Guangquan Zhang
Jie Lu
Ya Gao

# Multi-Level Decision Making

Models, Methods and Applications



Guangquan Zhang, Jie Lu, Ya Gao

Multi-Level Decision Making Guangquan Zhang, Jie Lu, Ya Gao, 2015-02-07 This monograph presents new developments in multi level decision making theory technique and method in both modeling and solution issues It especially presents how a decision support system can support managers in reaching a solution to a multi level decision problem in practice This monograph combines decision theories methods algorithms and applications effectively It discusses in detail the models and solution algorithms of each issue of bi level and tri level decision making such as multi leaders multi followers multi objectives rule set based and fuzzy parameters Potential readers include organizational managers and practicing professionals who can use the methods and software provided to solve their real decision problems PhD students and researchers in the areas of bi level and multi level decision making and decision support systems students at an advanced undergraduate master s level in information systems business administration or the application of computer science

Analyzing Narratives in Social Networks Zvi Lotker, 2021-08-28 This book uses literature as a wrench to pry open social networks and to ask different questions than have been asked about social networks previously. The book emphasizes the story telling aspect of social networks as well as the connection between narrative and social networks by incorporating narrative dynamic networks and time Thus it constructs a bridge between literature digital humanities and social networks This book is a pioneering work that attempts to express social and philosophic constructs in mathematical terms The material used to test the algorithms is texts intended for performance such as plays film scripts and radio plays mathematical representations of the texts or literature networks are then used to analyze the social networks found in the respective texts By using literature networks and their accompanying narratives along with their supporting analyses this book allows for a novel approach to social network analysis Machine Learning and Clustering for a Sustainable Future Alma Yunuen Raya-Tapia, Francisco Javier López-Flores, César Ramírez-Márquez, José María Ponce-Ortega, 2025-10-02 This book explores cutting edge machine learning and clustering techniques to tackle critical challenges in engineering environmental science and sustainability The book provides an in depth examination of clustering methodologies covering unsupervised and supervised techniques data preprocessing distance metrics and cluster validation methods such as the elbow and silhouette techniques Readers will find practical insights into applying these methods to real world problems including clustering greenhouse gas emissions optimizing energy systems and analyzing the energy food nexus in the context of global crises By integrating theoretical foundations with hands on applications this book serves as a valuable resource for researchers engineers and professionals seeking data driven solutions for sustainability challenges Computational Intelligence Applied to Decision-Making in Uncertain Environments Pedro Yobanis Piñero Pérez, Iliana Pérez Pupo, Janusz Kacprzyk, Rafael Esteban Bello Pérez, 2025-03-24 This book is dedicated to all those interested in the application of computational intelligence techniques for decision making in uncertain environments The book is organized into four parts The first part groups

together four works related to conversational systems and decision making using generative artificial intelligence The second part includes four articles associated with decision making in project oriented environments. The third part includes three works related to decision making in human health environments and decision making in sports training The fourth part of the book contains three articles associated with business decision making This book combines different artificial intelligence techniques for solving decision making problems among which the following stand out generative artificial intelligence linguistic data summarization techniques neutrosophic theory computing with words among other techniques. The techniques proposed in the book aim to simulate human tolerance in decision making processes in environments with uncertainty and imprecision The authors of the book stand out for their extensive experience in the development of basic and applied applications of computational intelligence The authors Pedro Y Pi ero P rez Iliana P rez Pupo Janusz Kacprzyk and Rafael E Bello P rez have published several books associated with artificial intelligence and applied computational intelligence They continue to work on fundamental and applied research on different artificial intelligence techniques to assist decision making in different areas of knowledge The authors thank all the engineers professors and researchers without whose efforts this book could not have been written Techniques, Tools and Methodologies Applied to Global Supply Chain Ecosystems Jorge Luis García-Alcaraz, Cuauhtémoc Sánchez-Ramírez, Liliana Avelar-Sosa, Giner Alor-Hernández, 2019-08-29 This book presents the latest developments concerning techniques tools and methodologies in supply chain ecosystems It gathers contributions from a variety of experts who analyze a range of case studies and industrial sectors such as manufacturing energy agricultural healthcare humanitarian logistics and urban goods distribution to name but a few The book is chiefly intended to meet the needs of two sectors firstly the academic sector so as to familiarize students professors and researchers with the tools that are now being used to optimize supply chains and secondly the industrial and managerial sector so that supply chain management practitioners can benefit from methods and tools that are yielding valuable results in other contexts

