoring system: development and laboratory testing. *Agricultural Engineering International: CIGR Journal*, 14(3):117-124.
- ◆ **Khot, L. R.**, M. Salyani, M. Farooq, T. W. Walker, R. D. Sweeb, P. A. Larbi, V. Smith, R. Pomolis and C. A. Stoops. 2011. Assessment of aerosol deposition and movement in open field conditions. *Agricultural Engineering International: CIGR Journal*, 31(3): 1-12.
- ◆ **Khot, L. R.**, D. R. Miller, A. L. Hiscox, M. Salyani, T. W. Walker and M. Farooq. 2011. Extrapolation of droplet catch measurements in aerosol application treatments. *Atomization and Sprays*, 21(2): 149-158.
- ◆ **Khot, L. R.**, M. Salyani and R. Sweeb. 2011. Solar and storage degradation of oil- and water-soluble fluorescent dyes. *Applied Engineering in Agriculture*, 27(2): 211-216.
- ◆ **Khot, L. R.**, L. Tang, B. L. Steward and S. Han. 2008. Sensor fusion for improving the estimation of roll and pitch for an agricultural sprayer vehicle. *Biosystems Engineering*, 101(1): 13-20.
- ◆ **Khot, L. R.**, L. Tang, S. Blackmore and M. Nørreremark. 2006. Navigational context recognition for an autonomous robot in a simulated tree plantation. *Transactions of the ASABE*, 49(5): 1579-1588.
- ◆ **Khot, L. R.**, V. M. Salokhe, H. P. W. Jayasuriya and H. Nakasima. 2007. Experimental validation of distinct element simulation for dynamic wheel-soil interaction. *Journal of Terramechanics*, 44(6): 429-437.
- ◆ Khorramnia, K., **L. R. Khot**, R. Ehsani, A. R. B. M. Shariff, S. B. Mansor, A. B. A. Rahim. 2013. Oil palm leaf nutrient estimation by optical sensing techniques. *Applied Engineering in Agriculture (Under Review)*.
- ◆ Jadhav, U., **L. R. Khot**, R. Ehsani, J. K. Schueller. 2013. Volumetric mass flow sensor for citrus mechanical harvesting machines. *Computers and Electronics in Agriculture (Under review)*.
- ◆ **Khot, L. R.**, R. Ehsani, J. M. Maja, J. M. Campoy, C. Wellington. 2013. Evaluation of deposition and coverage of an air-assisted sprayer, and two airblast sprayers in citrus orchards. *Applied Engineering in Agriculture (Under Review)*.

### Sensor technologies for food quality/safety

- ◆ Sankaran, S., **L. R. Khot**, and S. Panigrahi. 2012. Biology and applications of olfactory sensing system: a review. *Sensors and Actuators B*, 171-172, 1-17 [**Most downloaded Sensors and Actuators B article from SciVerse ScienceDirect January-December, 2012**]. <http://top25.sciencedirect.com/subject/chemistry/6/journal/sensors-and-actuators-b-chemical/09254005/archive/42/>

- ◆ **Khot, L. R.**, S. Panigrahi, C. Doetkott, Y. Chang, J. Glower, J. Amamcharla, C. Logue and J. Sherwood. 2012. Evaluation of technique to overcome small dataset problems during neural-network based contamination classification of packaged beef using integrated olfactory sensor system. *LWT - Food Science and Technology*, 45(2): 233-240.
- ◆ **Khot, L. R.**, S. Panigrahi and D. Lin. 2011. Development and evaluation of piezoelectric-polymer thin film sensors for low concentration detection of volatile organic compounds related to food safety applications. *Sensors and Actuators B*, 153(1): 1-10.
- ◆ **Khot, L. R.**, S. Panigrahi and P. Sengupta. 2010. Development and evaluation of chemoresistive polymer sensors for low concentration detection of volatile organic compounds related to food safety applications. *Sensing and Instrumentation for Food Quality and Safety*, 4(1): 20-34.
- ◆ **Khot, L. R.**, S. Panigrahi and S. Woznica. 2008. Neural-network-based classification of meat: evaluation of techniques to overcome small dataset problems. *Biological Engineering*, 1(2): 127-143.
- ◆ Pathan, P. B., **L. R. Khot** and P. A. Unde. 2001. Effect of packaging and storage on quality of pomegranate arils, *Beverage and Food World*, 28(11): 8-14.

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#### REFEREED CONFERENCE PROCEEDINGS PUBLICATIONS

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- ◆ Wellington, C., J. Campoy, **L. Khot**, and R. Ehsani. 2012. Orchard tree modeling for sprayer control, tree inventory, and autonomous navigation. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Algarve, Portugal.
- ◆ Panigrahi, S., Y. Chang, **L. R. Khot**, J. Glower and C. Logue. 2008. Integrated electronic nose system for detection of *Salmonella* contamination in meat. *IEEE Sensor Application Symposium, SAS 2008*: 85-88.

