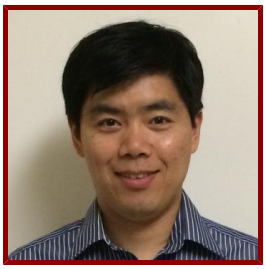
Stanford



Sherman Lo

Sr Research Engineer, Executive Director SCPNT, Program-Walter, T.

Bio

ACADEMIC APPOINTMENTS

- Sr Research Engineer, Executive Director SCPNT, Program-Walter, T.

ADMINISTRATIVE APPOINTMENTS

- Executive Director, Stanford Center for Position Navigation & Time, (2020- present)

HONORS AND AWARDS

- Leadership Award: Signals, GPSWorld (2014)
- Michael Richey Medal, Royal Institute of Navigation (RIN) (2011)
- Medal of Merit, International Loran Association (ILA) (2009)
- Service Award, International Loran Association (ILA) (2009)
- Early Achievement Award, Institute of Navigation (ION) (2005)
- President's Award, International Loran Association (ILA) (2003)
- William L. Polhemus Student Paper Award, International Loran Association (ILA) (2000)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Executive Vice President, Institute of Navigation (ION) (2021 - present)
- Associate Editor, Navigation: The Journal of the Institute of Navigation (2019 - present)
- Associate Editor, Satellite Navigation (2019 - present)
- Technical Advisory Board, UrsaNav (2019 - present)
- Meetings Chair, Institute of Navigation (ION) (2016 - 2021)
- Western Region Vice President, Institute of Navigation (ION) (2013 - 2015)
- Editorial Advisory Board, The Journal of Navigation, Royal Institute of Navigation (RIN) (2012 - present)
- Meetings Chair, Institute of Navigation (ION) (2011 - 2013)
- Board Member, International Loran Association (ILA) (2007 - 2013)
- Secretary, Institute of Navigation (ION), Northern California Chapter (2006 - present)

PROFESSIONAL EDUCATION

- BS, University of Maryland, College Park , Aerospace Engineering (1994)
- BS, University of Maryland, College Park , Mathematics (1994)

- MS, Stanford University , Aeronautics & Astronautics (1995)
- MS, Stanford University , EES&OR (now Managerial Science & Engineering) (1998)
- PhD, Stanford University , Aeronautics & Astronautics (2002)

SERVICE, VOLUNTEER, AND COMMUNITY WORK

- Pre Major Advisor

PATENTS

- Qiu; Di (Menlo Park, CA), Lo; Sherman (San Mateo, CA), Enge; Per (Mountain View, CA), Scott; Logan (Fort Collins, CO), Boneh; Dan (Stanford, CA), Karpf; Ron (Corvallis, OR). "United States Patent 8,391,488 Method and apparatus for using navigation signal information for geoencryption to enhance security", Geocodex, Leland Stanford Junior University, Mar 5, 2013
- Qiu; Di (Menlo Park, CA), Lo; Sherman (San Mateo, CA), De Lorenzo; David S. (Palo Alto, CA), Boneh; Dan (Palo Alto, CA), Enge; Per (Mountain View, CA). "United States Patent 8,315,389 Geosecurity methods and devices using geotags derived from noisy location data from multiple sources", Leland Stanford Junior University, Nov 20, 2012
- David De Lorenzo, Sherman Lo, Per Enge. "United States Patent 8,300,813 Secure Information Transfer Based on Global Position", Oct 31, 2012
- Sherman Lo, Per Enge, C. O. L. Boyce, Nicholas Alexeev. "United States Patent 8,120,533 METHOD AND SYSTEM FOR DERIVING LOCATION INFORMATION FROM UTILITY LINES", Leland Stanford Junior University, Feb 12, 2012
- Peter Levin, David De Lorenzo, Per Enge, Sherman Lo. "United States Patent 8,068,054 Receiver with means for ensuring bona fide of received signals", Nov 29, 2011
- Peter Levin, David De Lorenzo, Per Enge, Sherman Lo. "United States Patent 8,068,533 Receiver for GPS-like signals", Nov 29, 2011
- Peter Levin, David De Lorenzo, Per Enge, Sherman Lo. "United States Patent 8,068,533 Authenticating a signal based on an unknown component thereof", Nov 29, 2011
- Peter Levin, David De Lorenzo, Per Enge, Sherman Lo. "United States Patent 7,969,354 Authenticating a signal based on an unknown component thereof", Jun 28, 2011