Artificial Intelligence for Healthcare Applications and Management Boris Galitsky, Saveli Goldberg, 2022-01-13 Artificial Intelligence for Healthcare Applications and Management introduces application domains of various AI algorithms across healthcare management Instead of discussing AI first and then exploring its applications in healthcare afterward the authors attack the problems in context directly in order to accelerate the path of an interested reader toward building industrial strength healthcare applications Readers will be introduced to a wide spectrum of AI applications supporting all stages of patient flow in a healthcare facility The authors explain how AI supports patients throughout a healthcare facility including diagnosis and treatment recommendations needed to get patients from the point of admission to the point of discharge while maintaining quality patient safety and patient provider satisfaction AI methods are expected to decrease the burden on physicians improve the quality of patient care and decrease overall treatment costs Current conditions affected by COVID 19 pose new challenges for healthcare management and learning how to apply AI will be important for a broad

spectrum of students and mature professionals working in medical informatics. This book focuses on predictive analytics health text processing data aggregation management of patients and other fields which have all turned out to be bottlenecks for the efficient management of coronavirus patients Presents an in depth exploration of how AI algorithms embedded in scheduling prediction automated support personalization and diagnostics can improve the efficiency of patient treatment Investigates explainable AI including explainable decision support and machine learning from limited data to back up clinical decisions and data analysis Offers hands on skills to computer science and medical informatics students to aid them in designing intelligent systems for healthcare Informs a broad multidisciplinary audience about a multitude of applications of machine learning and linguistics across various healthcare fields Introduces medical discourse analysis for a high level representation of health texts Multi-Level Decision Making Guangguan Zhang, Jie Lu, Ya Gao, 2015 This monograph presents new developments in multi level decision making theory technique and method in both modeling and solution issues It especially presents how a decision support system can support managers in reaching a solution to a multi level decision problem in practice This monograph combines decision theories methods algorithms and applications effectively It discusses in detail the models and solution algorithms of each issue of bi level and tri level decision making such as multi leaders multi followers multi objectives rule set based and fuzzy parameters Potential readers include organizational managers and practicing professionals who can use the methods and software provided to solve their real decision problems PhD students and researchers in the areas of bi level and multi level decision making and decision support systems students at an advanced undergraduate master's level in information systems business administration or the application of computer **Documentation Abstracts** ,1997 Scientific and Technical Aerospace Reports, 1995 Informatics science Abstracts ,1986 Research Awards Index .1987 Trustworthy AI in Medical Imaging Marco Lorenzi, Maria A Zuluaga, 2024-11-25 Trustworthy AI in Medical Imaging brings together scientific researchers medical experts and industry partners working in the field of trustworthiness bridging the gap between AI research and concrete medical applications and making it a learning resource for undergraduates masters students and researchers in AI for medical imaging applications The book will help readers acquire the basic notions of AI trustworthiness and understand its concrete application in medical imaging identify pain points and solutions to enhance trustworthiness in medical imaging applications understand current limitations and perspectives of trustworthy AI in medical imaging and identify novel research directions Although the problem of trustworthiness in AI is actively researched in different disciplines the adoption and implementation of trustworthy AI principles in real world scenarios is still at its infancy This is particularly true in medical imaging where guidelines and standards for trustworthiness are critical for the successful deployment in clinical practice After setting out the technical and clinical challenges of AI trustworthiness the book gives a concise overview of the basic concepts before presenting state of the art methods for solving these challenges Introduces the key concepts of trustworthiness in AI

