SMART MOBILITY RESEARCH AT BGU

The Center for Integrative Transportation Innovation

אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

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SMART MOBILITY RESEARCH AT BEN-GURION UNIVERSITY OF THE NEGEV

The Center for Integrative Transportation Innovation

Ben-Gurion University of the Negev operates the CITI (Center for Integrative Transportation Innovation), a research center dedicated to smart integrated transportation. The Center is comprised of about 40 senior researchers from a range of faculties and disciplines at the university.

The researchers are involved in a range of aspects of transportation systems, such as urban and metropolitan planning, road safety, automatic/autonomous driving, V2X, information security and cyber security, advanced learning methods (AI, Deep Learning, Distributed Agent Computing, Behavioral Programming, etc.), sensors, big data (advanced statistical methods, information mining, visualization), mathematical models (performance research, optimization, game theory), energy solutions (alternative fuels, electric energy), mechanical design of vehicles (BGRacing team), economics (incentives and their implications) and more.

The above list illustrates the CITI's comprehensive approach, which strives to utilize the capabilities developed at BGU's Faculty of Engineering (which includes 13 departments and units, engaged in all fields of engineering) as well as in the faculties of Management, Natural Sciences, Life Sciences and the humanities and social sciences.

This brochure introduces CITI's researchers, and the subjects of their diverse research activities related to transportation fields.

We invite you to contact us and explore possible cooperation.

Traffic-signal-to-vehicle communication applications and their impact on driver behavior

Prof. Hillel Bar-Gera
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Expertise
Quantitative transportation analysis, transport models, traffic safety, ITS

OBJECTIVE

Advancement in communication technologies enables digital transfer of information about their current status from traffic signals to in-vehicle devices (e.g. smart phones). This information can be used to assist drivers with the decisions they need to make when the green phase ends, or to prepare for driving before the green phase starts. The purpose of this research is to examine the effects of these applications on driver behavior in an on-road driving experiment.

DESCRIPTION

The communication between traffic signal controllers and vehicles is implemented in two primary ways: through cellular connection, and through Dedicated Short Range Communication (DSRC). The latter option is based on technology developed by Autotalks. In the experiment, 100 subjects drive along a prescribed route in Beer-Sheva, with and without the system, and their behavior is monitored.

APPLICATIONS & PRODUCTS

This empirical research project is practically-oriented, with direct application to products that support the driving task, such as navigation applications, advanced driver assistance systems (ADAS), safety applications, and more. The communication channel can also be used for additional products, in which the traffic signal responds to the information provided by surrounding vehicles.

RELEVANT PUBLICATIONS

- Bar-Gera, H., Schechtman, E. & Musicant, O. (2017). Evaluating the Effect of Enforcement on Speed Distributions using Probe Vehicle Data. Transportation Research Part F, 46: 271–283
- Bar-Gera, H., Musicant, O., Schechtman, E. & Ze'evi, T. (2016). Quantifying the Yellow Signal Driver Behavior Based on Naturalistic Data From Digital Enforcement Cameras. Accident Analysis and Prevention, 96: 371–381.
- Gardner, L.M., Boyles, S.D., Bar-Gera, H. & Tang, K. (2014). Robust Tolling Schemes for High-Occupancy Toll Facilities Under Variable Demand. Transportation Research Record, 2450: 152-162.
- Blumberg Nitzani, M. & Bar-Gera, H. (2014). The effect of signalised intersections on dynamic traffic assignment solution stability. Transportmetrica A: Transport Science, 10(7): 622-646.
- Bar-Gera, H. & Carey, M. (2017) Representation requirements for perfect first-in-first-out verification in continuous flow dynamic models. Transportation Research Part B, 100: 284–301.

Machine learning for perception

Dr. Aharon Bar-Hillel
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Expertise
Computer learning

DESCRIPTION

At present work focuses mostly on deep learning methods.

Topics of interest include:

- Phenomics: solving complex visual discrimination problems in agricultural settings
- Autonomous robotic kit assembly with pose estimation networks and deep reinforcement learning
- Ultra sound imaging with deep learning and inverse problems in general
- Understanding and visualization of hidden layers in deep networks
- Visual object tracking

In the past, was a researcher in General Motors Research, working on active safety features and toward autonomous driving.

Has written papers about:

- Object detection and pose estimation, specifically: pedestrian detection
- Visual object tracking, specifically: vehicle tracking
- RADAR target classification
- Lane detection

RELEVANT PUBLICATIONS

- See the home page at: https://sites.google.com/site/aharonbarhillel/
- Google scholar citation: https://scholar.google.com/citations?user=x4GlT3IAAAAJ&hl=en

Serious games for positioning the transportation of tomorrow

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Expertise
Transportation models, travel behavior analysis

OBJECTIVE

My research aims to utilize smart mobility solutions, based on ICT architectures, to shape travel behavior and achieve social and sustainability goals in smart cities. My objectives are to understand how emerging technologies can influence human spatial behaviors (choice of location, mode, route, time of travel) and how this behavior interacts with the performance of the transportation system as a whole. I also use big data from pubic sources to study travel patterns and dynamics, including: smartcards, mobile phones, automatic vehicle locations for public transit and bike-sharing.

DESCRIPTION

I established and lead the GAMESlab, where we study the behavioral and operational dynamics of transportation systems based on three methodological pillars: big data, serious games (including virtual reality) and agent-based simulation models. I am PI in an ISF grant investigating the use of travel information and incentives strategies to promote the emergence of cooperation for the optimization of road traffic. Another ISF grant applies simulations and games to understand parking choice dynamics and find optimal pricing and zoning. Another project is aimed at understanding future traveler shifts towards ridesharing in autonomous vehicles using surveys, games and simulations. In research projects related to transit systems, I use big data analytics, including: smartcard analysis for extracting spatial and temporal travel behavior patterns, Automatic Vehicle Location for transit service reliability analysis and smart transit network design based on mobile phone records.