Teaching

COURSES

2024-25

- The Global Positioning System: Where on Earth are We, and What Time is It?: AA 115Q (Win)

2023-24

- The Global Positioning System: Where on Earth are We, and What Time is It?: AA 115Q (Win)

Publications

PUBLICATIONS

- **A Framework for GNSS Spoofing Detection Through Combinations of Metrics** *IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS*
  Rothmaier, F., Chen, Y., Lo, S., Walter, T.
  2021; 57 (6): 3633-3647
- **Automatic Dependent Surveillance-Broadcast (ADS-B) Universal Access Transceiver (UAT) transmissions for Alternative Positioning, Navigation, and Timing (APNT): Concept & practice** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Lo, S., Chen, Y.
  2021
- **GNSS spoofing detection through spatial processing** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Rothmaier, F., Chen, Y., Lo, S., Walter, T.
  2021
- **GNSS Spoofing Mitigation in the Position Domain**
  Rothmaier, F., Chen, Y., Lo, S., Walter, T., Inst Navigat

INST NAVIGATION.2021: 42-55

- **Reevaluating the Message Loss Rate of the Wide Area Augmentation System (WAAS) in Flight**
  Hirschberger, M. J., Lo, S., Walter, T., Inst Navigat
  INST NAVIGATION.2021: 218-228
- **ARAIM for Military Users: ISM Parameters, Constellation-Check Procedure and Performance Estimates**
  Katz, A., Pullen, S., Lo, S., Blanch, J., Walter, T., Katronick, A., Crews, M., Jackson, R., Inst Navigat
  INST NAVIGATION.2021: 173-188
- **GNSS interferometric reflectometry signature-based defense** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Lewis, S. W., Chow, C., Geremia-Nievinski, F., Akos, D. M., Lo, S.
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- **An Assessment of GPS Spoofing Detection Via Radio Power and Signal Quality Monitoring for Aviation Safety Operations** *IEEE INTELLIGENT TRANSPORTATION SYSTEMS MAGAZINE*
  Miralles, D., Levigne, N., Bornot, A., Rouquette, P., Akos, D. M., Chen, Y., La, S., Walter, T.
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- **1090 MHz ADS-B-Based Wide Area Multilateration System for Alternative Positioning Navigation and Timing** *IEEE SENSORS JOURNAL*
  Jheng, S., Jan, S., Chen, Y., Lo, S.
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- **Flight test of a pseudo-ranging signal compatible with existing distance measuring equipment (DME) ground stations** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Lo, S., Chen, Y., Enge, P., Pelgrum, W., Li, K., Weida, G., Soelter, A.
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- **Developing a Dual Polarization Antenna (DPA) for High Dynamic Applications**
  Lo, S., Chen, Y., Rothmaier, F., Zhang, G., Lee, C., Inst Navigat
  INST NAVIGATION.2020: 1001–20
- **Characterization of ADS-B Performance under GNSS Interference**
  Liu, Z., Lo, S., Walter, T., Inst Navigat
  INST NAVIGATION.2020: 3581-3591
- **Detection of GNSS Spoofing using NMEA Messages**
  Lee, D., Miralles, D., Akos, D., Konovaltsev, A., Kurz, L., Lo, S., Nedelkov, F.
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- **Robust Satellite Navigation in the Android Operating System using the Android Raw GNSS Measurements Engine and Location Providers**
  Miralles, D., Akos, D. M., Lee, D., Konovaltsev, A., Kurz, L., Lo, S.
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- **Message Design for a Robust Time Signal using Distance Measuring Equipment (DME) Pulse Pair Position Modulated (PPPM) Pseudo lite**
  Lo, S., Chen, Y.
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- **Accommodating Direction Ambiguities in Direction of Arrival based GNSS Spoof Detection**
  Jain, H., Lo, S., Chen, Y., Rothmaier, F., Powell, J., Inst Navigat
  INST NAVIGATION.2019: 274–89
- **Analysis of raw GNSS measurements derived navigation solutions from mobile devices with inertial sensors**
  Lee, D., Petit, M., Miralles, D., Lo, S., Akos, D., Inst Navigat
  INST NAVIGATION.2019: 3812–31