Presents state of the art methodologies for trustworthy AI in medical imaging Outlines major initiatives focusing on real world deployment of trustworthy principles in medical imaging applications Presents outstanding questions still to be solved Publications of the National Institute of Standards and Technology ... Catalog and discusses future research directions National Institute of Standards and Technology (U.S.), National Institute of Standards and Technology (U.S.). Information Resources and Services Division, 1994 Cumulated Index Medicus ,1991 **ERIC Identifier Authority List - (IAL) 1992** Carolyn R. Weller, Jim Houston, 1992 Technology Diffusion and Adoption: Global Complexity, Global Innovation Zolait, Ali Hussein Saleh, 2013-01-31 Technology Diffusion and Adoption Global Complexity Global Innovation discusses the emerging topics of information technology and the IT based solutions in global and multi cultural environments This comprehensive collection addresses the aspects of innovation diffusion in the field of business computing technologies and is essential for researchers practitioners academicians and educators all over the world 2013 International Conference on Computer Science and Artificial Intelligence Dr. Yuetong Lin, Dr. Gabriel Alungbe, 2014-11-16 The main objective of ICCSAI2013 is to provide a platform for the presentation of top and latest research results in global scientific areas The conference aims to provide a high level international forum for researcher engineers and practitioners to present and discuss recent advances and new techniques in computer science and artificial intelligence It also serves to foster communications among researcher engineers and practitioners working in a common interest in improving computer science artificial intelligence and the related fields We have received 325 numbers of papers through Call for Paper out of which 94 numbers of papers were accepted for publication in the conference proceedings through double blind review process The conference is designed to stimulate the young minds including Research Scholars Academicians and Practitioners to contribute their ideas thoughts and nobility in these two disciplines **Air University Abstracts of Research Reports** .1986 Sun Tracking and Solar Renewable Energy Harvesting Gerro Prinsloo, Robert Dobson, 2015-11-02 Free to download eBook on Practical Solar Tracking Design Solar Tracking Sun Tracker Solar Tracker Follow Sun Sun Position calculation Azimuth Elevation Zenith Sun following Sunrise Sunset Moon phase Moonrise Moonset calculators In harnessing power from the sun through a solar tracker or solar tracking system renewable energy system developers require automatic solar tracking software and solar position algorithms On axis sun tracking system such as the altitude azimuth dual axis or multi axis solar tracker systems use a sun tracking algorithm or ray tracing sensors or software to ensure the sun s passage through the sky is traced with high precision in automated solar tracker applications right through summer solstice solar equinox and winter solstice Eco Friendly and Environmentally Sustainable Micro Combined Solar Heat and Power m CHP m CCHP m CHCP with Microgrid Storage and Layered Smartgrid Control towards Supplying Off Grid Rural Villages in developing BRICS countries such as Africa India China and Brazil Off grid rural villages and isolated islands areas require mCHP and trigeneration solar power plants and associated isolated smart microgrid solutions to serve the

community energy needs This article describes the development progress for such a system also referred to as solar polygeneration The system includes a sun tracker mechanism wherin a parabolic dish or lenses are guided by a light sensitive mechanique in a way that the solar receiver is always at right angle to the solar radiation Solar thermal energy is then either converted into electrical energy through a free piston Stirling or stored in a thermal storage container The project includes the thermodynamic modeling of the plant in Matlab Simulink as well as the development of an intelligent control approach that includes smart microgrid distribution and optimization The book includes aspects in the simulation and optimization of stand alone hybrid renewable energy systems and co generation in isolated or islanded microgrids It focusses on the stepwise development of a hybrid solar driven micro combined cooling heating and power mCCHP compact trigeneration polygeneration and thermal energy storage TES system with intelligent weather prediction weak ahead scheduling time horizon and look ahead dispatch on integrated smart microgrid distribution principles The solar harvesting and solar thermodynamic system includes an automatic sun tracking platform based on a PLC controlled mechatronic sun tracking system that follows the sun progressing across the sky An intelligent energy management and adaptive learning control optimization approach is proposed for autonomous off grid remote power applications both for thermodynamic optimization and smart micro grid optimization for distributed energy resources DER The correct resolution of this load following multi objective optimization problem is a complex task because of the high number and multi dimensional variables the cross correlation and interdependency between the energy streams as well as the non linearity in the performance of some of the system components Exergy based control approaches for smartgrid topologies are considered in terms of the intelligence behind the safe and reliable operation of a microgrid in an automated system that can manage energy flow in electrical as well as thermal energy systems The standalone micro grid solution would be suitable for a rural village intelligent building district energy system campus power shopping mall centre isolated network eco estate or remote island application setting where self generation and decentralized energy system concepts play a role Discrete digital simulation models for the thermodynamic and active demand side management systems with digital smartgrid control unit to optimize the system energy management is currently under development Parametric simulation models for this trigeneration system polygeneration poligeneration quadgeneration are developed on the Matlab Simulink and TrnSys platforms In terms of model predictive coding strategies the automation controller will perform multi objective cost optimization for energy management on a microgrid level by managing the generation and storage of electrical heat and cooling energies in layers Each layer has its own set of smart microgrid priorities associated with user demand side cycle predictions Mixed Integer Linear Programming and Neural network algorithms are being modeled to perform Multi Objective Control optimization as potential optimization and adaptive learning techniques Automatic Solar Tracking Sun Tracking Satellite Tracking rastreador solar sequimento solar sequidor solar automático de sequimiento solar Gerro Prinsloo, Robert

