

# PRINTFRIENDLY1522.HTM

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🔍 **WHEN THE STATE NO LONGER KILLS** SANGMIN BAE,2012-02-01 WHY SOME COUNTRIES COMPLY WITH INTERNATIONAL NORMS AGAINST THE DEATH PENALTY WHILE OTHERS DO NOT.

🔍 *THE INTERNATIONAL LIBRARY OF ESSAYS ON CAPITAL PUNISHMENT, VOLUME 1* PETER HODGKINSON,2016-12-05 THIS VOLUME PROVIDES UP-TO-DATE AND NUANCED ANALYSIS ACROSS A WIDE SPECTRUM OF CAPITAL PUNISHMENT ISSUES. THE ESSAYS MOVE BEYOND THE CONVENTIONAL LEGAL APPROACH AND PROPOSE FRESH PERSPECTIVES, INCLUDING A UNIQUE CRITIQUE OF THE ABOLITION SECTOR. WRITTEN BY A RANGE OF LEADING EXPERTS WITH DIVERSE GEOGRAPHICAL, METHODOLOGICAL AND CONCEPTUAL APPROACHES, THE ESSAYS IN THIS VOLUME CHALLENGE RECEIVED WISDOM AND EMBRACE A HOLISTIC UNDERSTANDING OF CAPITAL PUNISHMENT BASED ON PRACTICAL EXPERIENCE AND EMPIRICAL DATA. THIS COLLECTION IS INDISPENSABLE READING FOR ANYONE SEEKING A COMPREHENSIVE AND DETAILED UNDERSTANDING OF THE COMPLEXITY OF THE DEATH PENALTY DISCOURSE.

🔍 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 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 WHEREIN 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.

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PRACTICAL SOLAR ENERGY HARVESTING, AUTOMATIC SOLAR TRACKING, SUN-TRACKING-SYSTEMS, SOLAR-TRACKERS AND SUN TRACKER SYSTEMS USING MOTORIZED AUTOMATIC POSITIONING CONCEPTS AND CONTROL PRINCIPLES. 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. IN GENERAL, THE BOOK MAY BENEFIT SOLAR RESEARCH AND SOLAR ENERGY APPLICATIONS IN COUNTRIES SUCH AS AFRICA, MEDITERRANEAN, ITALY, SPAIN, GREECE, USA, MEXICO, SOUTH AMERICA, BRAZILIA, ARGENTINA, CHILI, INDIA, MALAYSIA, MIDDLE EAST, UAE, RUSSIA, JAPAN AND CHINA. THIS BOOK ON PRACTICAL AUTOMATIC SOLAR-TRACKING SUN-TRACKING IS IN .PDF FORMAT AND CAN EASILY BE CONVERTED TO THE .EPUB .MOBI .AZW .ePub .FB2 .LIT .LRF .MOBI .PDB .PDF .TCR FORMATS FOR SMARTPHONES AND KINDLE BY USING THE [EBOOK.ONLINE-CONVERT.COM](http://EBOOK.ONLINE-CONVERT.COM) FACILITY. 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. 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. 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. 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 OF GEOSPATIAL TECHNOLOGIES (GIS, REMOTE SENSING, AND CARTOGRAPHY). CLIMATIC DATA AND WEATHER STATION OR WEATHER CENTER DATA, AS WELL AS QUERIES 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, FUJII 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 MEGA AVR, 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 CO<sub>2</sub> 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