APPLICATIONS & PRODUCTS

- System-optimal vehicle routing
- Parking pricing and optimal zoning
- Public transportation reliability and usage
- Adaptive public transportation
- Adoption of shared autonomous vehicles

RELEVANT PUBLICATIONS

- Klein, I., Levy N. & Ben-Elia, E. (2018). An agent-based model of the emergence of cooperation and a fair and stable system optimum using ATIS on a simple road network. Transportation Research C, 86: 183-201.
- Klein, I. & Ben-Elia, E. (2016). Emergence of cooperation in congested road networks using ICT and future and emerging technologies: A game-based review. Transportation Research C, 72: 10-28
- Ben-Elia, E. & Avineri, I. (2015). Response to travel information: A behavioural review. Transport Reviews, 35: 352-377.
- Ben-Elia, E., Di-Pace, R., Bifulco, G. N. & Shiftan, Y. (2013). The impacts of information's accuracy on route-choice. Transportation Research C, 46: 146–159.
- Ben-Elia, E. & Ettema, D. (2011). Rewarding rush-hour avoidance: A study of commuters' travel behavior, Transportation Research A, 45: 567-582.
- Ben-Elia, E. & Shiftan, Y. (2010). Which road do I take? A learning-based model of route choice with real-time information. Transportation Research A, 44: 249-264.

Human factors in traffic safety and automated driving

Dr. Avinoam Borowsky
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Expertise
Human factors, driver behavior, man-machine interaction, eye tracking, scenario design

OBJECTIVE

My main research interests are human factors in traffic safety. I am mostly interested in understanding and modeling driver behavior under various conditions such as driver distraction, automated driving, and stress and fatigue, as well as understanding the effect of age and driving experience on drivers' performance. I am also interested in understanding the interaction between drivers and automated vehicles and in-vehicle technologies, including issues such as transfer of control, driver comfort and behavioral adaptation.

DESCRIPTION

The main topic studied currently in the Human Performance Evaluation Lab is drivers' interactions with fully autonomous and partially automated driving. Some of the studies focusing on fully autonomous driving deal with the question of how autonomous vehicles should behave so that passengers of such vehicles will accept and trust the technology and will feel comfortable and safe using such vehicles. Our studies on partial automation focus on better understanding how drivers adapt to new technologies and how well they perform when manual driving is required.

APPLICATIONS & PRODUCTS

We are interested in designing scenarios and experiments that will allow us to optimally investigate the interaction between drivers, the traffic environment and new continuously developing in-vehicle technologies.

RELEVANT PUBLICATIONS

- Borowsky, A. & Oron-Gilad, T. (2016). The effects of automation failure and secondary task on drivers' ability to mitigate hazards in highly or semi-automated vehicles. Advances in Transportation Studies, 1: 59-70.
- Borowsky, A., Horrey, W.J., Liang, Y., Garabet, A., Simmons, S. & Fisher, D.L. (2016). The effects of brief visual interruption tasks on drivers' ability to resume their visual search for a pre-cued hazard. Accident Analysis and Prevention, 93: 207-216.
- Samuel, S., Borowsky, A., Zilberstein, S. & Fisher, D.L. (2016). Minimum time to situation awareness in scenarios involving transfer of control from an automated driving suite. Transportation Research Record, 2602(1): 115-120.

The effects of in-cabin music on driver perception and vehicular control

Prof. Warren Brodsky
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Music Science Lab
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Expertise
Use of music in automotive branding, effects of music on driver behavior and vehicular performance

OBJECTIVE

- Music applications for branding automobiles.
- We conduct empirical and applied research concerning the effects of music on driver behavior and vehicular performance. The studies employ driving simulators and on-road demonstrations.

APPLICATIONS & PRODUCTS

- Model for automotive music branding based on engineering design language.
- In-Car Music: An Alternative Music Background Designed For Driver Safety. An original 40 minute music program. Composed and arranged by Israeli composer Micha Kizner. Recorded in a professional recording studio with five top Israeli studio players. Validated by Brodsky & Slor (2013) in on-road study funded by the Israel National Road Safety Authority (RSA).

RELEVANT PUBLICATIONS

- Brodsky, W. (2002). The effects of music tempo on simulated driving performance and vehicular control. Transportation Research, F, 4: 219-241.
- Brodsky, W. (2011). Developing a functional method to apply music in branding: design language generated music. Psychology of Music, 39(2):261-283.
- Brodsky, W. & Kizner, M. (2012). Exploring an alternative in-car music background designed for driver safety. Transportation Research, F, 15(3): 162-173.
- Brodsky, W. & Slor, Z. (2013). Background music as a risk factor for distraction among young-novice drivers. Accident Analysis & Prevention, 59: 382-393.
- Brodsky, W. (2014). Driving while listening to music. In: B. Thompson & J. G. Golson (eds), Music in the Social and Behavioral Sciences: An Encyclopedia, Pp. 341-345. London: Sage.
- Brodsky, W. (2015). Driving With Music: Cognitive-Behavioural Implications. Human Factors in Road and Rail Transportation Series. CRC Press, Taylor & Francis.
- Brodsky, W., Olivieri, D. & Chekaluk, E. (2018). Music-genre induced driver aggression: a case of media delinquency and risk-promoting popular culture. Music & Science, 1(1): 1-17.
- Brodsky, W. (2018). A Performance analysis of in-car music engagement as an indication of driver distraction and risk. Transportation Research, F, 55: 210-218.