Dobson, 2015-11-01 Automatic Solar Tracking Sun Tracking This book details Automatic Solar Tracking Sun Tracking Systems Solar Trackers and Sun Tracker Systems An intelligent automatic solar tracker is a device that orients a payload toward the sun Such programmable computer based solar tracking device includes principles of solar tracking solar tracking systems as well as microcontroller microprocessor and or PC based solar tracking control to orientate solar reflectors solar lenses photovoltaic panels or other optical configurations towards the sun Motorized space frames and kinematic systems ensure motion dynamics and employ drive technology and gearing principles to steer optical configurations such as mangin parabolic conic or cassegrain solar energy collectors to face the sun and follow the sun movement contour continuously seguimiento solar y automatizaci n automatizaci n seguidor solar tracking solar e automa o automa o seguidor solar insequimento solare insequitore solare energia termica sole seguito posizionatore motorizzato In harnessing power from the sun through a solar tracker or practical solar tracking system renewable energy control automation systems require automatic solar tracking software and solar position algorithms to accomplish dynamic motion control with control automation architecture circuit boards and hardware On axis sun tracking system such as the altitude azimuth dual axis or multi axis solar tracker systems use a sun tracking algorithm or ray tracing sensors or software to ensure the sun's passage through the sky is traced with high precision in automated solar tracker applications right through summer solstice solar equinox and winter solstice A high precision sun position calculator or sun position algorithm is this an important step in the design and construction of an automatic solar tracking system The content of the book is also applicable to communication antenna satellite tracking and moon tracking algorithm source code for which links to free download links are provided From sun tracing software perspective the sonnet Tracing The Sun has a literal meaning Within the context of sun track and trace this book explains that the sun's daily path across the sky is directed by relatively simple principles and if grasped understood then it is relatively easy to trace the sun with sun following software Sun position computer software for tracing the sun are available as open source code sources that is listed in this book The book also describes the use of satellite tracking software and mechanisms in solar tracking applications Ironically there was even a system called sun chaser said to have been a solar positioner system known for chasing the sun throughout the day Using solar equations in an electronic circuit for automatic solar tracking is quite simple even if you are a novice but mathematical solar equations are over complicated by academic experts and professors in text books journal articles and internet websites In terms of solar hobbies scholars students and Hobbyist's looking at solar tracking electronics or PC programs for solar tracking are usually overcome by the sheer volume of scientific material and internet resources which leaves many developers in frustration when search for simple experimental solar tracking source code for their on axis sun tracking systems. This booklet will simplify the search for the mystical sun tracking formulas for your sun tracker innovation and help you develop your own autonomous solar tracking controller By directing the solar collector directly into the sun a solar harvesting means or device can harness