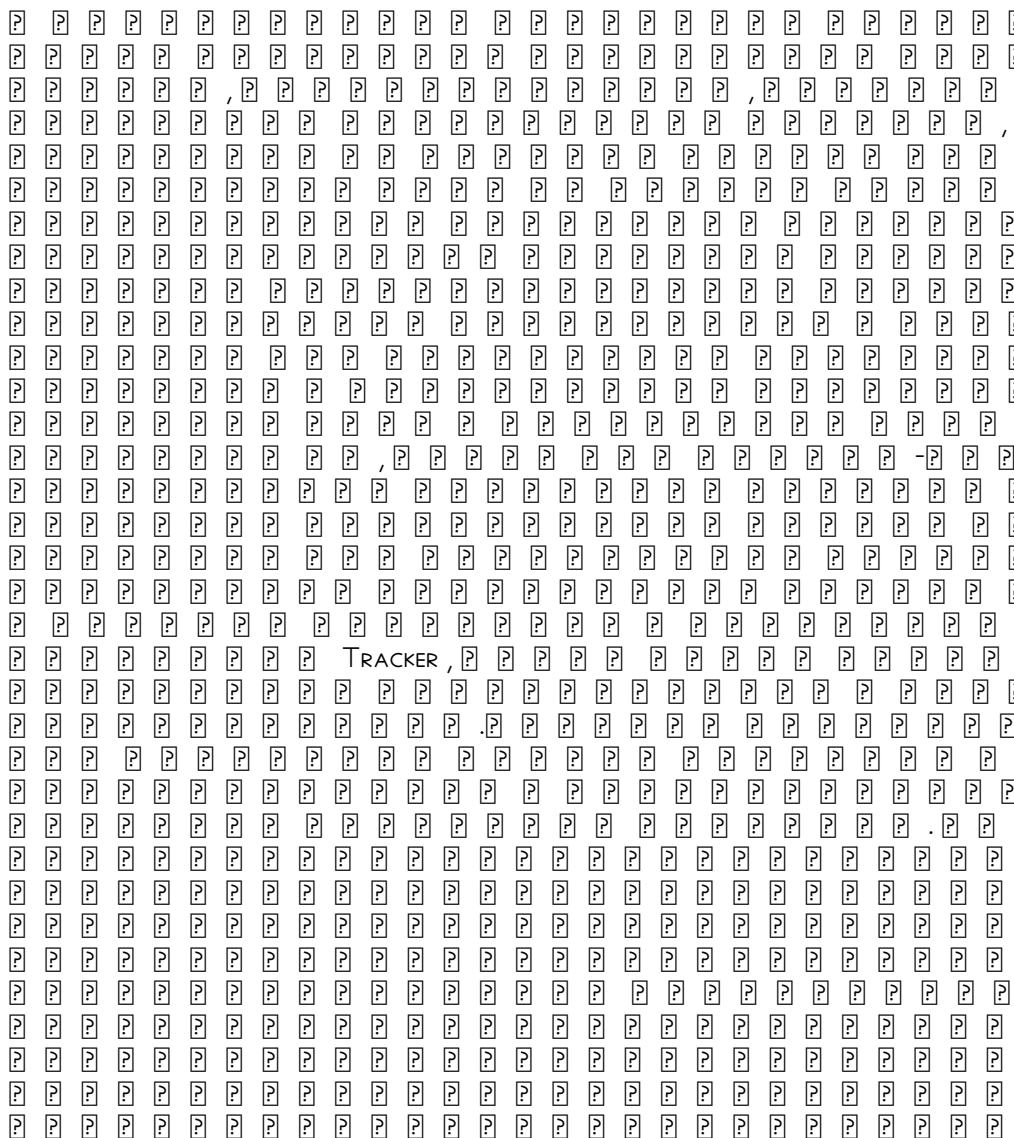


TRACKER ROBOT, SOLAR FREEZER, SOLAR COOKER, SOLAR DRIER, SOLAR PUMP, SOLAR FREEZER, OR SOLAR DRYER PROJECT. WHETHER YOUR SOLAR ELECTRONIC CIRCUIT DIAGRAM INCLUDE A SIMPLIFIED SOLAR CONTROLLER DESIGN IN A SOLAR ELECTRICITY PROJECT, SOLAR POWER KIT, SOLAR HOBBY KIT, SOLAR STEAM GENERATOR, SOLAR HOT WATER 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<sub>2</sub>) 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 PHOTOSENSISTORS 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.

SOLAR-TRACKING SOLAR-Tracker Systems.