Development of autonomous systems using script-guided languages

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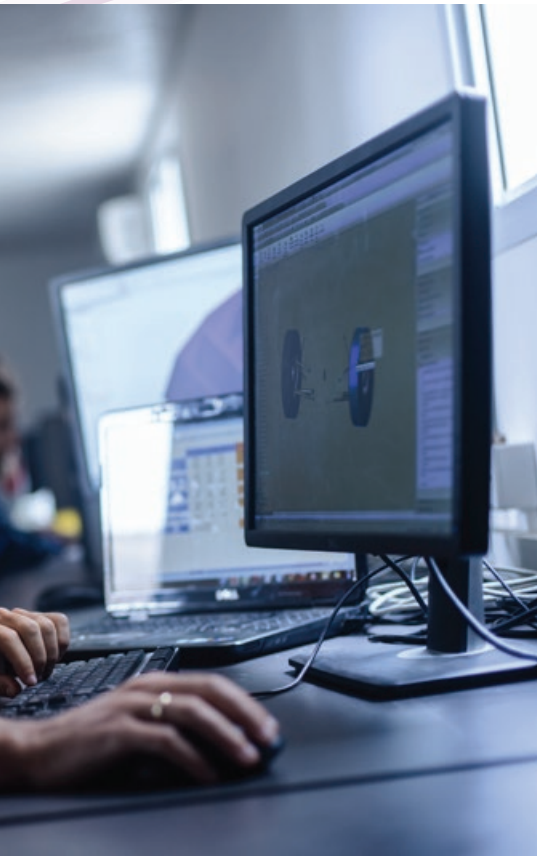
Expertise
Software engineering, Internet-of-Things



OBJECTIVE

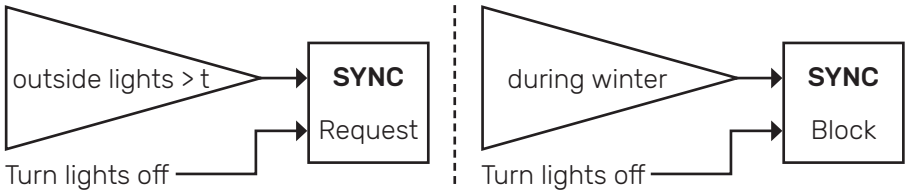
I am interested in the development of a simple contextual language and a computation model for modeling reactive systems for autonomous vehicles, traffic management, the Internet-of-Things, and more.

DESCRIPTION:

I am working on a model that allows visual specification of how systems interact and react to the environment. The specification is then translated to a functioning reactive system. Because the model is built by weaving independent scenarios (a.k.a., behavioral-programming), programmers can easily build bugless complex behaviors (as our experimental research shows).

Consider, for example, a requirement to turn off the lights of an autonomous car if the outside light level is above a threshold t. Another requirement, though, may forbid turning off car lights during the winter. Our approach allows for specifying these requirements independently, while weaving them at runtime.

Fig. 1 The two independent scenarios are synced during runtime



APPLICATIONS & PRODUCTS

Our model is aimed at a reactive system and is currently used in developing complex systems, such as smart buildings, satellites, and safety-assistance systems for cyclists.

RELEVANT PUBLICATIONS

- Elyasaf, A., Harel, D., Marron, A. & Weiss, G. (2017). Towards integration of context-based and scenario-based development. Federation of International Conferences on Software Technologies: Applications and Foundations, Cham 2017, pp. 225-231.
- Marron, A., Arnon, B., Elyasaf, A., et al. (2016). (im)possible things before breakfast: Building-blocks and design-principles for wise computing. D&P@ MoDELS, 2016, pp. 94-10.

Autonomous vehicles

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Expertise
Autonomous robotics

OBJECTIVE

Provide know-how and solutions in all areas related to Autonomous Robotics. Specific areas of research include: autonomous platforms, computer architecture, control, image and signal processing, neural networks and fuzzy logic, electrochemical processes, robotics, biomedicine, biotechnology and biosensors.

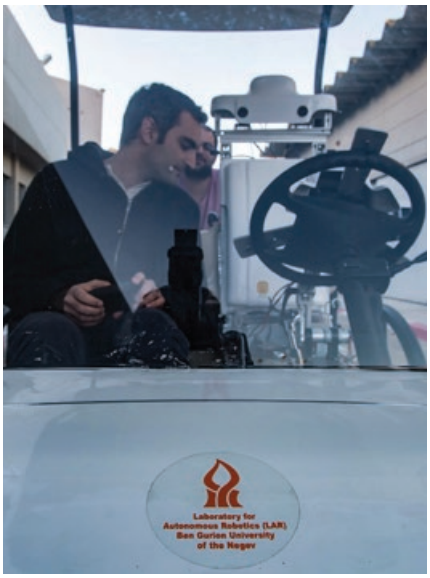
DESCRIPTION

The Laboratory for Autonomous Robotics was founded in 1998. Due to the complexity and interdisciplinary nature of autonomous robotics, researchers and students from different disciplines work in close collaboration, combining the practical and the theoretical in diverse approaches to robotics science. The LAR has made great research achievements in autonomous vehicles, defense, space-related robots, cognition, computer vision and graphics and anthropomorphic robots. Autonomous vehicles include unmanned aerial vehicles (UAV), unmanned ground vehicles (UGV), unmanned sea and underwater vehicles (UUV). The LAR is a member of Team Avant-Guardium in the DARPA Urban Grand Challenge and in DARPA's Robotics.

Recently, LAR developed the Hydro Camel I & II, the first ISraeli autonomous submarine. Further developments include the Intelligent Vehicle Operator (IVO) and FIND, a central vascular access solution. For the past four years LAR' researchers conducted basic and applied research in UUV, UAV, UGV and instrumentation technologies relevant to defense, industrial, transportation, biomedicine and oceanography tasks.

APPLICATIONS & PRODUCTS

LAR has extensive experience fusing basic research with practical systems. This capability has enabled producing complete systems and the creation of three spin-off companies.



RELEVANT PUBLICATIONS

- H. Guterman & O. Yecheli. Universal Autonomous Robotic Driving System. WO 2016178213 A1.
- H. Guterman, A. Kolaman & R. Hagage. Methods of Producing Video Images That are Independent of the Background Lighting. PCTIIL2017/050287.
- A. Kolaman, M. Levov, R. Hagage & H. Guterman (2016). Amplitude Modulated Video Camera - Light Separation in Dynamic Scenes. IEEE Conference on Computer Vision and Pattern Recognition (CVPR).
- B. Braginsky & H. Guterman (2016). Obstacle Avoidance Approaches for Autonomous Underwater Vehicle: Simulation and Experimental Results. IEEE Journal of Oceanic Engineering 41: 4.