sunlight or thermal heat This is achieved with the help of sun angle formulas solar angle formulas or solar tracking procedures for the calculation of sun s position in the sky Automatic sun tracking system software includes algorithms for solar altitude azimuth angle calculations required in following the sun across the sky In using the longitude latitude GPS coordinates of the solar tracker location these sun tracking software tools supports precision solar tracking by determining the solar altitude azimuth coordinates for the sun trajectory in altitude azimuth tracking at the tracker location using certain sun angle formulas in sun vector calculations Instead of follow the sun software a sun tracking sensor such as a sun sensor or webcam or video camera with vision based sun following image processing software can also be used to determine the position of the sun optically Such optical feedback devices are often used in solar panel tracking systems and dish tracking systems Dynamic sun tracing is also used in solar surveying DNI analyser and sun surveying systems that build solar infographics maps with solar radiance irradiance and DNI models for GIS geographical information system In this way geospatial methods on solar environment interaction makes use use of geospatial technologies GIS Remote Sensing and Cartography Climatic data and weather station or weather center data as well as gueries from sky servers and solar resource database systems i e on DB2 Sybase Oracle SQL MySQL may also be associated with solar GIS maps In such solar resource modelling systems a pyranometer or solarimeter is normally used in addition to measure direct and indirect scattered dispersed reflective radiation for a particular geographical location Sunlight analysis is important in flash photography where photographic lighting are important for photographers GIS systems are used by architects who add sun shadow applets to study architectural shading or sun shadow analysis solar flux calculations optical modelling or to perform weather modelling Such systems often employ a computer operated telescope type mechanism with ray tracing program software as a solar navigator or sun tracer that determines the solar position and intensity The purpose of this booklet is to assist developers to track and trace suitable source code and solar tracking algorithms for their application whether a hobbyist scientist technician or engineer Many open source sun following and tracking algorithms and source code for solar tracking programs and modules are freely available to download on the internet today Certain proprietary solar tracker kits and solar tracking controllers include a software development kit SDK for its application programming interface API attributes Pebble Widget libraries widget toolkits GUI toolkit and UX libraries with graphical control elements are also available to construct the graphical user interface GUI for your solar tracking or solar power monitoring program The solar library used by solar position calculators solar simulation software and solar contour calculators include machine program code for the solar hardware controller which are software programmed into Micro controllers Programmable Logic Controllers PLC programmable gate arrays Arduino processor or PIC processor PC based solar tracking is also high in demand using C Visual Basic VB as well as MS Windows Linux and Apple Mac based operating systems for sun path tables on Matlab Excel Some books and internet webpages use other terms such as sun angle calculator sun position calculator or solar angle calculator

As said such software code calculate the solar azimuth angle solar altitude angle solar elevation angle or the solar Zenith angle Zenith solar angle is simply referenced from vertical plane the mirror of the elevation angle measured from the horizontal or ground plane level Similar software code is also used in solar calculator apps or the solar power calculator apps for IOS and Android smartphone devices Most of these smartphone solar mobile apps show the sun path and sun angles for any location and date over a 24 hour period Some smartphones include augmented reality features in which you can physically see and look at the solar path through your cell phone camera or mobile phone camera at your phone s specific GPS location In the computer programming and digital signal processing DSP environment free open source program code are available for VB Net Delphi Python C C C PHP Swift ADM F Flash Basic QBasic GBasic KBasic SIMPL language Squirrel Solaris Assembly language on operating systems such as MS Windows Apple Mac DOS or Linux OS Software algorithms predicting position of the sun in the sky are commonly available as graphical programming platforms such as Matlab Mathworks Simulink models Java applets TRNSYS simulations Scada system apps Labview module Beckhoff TwinCAT Visual Studio Siemens SPA mobile and iphone apps Android or iOS tablet apps and so forth At the same time PLC software code for a range of sun tracking automation technology can follow the profile of sun in sky for Siemens HP Panasonic ABB Allan Bradley OMRON SEW Festo Beckhoff Rockwell Schneider Endress Hauser Fudji electric Honeywell Fuchs Yokonawa or Muthibishi platforms Sun path projection software are also available for a range of modular IPC embedded PC motherboards Industrial PC PLC Programmable Logic Controller and PAC Programmable Automation Controller such as the Siemens S7 1200 or Siemens Logo Beckhoff IPC or CX series OMRON PLC Ercam PLC AC500plc ABB National Instruments NI PXI or NI cRIO PIC processor Intel 8051 8085 IBM Cell Power Brain or Truenorth series FPGA Xilinx Altera Nios Intel Xeon Atmel megaAVR MPU Maple Teensy MSP XMOS Xbee ARM Raspberry Pi Eagle Arduino or Arduino AtMega microcontroller with servo motor stepper motor direct current DC pulse width modulation PWM current driver or alternating current AC SPS or IPC variable frequency drives VFD motor drives also termed adjustable frequency drive variable speed drive AC drive micro drive or inverter drive for electrical mechatronic pneumatic or hydraulic solar tracking actuators The above motion control and robot control systems include analogue or digital interfacing ports on the processors to allow for tracker angle orientation feedback control through one or a combination of angle sensor or angle encoder shaft encoder precision encoder optical encoder magnetic encoder direction encoder rotational encoder chip encoder tilt sensor inclination sensor or pitch sensor Note that the tracker's elevation or zenith axis angle may measured using an altitude angle declination angle inclination angle pitch angle or vertical angle zenith angle sensor or inclinometer Similarly the tracker's azimuth axis angle be measured with a azimuth angle horizontal angle or roll angle sensor Chip integrated accelerometer magnetometer gyroscope type angle sensors can also be used to calculate displacement Other options include the use of thermal imaging systems such as a Fluke thermal imager or robotic or vision based solar tracker systems that employ face tracking head