- **Going Back for the Future: Large/Mega LEO Constellations for Navigation**
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- **Improvements to Steady State Spoof Detection with Experimental Validation using a Dual Polarization Antenna**
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  Rothmaier, F., Chen, Y., Lo, S., Powell, J., Inst Navigat
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  Perkins, A., Chen, Y., Lo, S., Lee, C., Powell, J., Inst Navigat
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- **An Augmentation and Integrity Monitoring Network for Railway and Automotive Transportation**
  Salvatori, P., Stallo, C., Coluccia, A., Pullen, S., Lo, S., Neri, A., Inst Navigat
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  Perkins, A., Lo, S., Powell, J., Inst Navigat
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  Strizic, L., Akos, D. M., Lo, S., Inst Navigat
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  Manfredini, E., Akos, D. M., Chen, Y., Lo, S., Walter, T., Enge, P., Inst Navigat
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- **Geometric Rules for Terrestrial Radionavigation Multipath Mitigation by Averaging** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
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  Perkins, A., Chen, Y., Lee, W., Lo, S., Enge, P., INST NAVIGAT
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- **Projected Performance of a Baseline High Integrity GNSS Railway Architecture under Nominal and Faulted Conditions**
  Lo, S., Pullen, S., Blanch, J., Enge, P., Neri, A., Palma, V., Salvitti, M., Stallo, C., INST NAVIGAT
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Kuusniemi, H., Blanch, J., Chen, Y., Lo, S., Innac, A., Ferrara, G., Honkala, S., Bhuiyan, M. H., Thombre, S., Soderholm, S., Walter, T., Phelts, R., Enge, et al
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- **Containing a Difficult Target: Techniques for Mitigating DME Multipath to Alternative Position Navigation and Timing (APNT)** *International Technical Meeting of the Institute-of-Navigation*
  Lo, S., Chen, Y. H., Segal, B., Peterson, B., Enge, P., Erikson, R., Lilley, R.
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- **Potential radio frequency interference with the GPS L5 band for radio occultation measurements** *ATMOSPHERIC MEASUREMENT TECHNIQUES*
  Wolff, A. M., Akos, D. M., Lo, S.
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- **Development of a Real-time GNSS Software Receiver for Evaluating RAIM in Multi-constellation** *International Technical Meeting of the Institute-of-Navigation*
  Chen, Y., Lo, S., Akos, D. M., Choi, M., Blanch, J., Walter, T., Enge, P.
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- **Multipath Benefits of BOC vs. BPSK Modulated Signals Using On-Air Measurements** *International Technical Meeting of the Institute-of-Navigation*
  Lee, C., Chen, Y., Wong, G., Lo, S., Enge, P.
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- **Validation of a Controlled Reception Pattern Antenna (CRPA) Receiver Built from Inexpensive General-purpose Elements During Several Live Jamming Test Campaigns** *International Technical Meeting of the Institute-of-Navigation*
  Chen, Y., Lo, S., Akos, D. M., De Lorenzo, D. S., Enge, P.
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- **Design and Implementation of Real-Time Software Radio for Anti-Interference GPS/WAAS Sensors** *SENSORS*
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- **Calibrating adaptive antenna arrays for high-integrity GPS** *GPS SOLUTIONS*
  De Lorenzo, D. S., Lo, S. C., Enge, P. K., Rife, J.
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- **Signal Structure Study for a Passive Ranging System using Existing Distance Measuring Equipment (DME)** *International Technical Meeting (ITM) of the Institute-of-Navigation (ION)*
  Lo, S. C., Enge, P. K.
  INST NAVIGATION.2012: 97–107