Automobile safety via LIDAR

Prof. (Emer.) Natan Kopeika
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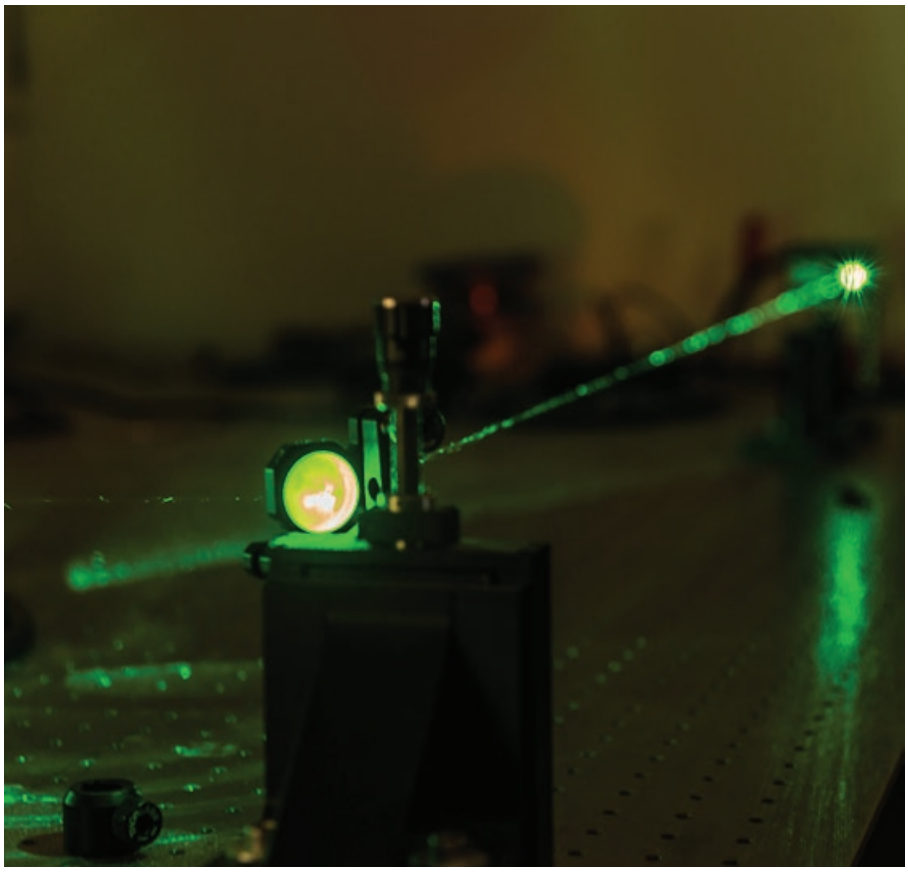
Expertise
Imaging systems, MMW systems

OBJECTIVE

I'm interested in designing optical and millimeter wave efficient and secure imaging, lidar, and communication systems between vehicles themselves (V2V) and between vehicles and infrastructure (V2I), as well as pedestrian and other object avoidance systems.

APPLICATIONS & PRODUCTS

High speed active and passive imaging can be used to prevent collisions with other vehicles and pedestrians, as well as other objects. We are developing ultra high speed 3-dimensional imaging and wireless mm wave communication systems that can be used for such purposes.



RELEVANT PUBLICATIONS

- O. David, N.S. Kopeika & B. Weizer (2006). Range-gated Active Night Vision System for Automobiles. Applied Optics, 45: 7248-7254.
- A. Abramovich, N.S. Kopeika & D. Rozban (2008). Design of Inexpensive Diffraction Limited Focal Plane Arrays for mm Wavelength and Terahertz Radiation Using Glow Discharge Detector Pixels, J. Appl. Phys, 104: 033302-1 –033302 -4.
- A. Aharon, D. Rozban, A. Abramovich, Y. Yitzhaky & N. Kopeika (2016). Detection and upconversion of three-dimensional MMW/THz images to the visible. Photonics Res. 4 (6): 306-312. DOI: 10.1364/PRJ.4.000306.
- A. Aharon, D. Rozban, A. Abramovich, Y. Yitzhaky & N.S. Kopeika (2017). MMW/THz Imaging using Upconversion to Visible, Based on Glow Discharge Detector Array and CCD Camera. Counterterrorism, Crime Fighting, Forensics, and Surveillance Technologies, Proc. SPIE, vol. 10441, DOI: 10.1117/12.2278067.

Mining telematics data streams for predictive vehicles maintenance

Prof. Mark Last
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Expertise
Data science

OBJECTIVE

- Issue an early warning of a failure expected in certain systems or subsystems of an individual vehicle with Telematics-based sensory data and warranty failure data.
- Predict failures expected in certain systems or subsystems of an individual vehicle beyond the warranty period from a very limited amount of post-warranty failure data.
- Predict certain important values (e.g. voltage, pressure, etc.) in an individual vehicle.

DESCRIPTION

Prof. Mark Last and his team worked on a joint project with the General Motors India Science Lab during which they developed:

1. An initial version of the Early Warning Algorithmic Tool using a fuzzy logic algorithm, which is capable of detecting positive and negative shifts in time-to-failure and mileage-to-failure distributions from warranty data.
2. Various prediction algorithms, including decision-tree, single-target and multi-target Info-Fuzzy Networks (IFN and M-IFN), Naïve Bayes, and MetaCost, were applied to GM Telematics-based sensory data. These were then evaluated on the basis of the trade-off between accurate prediction of a critical failure ("true positive rate"), "false alarm" rate, and the size of each model (number of prediction rules). The M-IFN construction algorithm produced a compact and interpretable model of 14 rules estimating the probability distributions of two target attributes (Battery Failure and Time to Failure).
3. Four different failure types of warranty claims were used to build multi-dimensional failure prediction models. We developed a new failure probability estimation algorithm, which automatically chooses the best subset of discrete and continuous predictive dimensions, as well as the best number of equal-size intervals for each continuous predictive dimension.

APPLICATIONS & PRODUCTS

A predictive maintenance system, which can be installed on any autonomous or non-autonomous vehicle.