tracking hand tracking eye tracking and car tracking principles in solar tracking With unattended decentralised rural island isolated or autonomous off grid power installations remote control monitoring data acquisition digital datalogging and online measurement and verification equipment becomes crucial It assists the operator with supervisory control to monitor the efficiency of remote renewable energy resources and systems and provide valuable web based feedback in terms of CO2 and clean development mechanism CDM reporting A power quality analyser for diagnostics through internet WiFi and cellular mobile links is most valuable in frontline troubleshooting and predictive maintenance where quick diagnostic analysis is required to detect and prevent power quality issues Solar tracker applications cover a wide spectrum of solar applications and solar assisted application including concentrated solar power generation solar desalination solar water purification solar steam generation solar electricity generation solar industrial process heat solar thermal heat storage solar food dryers solar water pumping hydrogen production from methane or producing hydrogen and oxygen from water HHO through electrolysis Many patented or non-patented solar apparatus include tracking in solar apparatus for solar electric generator solar desalinator solar steam engine solar ice maker solar water purifier solar cooling solar refrigeration USB solar charger solar phone charging portable solar charging tracker solar coffee brewing solar cooking or solar dying means Your project may be the next breakthrough or patent but your invention is held back by frustration in search for the sun tracker you require for your solar powered appliance solar generator solar tracker robot solar freezer solar cooker solar drier solar pump solar freezer or solar dryer project Whether your solar electronic circuit diagram include a simplified solar controller design in a solar electricity project solar power kit solar hobby kit solar steam generator solar hot water system solar ice maker solar desalinator hobbyist solar panels hobby robot or if you are developing professional or hobby electronics for a solar utility or micro scale solar powerplant for your own solar farm or solar farming this publication may help accelerate the development of your solar tracking innovation Lately solar polygeneration solar trigeneration solar triple generation and solar quad generation adding delivery of steam liquid gaseous fuel or capture food grade CO 2 systems have need for automatic solar tracking These systems are known for significant efficiency increases in energy yield as a result of the integration and re use of waste or residual heat and are suitable for compact packaged micro solar powerplants that could be manufactured and transported in kit form and operate on a plug and play basis Typical hybrid solar power systems include compact or packaged solar micro combined heat and power CHP or mCHP or solar micro combined cooling heating and power CCHP CHPC mCCHP or mCHPC systems used in distributed power generation These systems are often combined in concentrated solar CSP and CPV smart microgrid configurations for off grid rural island or isolated microgrid minigrid and distributed power renewable energy systems Solar tracking algorithms are also used in modelling of trigeneration systems using Matlab Simulink Modelica or TRNSYS platform as well as in automation and control of renewable energy systems through intelligent parsing multi objective adaptive learning control and control optimization strategies Solar tracking algorithms also find