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#### NON-REFEREED CONFERENCE PUBLICATIONS

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- **Khot, L. R.**, S. E. Jones, P. Trivedi, M. R. Ehsani, N. Wang and J. I. Reyes-De-Corcuera. 2013. **Thermal Treatment of Huanglongbing Infected Trees using In-Field Solar Heating System**. ASABE Annual International Meeting, 21-24 July 2013, Kansas City, MI. Abstract number: 1591334.
- Sankaran, S., **L. R. Khot**, J. M. J. Maja, and R. Ehsani. 2013. **Comparison of two multiband cameras for use on small UAVs in agriculture**. 5th IEEE Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing (WHISPERS), 25-28 June 2013, Gainesville, FL.
- **Khot, L. R.**, S. E. Jones, P. Trivedi, M. R. Ehsani, N. Wang and J. I. Reyes-De-Corcuera. 2013. **In-field thermal treatment of Huanglongbing (HLB) infected trees**. Proceedings of the 3<sup>rd</sup> International Conference on HLB, Abstract no. 7.21P.
- **Khot, L. R.**, R. Ehsani, G. Albrigo, W. Swen, J. C. Neto, J. Campoy and C. Wellington. 2012. **Validation of variable rate spray decision rules in intricate micro-metrological conditions**. 11<sup>th</sup> International conference on Precision Agriculture, Indianapolis, IN. ICPA Abstract no.1314.
- **Khot, L. R.**, R. Ehsani, S. D. Tumbo, A. Schumann, W. M. Larzelere and G. Albrigo\*. 2011. **Testing a variable rate airblast sprayer for use in citrus**. AHS 2011 Annual Conference, 25-28 Sept. 2011, Waikoloa, Hawaii. Posters nos. SCRI-13 & Citrus Crops. 65.
- **Khot, L. R.**, J. M. Maja, R. Ehsani and S. Buchanon. 2011. **Citrus canopy volume and yield estimation using photosynthetically active radiation based mobile sensor system**. Presentation at ASABE 2011 Annual International Meeting, Louisville, KY, Aug. 7-10, 2011.
- **Khot, L. R.**, M. Salyani and R. Sweeb. 2010. **Degradation of oil- and water-soluble fluorescent dyes**. Presented at 2010 ASABE Annual International Meeting, Pittsburgh, PA. Paper number: 1008369.

- **Khot, L. R., S. Panigrahi, Y. Chang and J. S Glower. 2008. Olfactory sensing with adaptive wavelet transform for food safety application.** Presented at 2008 ASABE Annual International Meeting, Providence, RI. Paper number: 085240.
- S.Panigrahi, S. Sankaran and **L. R. Khot. 2008. Evaluation of metal oxide-based nano-structured sensing material for detection of compounds associated with meat contamination.** Poster presentation at 2008 Biological Engineering annual conference, Chapel Hill, NC.
- **Khot, L. R., S. Panigrahi, J. S Glower, P. Bhattacharyajee, J. Sherwood and C. Logue. 2007. Temporal analysis of VOC profile of packaged meat during spoilage.** Presented at 2007 ASABE/CSBE North Central Intersectional Meeting, Paper number: RRV-07109.
- **Khot, L. R., S. Panigrahi, J. S Glower, P. Bhattacharyajee, Y. Chang, J. Sherwood and C. Logue. 2007. An automated headspace sampling system for meat safety.** Presented at 2007 ASABE Annual International Meeting, Minneapolis, MN. Paper number: 073101.
- **Khot, L. R. and S. Panigrahi. 2006. Wavelet transform: a tool for pattern recognition of olfactory signal.** Presented at 2006 ASABE/CSBE North Central Intersectional Meeting, Saskatoon, SK, Canada. Paper number: MBSK 06-213.
- **Khot, L. R., L. Tang and K. Hayashi. 2006. Modeling and simulation of a four-wheel-steered agricultural robotic vehicle.** Presented at 2006 ASABE Annual International Meeting, Portland, OR. Paper number: 061106.
- **Khot, L. R., L. Tang, B. L Steward and S. Han. 2006. Sensor fusion for roll and pitch estimation improvement of an agricultural sprayer vehicle.** Presented at 2006 ASABE Annual International Meeting, Portland, OR. Paper number: 061159.
- **Khot, L. R., V.M. Salokhe and H. P. W. Jayasuriya. 2005. Experimental validation of distinct element simulation for dynamic wheel-soil interaction.** Presented at 2005 ASABE Annual International Meeting, Tampa, FL. Paper No: 053120.
- **Khot, L. R., L. Tang, S.B. Blackmore and M. Nørremark. 2005. Posture estimation for autonomous weeding robots navigation in nursery tree plantations.** Presented at 2005 ASABE Annual International Meeting, Tampa, FL. Paper No: 053092.
- **Khot, L. R. H. P. W. Jayasuriya and V. M. Salokhe. 2004. Precision agriculture: problems and strategies to overcome in adoption under Indian conditions.** Presentation at 38th Annual Convention and Symposium of Indian Association of Agricultural Engineers (ISAE), January 16-18, 2004, Dapoli, Maharashtra, India.
- **Khot, L. R. V. M. Salokhe and H. P. W. Jayasuriya. 2004. Tractor operator's comfort and performance: effect of vibration and noise.** Presentation at 38th Annual Convention and Symposium of Indian Association of Agricultural Engineers (ISAE), January 16-18, 2004, Dapoli, Maharashtra, India.