RELEVANT PUBLICATIONS

- M. Last, Y. Mendelson, S. Chakrabarty & K. Batra (2009). Early Warning from Car Warranty Data using a Fuzzy Logic Technique. In: Scalable Fuzzy Algorithms for Data Management and Analysis: Methods and Design. Laurent and Lesot (Editors), IGI Global, pp. 347-364.
- M. Last, A. Sinaiski & H. S. Subramania (2010). Predictive Maintenance with Multi-Target Classification Models. ND2 International Conference on Intelligent Information and Database Systems (ACIIDS 2010), Hue City, Vietnam, Springer-Verlag, Lecture Notes in Artificial Intelligence, 5991: 368-377.
- M. Last, A. Sinaiski & H. S. Subramania (2011). Condition-based Maintenance with Multi-Target Classification Models, New Generation Computing (Special Issue on Hybrid and Ensemble Methods in Machine Learning), 29, 3: 245-260.
- M. Last, A. Zhmudyak, H. Halpert & S. Chakrabarty (2013). Multi-dimensional Failure Probability Estimation in Automotive Industry Based on Censored Warranty Data. In: Synergies of Soft Computing and Statistics for Intelligent Data Analysis, Springer, Advances in Intelligent Systems and Computing, 190: 507-515.

Game theory and incentives in transportation settings

Dr. Omer Lev
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Expertise
Game theory, AI

OBJECTIVE

Understanding the interaction and behavior of multiple agents – humans or otherwise – in an intricate environment.

DESCRIPTION

Using game-theoretic analysis, I examine what motivates the behavior of agents (for example, choosing a particular route to their destination), and use decision-making models to see how they adapt their behavior to various incentives.

APPLICATIONS & PRODUCTS

Analysis of routing structure and its load under various behavioral assumptions.

Incentives design to entice particular desired behaviors.

RELEVANT PUBLICATIONS

- Lev, O., Tennenholtz, M. & Zohar, A. (2015). An Axiomatic Approach to Routing. Proceedings TARK 2015, arXiv:1606.07295: 194–206. DOI: 10.4204/EPTCS.215.14
- Meir, R., Lev, O. & Rosenschein, J.S. (2014). A Local-Dominance Theory of Voting Equilibria. EC 2014. DOI: 10.1145/2600057.2602860

Automotive research at the Center for Power Electronics and Mixed-Signal IC

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Dr. Michael Evzelman
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Department of Electrical and Computer Engineering
Center for Power Electronics and Mixed-Signal IC
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Expertise
Wireless power transfer, powered roadways, transportation system integration, energy storage, intelligent control, IC design

OBJECTIVE

Advancing cutting-edge fundamental and applicative research in power conversion, energy storage and electronics miniaturization techniques, with the goal to achieve an integrated transportation system in support of higher quality of life and a cleaner environment. With a special emphasis applied to productization and manufacturability of the concepts.

DESCRIPTION

Transportation electrification is an important global trend. The implications are broad, spanning several domains: environmental, social and technological.

The PEMIC Center presents the facilities, equipment, and highly trained personnel for carrying out research in the field of Transportation Systems Integration. The experience and background in industry collaboration of the key personnel, enable the advancement of research towards application in a product, i.e. building in-house laboratory prototypes.

The Center includes state of the art measurement equipment, high/low voltage/current sources, soldering and design capabilities, IC design software and PDKs of several foundries.

APPLICATIONS & PRODUCTS

- Wireless power transfer in continually moving environments: VR helmets, vehicles, robots, drones, etc.
- Fast charging of battery powered equipment
- Electromagnetic payload transportation
- Battery balancing and optimization for lifetime and performance benefits
- IC design analog and digital, converter miniaturization
- Power management

RELEVANT PUBLICATIONS

- N. Dahan, M. M. Peretz & I. Zeltser (2017). Cell-level hybrid architectures for active balancing of serially-connected batteries, IEEE Applied Power Electron. Conf. and Exposition (APEC), Tampa, FL, pp. 2382-2389
- M. Evzelman, M. M. Ur Rehman, K. Hathaway, R. Zane, D. Costinett & D. Maksimovic (2016). Active Balancing System for Electric Vehicles With Incorporated Low-Voltage Bus, IEEE Trans. on Power Electron., 31(11): 7887-7895.
- B. Mahdavikhah, M. Peretz & A. Prodic (2012). Low-volume power supply for vehicular fuel injection systems, IEEE Conf. on Industrial Electron., Montreal, pp. 531-536.
- A. Cervera, Z. Rubinshtein, M. Gad, R. Riemer & M. M. Peretz (2016). Biomechanical Energy Harvesting System With Optimal Cost-of-Harvesting Tracking Algorithm, IEEE Journal of Emerging and Selected Topics in Power Electron., 4(1): 293-302.
- O. Kirshenboim, A. Cervera & M. M. Peretz (2017). Improving Loading and Unloading Transient Response of a Voltage Regulator Module Using a Load-Side Auxiliary Gyrator Circuit, IEEE Trans. on Power Electron., 32(3): 1996-2007.

*Check PEMIC website for more information

Routing betweenness centrality for monitoring transportation networks

Dr. Rami Puzis
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Expertise
Network analysis, cyber security

OBJECTIVE

Apply machine learning to learning the routing schemes of drivers during different parts of the day/week in order to develop generic and easy to compute centrality measures for transportation networks.

DESCRIPTION

'Routing Betweenness Centrality' algorithms rely on arbitrary probabilistic loop free routing strategy in order to compute the centrality of nodes, links, or groups thereof. Such a scheme can be represented as a function which outputs the probability of a driver taking a specific turn given the properties of the junction, the roads, his final destination and contextual information. Some of these properties may include centrality indices computed using traditional methods. Such a probabilistic routing function can be learnt using standard machine learning algorithms given a training set of driver routes. These routes can either represent the real measured routes or be computed through traditional (heavyweight) traffic assignment algorithms. Once the probabilistic routing function is devised, Routing Betweenness Centrality can use it to efficiently compute the coverage of any set of deployed monitors or optimize their deployment.