application in developing solar models for country or location specific solar studies for example in terms of measuring or analysis of the fluctuations of the solar radiation i e direct and diffuse radiation in a particular area Solar DNI solar irradiance and atmospheric information and models can thus be integrated into a solar map solar atlas or geographical information systems GIS Such models allows for defining local parameters for specific regions that may be valuable in terms of the evaluation of different solar in photovoltaic of CSP systems on simulation and synthesis platforms such as Matlab and Simulink or in linear or multi objective optimization algorithm platforms such as COMPOSE EnergyPLAN or DER CAM A dual axis solar tracker and single axis solar tracker may use a sun tracker program or sun tracker algorithm to position a solar dish solar panel array heliostat array PV panel solar antenna or infrared solar nantenna A self tracking solar concentrator performs automatic solar tracking by computing the solar vector Solar position algorithms TwinCAT SPA or PSA Algorithms use an astronomical algorithm to calculate the position of the sun It uses astronomical software algorithms and equations for solar tracking in the calculation of sun's position in the sky for each location on the earth at any time of day Like an optical solar telescope the solar position algorithm pin points the solar reflector at the sun and locks onto the sun's position to track the sun across the sky as the sun progresses throughout the day Optical sensors such as photodiodes light dependant resistors LDR or photoresistors are used as optical accuracy feedback devices Lately we also included a section in the book with links to microprocessor code on how the PixArt Wii infrared camera in the Wii remote or Wiimote may be used in infrared solar tracking applications In order to harvest free energy from the sun some automatic solar positioning systems use an optical means to direct the solar tracking device These solar tracking strategies use optical tracking techniques such as a sun sensor means to direct sun rays onto a silicon or CMOS substrate to determine the X and Y coordinates of the sun s position In a solar mems sun sensor device incident sunlight enters the sun sensor through a small pin hole in a mask plate where light is exposed to a silicon substrate In a web camera or camera image processing sun tracking and sun following means object tracking software performs multi object tracking or moving object tracking methods In an solar object tracking technique image processing software performs mathematical processing to box the outline of the apparent solar disc or sun blob within the captured image frame while sun localization is performed with an edge detection algorithm to determine the solar vector coordinates An automated positioning system help maximize the yields of solar power plants through solar tracking control to harness sun s energy In such renewable energy systems the solar panel positioning system uses a sun tracking techniques and a solar angle calculator in positioning PV panels in photovoltaic systems and concentrated photovoltaic CPV systems Automatic on axis solar tracking in a PV solar tracking system can be dual axis sun tracking or single axis sun solar tracking It is known that a motorized positioning system in a photovoltaic panel tracker increase energy yield and ensures increased power output even in a single axis solar tracking configuration Other applications such as robotic solar tracker or robotic solar tracking system uses robotica with artificial intelligence in the control optimization of

energy yield in solar harvesting through a robotic tracking system Automatic positioning systems in solar tracking designs are also used in other free energy generators such as concentrated solar thermal power CSP and dish Stirling systems. The sun tracking device in a solar collector in a solar concentrator or solar collector Such a performs on axis solar tracking a dual axis solar tracker assists to harness energy from the sun through an optical solar collector which can be a parabolic mirror parabolic reflector Fresnel lens or mirror array matrix. A parabolic dish or reflector is dynamically steered using a transmission system or solar tracking slew drive mean In steering the dish to face the sun the power dish actuator and actuation means in a parabolic dish system optically focusses the sun's energy on the focal point of a parabolic dish or solar concentrating means A Stirling engine solar heat pipe thermosyphin solar phase change material PCM receiver or a fibre optic sunlight receiver means is located at the focal point of the solar concentrator The dish Stirling engine configuration is referred to as a dish Stirling system or Stirling power generation system Hybrid solar power systems used in combination with biogas biofuel petrol ethanol diesel natural gas or PNG use a combination of power sources to harness and store solar energy in a storage medium Any multitude of energy sources can be combined through the use of controllers and the energy stored in batteries phase change material thermal heat storage and in cogeneration form converted to the required power using thermodynamic cycles organic Rankin Brayton cycle micro turbine Stirling with an inverter and charge controller

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