- **The Need for a Robust Precise Time and Frequency Alternative to Global Navigation Satellite Systems**
  Narins, M., Enge, P., Peterson, B., Lo, S., Chen, Y., Akos, D., Lombardi, M., ION
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- **Capacity Study of Multilateration (MLAT) based Navigation for Alternative Position Navigation and Timing (APNT) Services for Aviation** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
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- **Assessing the Capability of Distance Measuring Equipment (DME) to Support Future Air Traffic Capacity** *NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION*
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  Seo, J., Chen, Y., De Lorenzo, D. S., Lo, S., Enge, P., Akos, D., Lee, J.
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- **Alternative Position Navigation & Timing (APNT) Based on Existing DME and UAT Ground Signals** *24th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS)*
  Lo, S. C., Peterson, B., Akos, D., Narins, M., Loh, R., Enge, P.
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- **Capacity Study of Two Potential Alternative Position Navigation and Timing (APNT) Services for Aviation** *International Technical Meeting of the Institute of Navigation*
  Lo, S. C., Enge, P.
  INST NAVIGATION.2011: 192–205
- **Reliable Location-Based Services from Radio Navigation Systems** *SENSORS*
  Qiu, D., Boneh, D., Lo, S., Enge, P.
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- **Improving Loran Coverage with Low Power Transmitters** *JOURNAL OF NAVIGATION*
  Lo, S. C., Peterson, B. B., Hardy, T., Enge, P. K.
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- **Methodology and Design for the Broadcast of GNSS Integrity Information derived from SBAS on Low Bandwidth Data Channels** *NAVIGATION-THE JOURNAL OF THE INSTITUTE OF NAVIGATION*
  Lo, S. C., Enge, P. K.
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- **Preliminary Assessment of Alternative Navigation Means for Civil Aviation** *2010 International Technical Meeting of the Institute-of-Navigation*
  Lo, S., Niles, F., Loh, R., Eldredge, L., Narins, M.
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- **Simple Loran Cycle Error Detection Algorithms for Maritime Harbor Entrance Approach Operations** *2010 International Technical Meeting of the Institute-of-Navigation*
  Peterson, B. B., Lo, S. C., Enge, P. K.
  INST NAVIGATION.2010: 472–479
- **Authenticating Aviation Augmentation System Broadcasts** *Position Location and Navigation Symposium (PLANS)*
  Lo, S. C., Enge, P. K.
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- **The WAAS/L5 Signal for Robust Time Transfer: Adaptive Beamsteering Antennas for Satellite Time Synchronization** *23rd International Technical Meeting of the Satellite Division of the Institute-of-Navigation (ION GNSS-2010)*
  De Lorenzo, D. S., Lo, S. C., Seo, J., Chen, Y., Enge, P. K.
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- **Compass-M1 Broadcast Codes in E2, E5b, and E6 Frequency Bands** *IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING*
  Gao, G. X., Chen, A., Lo, S., De Lorenzo, D., Walter, T., Enge, P.
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- **Physical Pseudo Random Function in Radio Frequency Sources for Security** *2009 International Technical Meeting of the Institute-of-Navigation*
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- **Developing and Validating the Loran Temporal ASF Bound Model for Aviation** *NAVIGATION-THE JOURNAL OF THE INSTITUTE OF NAVIGATION*
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INST NAVIGATION.2009: 586–597

- **Design and Performance of a Minimum-Variance Hybrid Location Algorithm Utilizing GPS and Cellular Received Signal Strength for Positioning in Dense Urban Environments** *2009 International Technical Meeting of the Institute-of-Navigation*
  De Lorenzo, D. S., Lo, S. C., Enge, P. K., Feuerstein, M., Bhattacharya, T. K., Spain, S., Kang, Z.
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- **Pattern Classification for Geotag Generation** *22nd International Technical Meeting of the Satellite Division of the Institute-of-Navigation (ION GNSS-09)*
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- **A measure of Loran location-based information** *IEEE/ON Position, Location and Navigation Symposium*
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- **Assessment of the Methodology for Bounding Loran Temporal ASF for Aviation** *2008 National Technical Meeting of the Institute-of-Navigation*
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  Qiu, D., Lo, S., Enge, P., Boneh, D., Peterson, B.
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- **Proving the Integrity of the Weighted Sum Squared Error (WSSE) Loran Cycle Confidence Algorithm** *NAVIGATION-THE JOURNAL OF THE INSTITUTE OF NAVIGATION*
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  Gao, G. X., De Lorenzo, D. S., Chen, A., Lo, S. C., Akos, D. M., Walter, T., Enge, P.
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  Lo, S. C., Peterson, B. B., Enge, P. K.
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