APPLICATIONS & PRODUCTS

- Traffic monitoring
- Camera / radar placement
- Optimization of police patrols

RELEVANT PUBLICATIONS

- S. Dolev, Y. Elovici & R. Puzis (2010). Routing Betweenness Centrality. Journal of the ACM, 57 (4): 1-27.
- Y. Altshuler, R. Puzis, Y. Elovici, S. Bekhor & A. Pentland (2011). Augmented Betweenness Centrality for Mobility Prediction in Transportation Networks. Finding Patterns of Human Behaviors in NEtwork and MObility Data (NEMO).
- R. Puzis, Y. Altshuler, Y. Elovici, S. Bekhor, Y. Shiftan & A. Pentland (2013). Augmented Betweenness Centrality for Environmentally-Aware Traffic Monitoring in Transportation Networks. Journal of Intelligent Transportation Systems, 17(1): 91–105.
- R. Puzis, Y. Altshuler, Y. Elovici, S. Bekhor & A. Pentland (2015). On the Rationality and Optimality of Transportation Networks Defense: A Network Centrality Approach. In: Securing Transportation Systems, Y. Shiftan (ed), Springer.

Planning urban movement

Dr. Yodan Rofè
Department of Geography and Environmental Development
yrofe@bgu.ac.il

Expertise
Urban design, street design, urban planning

OBJECTIVE

Developing models that explain pedestrian movement and activity in urban space.

Finding ways to improve sense of well-being and safety for pedestrians on urban streets.

DESCRIPTION

My research concentrates on making streets into multi-functional entities capable of supporting social and economic life in cities. We work on both configurational models, modeling how the network of streets shapes human movement, which in turn influences other social and economic aspects of the city, and perceptual and spatial models looking into how the local environment influences choice of movement path, and the sense of well-being while walking or engaging in other activities in public space.

RELEVANT PUBLICATIONS

- Omer, I., Gitelman, V., Rofè, Y., Lerman, Y., Kaplan, N. & Doveh, E. (2017). Evaluating crash risk in urban areas based on vehicle and pedestrian modeling. Geographical Analysis, 49(4): 387–408.
- Benenson, I., Ben-Elia, E., Rofé, Y. & Geyzersky, D. (2017). The benefits of a high-resolution analysis of transit accessibility. International Journal of Geographical Information Science, 31(2): 213–236.
- Omer, I., Rofè, Y. & Lerman, Y. (2015). The impact of planning on pedestrian movement: contrasting pedestrian movement models in pre-modern and modern neighborhoods in Israel. International Journal of Geographical Information Science, 29(12): 1–22.

Public policy and consumer behavior in transportation

Dr. Stav Rosenzweig
The Department of Management
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Expertise
Innovation, technology, knowledge, public policy and consumer behavior

DESCRIPTION

Dr. Rosenzweig's research focuses on the driving behavior of consumers, and the way it is affected by policy measures. For example, her research found that a policy that incentivized consumers to buy energy-efficient cars, effectively caused a rebound effect, that is, it increased the kilometers traveled.

A second project explores the mechanism than may underlie increased driving. This research suggests that presenting a pollution scale that reveals the purchased car's pollution rating may cause a "licensing effect": the consumer may feel that she has done good by buying a car with an environmental rating, and consequently license herself to be "bad" by increasing her driving.

Another research project addresses consumer behavior and risk perception. Policies that incentivize consumers to buy energy-efficient cars effectively increase the share of small and light-weight cars on the road. Small and light-weight cars also increase hazard in case of an accident. But if drivers of small and light cars feel that their car is less safe, they might adjust their driving behavior accordingly, thereby offsetting the potential hazard.

RELEVANT PUBLICATIONS

- Steren, A., Rubin, O. D. & Rosenzweig, S. (2016). Assessing the Rebound Effect Using a Natural Experiment Setting: Evidence from the Private Transportation Sector in Israel. Energy Policy, 93: 41-49.

Energy efficiency in transportation: Policy and implications

Dr. Ofir Rubin
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Expertise
Energy & environmental policy, modeling energy markets, energy efficiency in transportation

DESCRIPTION

Dr. Ofir Rubin focuses his research on economic modeling of energy markets, management of natural resources, and the economics and environmental aspects of renewable energy. In the realm of transportation, he investigates the performance of policies designed to promote energy efficiency as well as environmental and political objectives. Specific topics of interest include green taxation, alternative fuels in transportation and the conjunction of policy regulation with firms' strategic behavior. His current project, funded by the Israeli Science Foundation, focuses on the impact of consumers' response to policy regulation in terms of type of car purchased, fuel usage and implications for drivers' risk perception and road safety.

RELEVANT PUBLICATIONS

- Steren, A., Rubin, O. D. & Rosenzweig, S. (2016). Assessing the Rebound Effect Using a Natural Experiment Setting: Evidence from the Private Transportation Sector in Israel. Energy Policy, 93: 41-49.
- Feng, H., Rubin, O. D. & Babcock, B. A. (2010). Greenhouse Gas Impacts of Ethanol from Iowa Corn: Life Cycle Assessment versus System Wide Approach. Biomass and Bioenergy, 34(6): 912-921.

Low-cost high-resolution infrared detector for autonomous car sensors

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Expertise
Low-cost infrared imaging sensors

OBJECTIVE

Autonomous car capabilities are very much dependent on the quality of its sensors and their performance. A very cost-effective focal plane array that can serves as an imaging sensor at the wavelength around 1550nm (SWIR-short wavelength infrared) could be the ultimate solution. Cameras based on such sensors will not be affected by sun glints and will be able to see through fog and dust. With such low cost devices, 4 to 6 cameras can be installed around the car for maximal situation awareness.

DESCRIPTION

We propose a novel device that is based on nanotechnology and solid state technology. This device, which is half a micrometer in thickness, converts the SWIR (1550nm central wavelength) image projected on one side of the layer into same visible image that is emitted from the other side of the layer. At present the photon to photon conversion efficiency is about 10%. When attached to any silicon CMOS or CCD visible detector, this layer converts it to an infrared detector. All non-uniformity correction is done simultaneously on the layer with the silicon detector that is attached to it. The overall cost of such a combined device can be as low as a few dollars. Therefore, several cameras can be installed on each autonomous car.

APPLICATIONS & PRODUCTS

Many applications are possible once one can make such an infrared sensor at a low price. The main application is in the field of autonomous vehicle sensors that are resistant to sun glints and can penetrate through fog and dust.

Additional applications are the second rear camera in advanced smart phones, where all the mechanical and electrical interfaces are the same for both cameras; defense and paramilitary applications (such as fire fighters), where such a device can be attached to the camera of augmented reality (AR) glasses, converting them into combined night vision glasses and AR glasses; and disposable swallowed devices, such as PillCam, where onverting the camera in to a SWIR camera can very much enhance pathologies-detection capability and at much earlier stages.

RELEVANT PUBLICATIONS

- G. Sarusi & Y. Golan (2014). SWIR to Visible Image Upconversion Integrated Device. PCT 32518/US, EU and Canada (Granted in US)
- G. Sarusi & Ibrahim Abdulhalim (2014). SWIR to Visible Upconversion Optical System. PCT 32594/US/14 (National Phase)
- G. Sarusi, T. Tempelman, E. Hechster, I. Visoly-Fisher & Y. Golan (2016). Architecture, Development and Implementation of a SWIR to Visible Integrated Up-Conversion Imaging Device. Proceedings of the SPIE, Vol. 9884, id. 98840L. DOI: 10.1117/12.2231526
- T. Templeman, S. Sengupta, N. Maman, E. Bar-Or, M. Shandalov, V. Ezersky, E. Yahel, G. Sarusi, I. Visoly-Fisher & Y. Golan (2018). Oriented attachment: A path to columnar morphology in chemical bath deposited pbse thin films. Cryst. Growth Des., 18(2): 1227–1235. DOI: 10.1021/acs.cgd.7b01771

Aspects of connected vehicle networks

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Expertise
Connected cars, inter- and intra-vehicle communications security

OBJECTIVE

I'm interested in designing efficient and secure communication mechanisms between vehicles themselves (V2V), between vehicles and the infrastructure (V2I), between vehicles and the cloud. The following are also of particular interest: distributed management of the swarm of autonomous cars; traffic management; security and privacy aspects in swarms; and location identification in autonomous swarms.

DESCRIPTION

A connected vehicle network is designed to provide a secure and private method for drivers to use the roads in a certain area most efficiently. Cars may connect to access points (Wi-Fi, 3G, LTE) through a central authority like a cloud, roadside units (RSUs) or communicate directly. Each kind of communication leads to different scenarios that require attention. For example, the cloud monitors and analyzes the car's movements and other functions in order to provide certain services to the driver, like driving instructions. The legitimate questions here are how to keep the privacy of a driver's information? Or alternately, if cars communicate directly, a malicious group of cars may try to gain leadership of the entire network in order to control all traffic and produce undesirable misbehavior. We are trying to resolve all such scenarios.

APPLICATIONS & PRODUCTS

We are usually interested in designing efficient algorithms that are validated by mathematical theory and extensive sets of simulation, producing both academic papers and patents.

RELEVANT PUBLICATIONS

- S. Dolev, L. Krzywiecki, N. Panwar & M. Segal. Certificating vehicle public key with vehicle attributes. Patent No. US 20150052352 A1.
- S. Dolev, L. Krzywiecki, N. Panwar & M. Segal (2017). Dynamic attribute based vehicle authentication, ACM Wireless Networks, 23(4): 1045-1062.
- Y. Allouche & M. Segal (2015). A Cluster-based beaconing approach in VANET II: Communication process. Elsevier Vehicular Communications, 2(2): 80-94.
- D. Zelikman & M. Segal (2015). Reducing interferences in VANETs. IEEE Transactions on Intelligent Transportation Systems, 16(3): 1582-1587.
- O. Ben-Shahar, A. Dolgin, S. Dolev & M. Segal (2014). Leader Election in Flocking Swarms. Ad Hoc Networks, 12: 250-258.

High-quality scalable multi-agent pathfinding

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Dr. Roni Stern
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Department of Software and Information Systems Engineering

Expertise
AI, heuristic search, multi-agent pathfinding

RELEVANT PUBLICATIONS

- D. Atzmon, R. Stern, A. Felner, G. Wagner, R. Barták & N.-F. Zhou (2018). Robust Multi Agent Path Finding. SOCS 2018: 2-9.
- Felner, et al. (2018) Adding Heuristics to Conflict-Based Search for Multi-Agent Path Finding. ICAPS 2018: 83-87.
- R. Barták, N.-F. Zhou, R. Stern, E. Boyarski & P. Surynek (2017). Modeling and Solving the Multi-agent Pathfinding Problem in Picat. ICTAI 2017: 959-966.
- A. Felner, R. Stern et al. (2017). Search-Based Optimal Solvers for the Multi-Agent Pathfinding Problem: Summary and Challenges. SOCS 2017: 29-37.
- G. Sharon, R. Stern, A. Felner & N. Sturtevant (2015). Conflict-based Search for Optimal Multi-agent Pathfinding. Artif. Intell., 219: 40-66.

OBJECTIVE

We are interested in the problem called "Multi-agent path finding" (MAPF). The input to the problem is a graph or an environment and a number of agents, each with its start and goal locations. The task is to find collision free paths for multiple agents from their start location to their goal location. This is a central problem in the artificial intelligence community and it has many possible applications in the area of traffic and transportation.

DESCRIPTION

Solving MAPF problems efficiently is topical due to the increasing importance of multi-robot systems in many applications, such as automated warehousing and automated airplane towing. Finding optimal or bounded-suboptimal MAPF plans is NP-hard for many versions of the MAPF problem and this makes the problem extremely challenging, especially when the number of agents is large. Our previous and current research focused on efficiently finding optimal or bounded suboptimal solutions to this problem. Many of the common algorithms for this problem have been developed in our lab. Currently, our research has shifted to focus on more real-world scenarios and adopting the various pure scientific algorithms to such real-world settings. Settings include (1) Continuous (non-discrete) environments, (2) Non-uniformly sized agents, (3) Interchangeable agents/robots, and (5) 3D environments and (5) Agents that appear and disappear during the problem solving.

APPLICATIONS & PRODUCTS

Many real-world problems have a strong component of MAPF. Automatic traffic control in junctions, or in general, have a strong MAPF component, as we want to lead the cars to their destinations as efficiently as possible without colliding with other cars. Similarly, robot warehouses and traffic control are other real-world applications of MAPF.

V2X wireless communication and authentication

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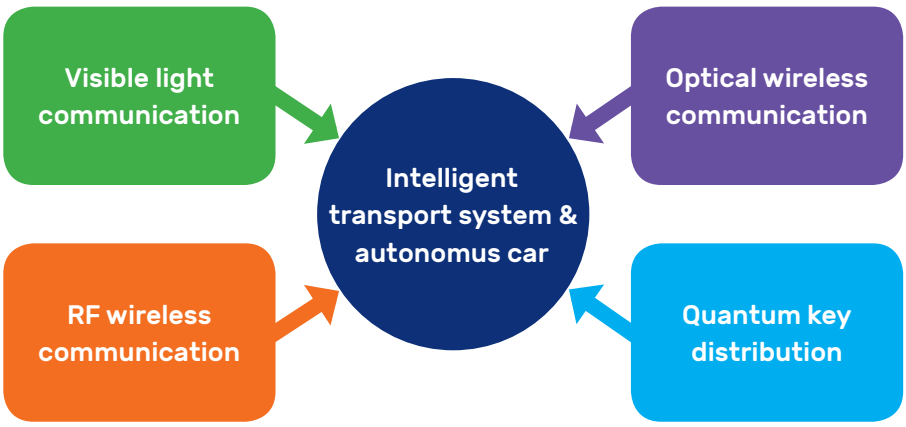
OBJECTIVE

Advance fundamental and applicative cutting-edge research in wireless communication, optical wireless communication, quantum key distribution, optical navigation, Li-Fi, visible light communication for Intelligent transport systems and smart city application.

Intelligent transport systems have become the chief technology for traffic management, monitoring and control, and increasing road safety. Radio frequency and optical wireless communication technologies have been proposed as a means for establishing communication between vehicular and road infrastructure, such as traffic lights, billboards and road infrastructures, and for providing inter-vehicular communication. These technologies provide one-way or two-way short-range to medium-range wireless communication links that are specifically designed for the automotive sphere. In addition, authentication between network elements such as vehicles, road infrastructure, and information systems has become extremely important in preventing hacking.



APPLICATIONS & PRODUCTS

Communication, navigation, and authentication for the next generation of transportation systems and autonomous cars.

The key to successful design is interaction

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Expertise
Human factors engineering, human-machine interaction, Human autonomy teaming, Human-robot interaction, Decision support systems, User-centered design

OBJECTIVE
Support users via design.

DESCRIPTION
Human-machine systems consist of an arrangement of people and machines (or physical components) interacting within an environment in order to achieve a set of system goals. As such systems become more complex, smart and autonomous, the challenge of designing the interaction increases and more emphasis should be placed on agents' mutual understanding and communication.

The shift from technology exploitation to technology for all users is challenging and requires user/use-centered design approaches. In my research, I explore how design can be influenced by user needs and characteristics, with the goal to improve acceptance and use and avoid misuse of complex systems.

APPLICATIONS & PRODUCTS
Vehicles and HMI, trucks and fleets, pedestrians and road traffic systems, drones and unmanned aerial systems, unmanned systems and autonomous vehicles.

RELEVANT PUBLICATIONS

- Porat T., Oron-Gilad, T., Rottem-Hovev, M. & Silbiger, J. (2016). Supervising and Controlling Unmanned Systems: A Multi-Phase Study with Subject Matter Experts. Frontiers in Psychology, 7: 568. DOI: 10.3389/fpsyg.2016.00568
- Thropp J., Oron-Gilad T., Szalma J.L. & Hancock P.A. (2018). Calibrating Adaptable Automation to Individuals. IEEE Transactions on Human-Machine Systems, 48 (6): 691-701. DOI: 10.1109/THMS.2018.2844124
- Kalantarov, S., Riemer, R.,& Oron-Gilad, T. (2018). Pedestrians' Road Crossing Decisions and Body Parts' Movements. Transportation Research Part F, 53: 155-171. DOI: 10.1016/j.trf.2017.09.012
- Oron-Gilad, T., & Hancock, P.A (2017). From Ergonomics to Hedonomics: Trends in Human Factors and Technology: The Role of Hedonomics Revisited. In: Myounghoon Jeon (Ed.), Emotions and Affect in Human Factors and Human-Computer Interaction, Elsevier Academic Press: Cambridge, MA.

ABOUT BGN TECHNOLOGIES LTD.

BGN Technologies is the technology transfer company of Ben-Gurion University of the Negev (BGU). BGN Technologies brings technological innovations from the lab to the market and fosters research collaborations and entrepreneurship among researchers and students. To date, BGN Technologies has established over 100 startup companies in the fields of Biotech, Hi-tech and Cleantech and initiated leading technology hubs, incubators and accelerators. During the past decade, BGN Technologies focused on creating long-term partnerships with multinationals such as Deutsche Telekom, Dell-EMC, Lockheed Martin and PayPal, securing value and growth for BGU and the Negev region.

http://in.bgu.ac.il/en/BGN

ABOUT BEN-GURION UNIVERSITY OF THE NEGEV

Ben-Gurion University of the Negev is the fastest growing research university in Israel. With 20,000 students, 4,000 staff and faculty members, and three campuses in Beer-Sheva, Sede Boqer and Eilat, BGU is an agent of change, fulfilling the vision of David Ben-Gurion, Israel's first prime minister, who envisaged the future of Israel emerging from the Negev. The University is at the heart of Beer-Sheva's transformation into the country's cyber capital, where leading multinational corporations leverage BGU's expertise to generate innovative R&D.

As it counts up to its fiftieth anniversary, BGU's mission continues to be effecting change, locally, regionally and internationally. With faculties in Engineering, Health Sciences, Natural Sciences, Humanities and Social Sciences, Business and Management, and Desert Studies, BGU is a university with a conscience, active both on the frontiers of science and in the community. Over a third of our students participate in one of the world's most developed community action programs. BGU is a recognized national and global leader in multiple fields, actively encouraging multi-disciplinary collaborations with government and industry, and nurturing entrepreneurship and innovation in all its forms.

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