**AUTOMATIC SOLAR TRACKING SUN TRACKING SATELLITE TRACKING**  
**RASTREADOR SOLAR SEGUIMIENTO SOLAR SEGUIDOR SOLAR AUTOMATICO DE**  
**SEGUIMIENTO 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, INSEGUIMENTO 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 OF GEOSPATIAL TECHNOLOGIES (GIS, REMOTE SENSING, AND CARTOGRAPHY). CLIMATIC DATA AND WEATHER STATION OR WEATHER CENTER DATA, AS WELL AS QUERIES 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 APPLET'S 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, FUJII 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 MEGA AVR, 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 CO<sub>2</sub> 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<sub>2</sub>) 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.

🔍 SCOTTISH EDUCATION T. G. K. BRYCE, 2018-06-21 INTERROGATES THE RISE OF NATIONAL PHILOSOPHIES AND THEIR IMPACT ON COSMOPOLITANISM AND NATIONALISM.

🔍 MEMORY CRASH GEORGIY KASIANOV, 2022-01-09 THIS ACCOUNT OF HISTORICAL POLITICS IN UKRAINE, FRAMED IN A BROADER EUROPEAN CONTEXT, SHOWS HOW SOCIAL, POLITICAL, AND CULTURAL GROUPS HAVE USED AND MISUSED THE PAST FROM THE FINAL YEARS OF THE SOVIET UNION TO 2020. GEORGIY KASIANOV DETAILS PRACTICES RELATING TO HISTORY AND MEMORY BY A VARIETY OF ACTORS, INCLUDING STATE INSTITUTIONS, NON-GOVERNMENTAL ORGANIZATIONS, POLITICAL PARTIES, HISTORIANS, AND LOCAL GOVERNMENTS. HE IDENTIFIES THE MAIN POLITICAL PURPOSES OF THESE PRACTICES IN THE CONSTRUCTION OF NATION AND IDENTITY, STRUGGLES FOR POWER, WARFARE, AND INTERNATIONAL RELATIONS. KASIANOV CONSIDERS THE UKRAINIAN CASE IN THE CONTEXT OF A GLOBAL INCREASE IN THE POLITICS OF HISTORY AND MEMORY, WITH PARTICULAR EMPHASIS ON A DISTINCTIVE EAST-EUROPEAN VARIETY. HE PAYS SPECIAL ATTENTION TO THE USE AND ABUSE OF HISTORY IN RELATIONS BETWEEN UKRAINE, RUSSIA, AND POLAND.

🔍 APAIS 1999: AUSTRALIAN PUBLIC AFFAIRS INFORMATION SERVICE ,

🔍 ONE HEALTH METHTHIKA VITHANAGE, MAJETI NARASIMHA VARA PRASAD, 2023-07-19 A BALANCED AND MULTIDISCIPLINARY EXPLORATION OF THE ONE HEALTH CONCEPT IN ONE HEALTH: HUMAN, ANIMAL, AND ENVIRONMENT TRIAD, A TEAM OF DISTINGUISHED RESEARCHERS INTRODUCES AND EXPLAINS THE CONCEPT OF ONE HEALTH BY PROVIDING AN OVERVIEW OF THE ONE HEALTH IDEA FROM THE PERSPECTIVE OF DIVERSE DISCIPLINES, FROM EARTH AND ENVIRONMENTAL SCIENCE TO ECOLOGY AND CONSERVATION TO VETERINARY AND HUMAN MEDICINE. THE AUTHORS ALSO PRESENT CASE STUDIES DEMONSTRATING THE REAL-WORLD CHALLENGES AND OPPORTUNITIES OF THIS INTERDISCIPLINARY APPROACH TO

SUSTAINABLE HUMAN WELL-BEING. READERS WILL FIND INSIGHTFUL DISCUSSIONS OF THE INTERACTIONS BETWEEN CHEMICAL POLLUTANTS AND WATER, SOIL, AND THE ATMOSPHERE, AS WELL AS DETAILED EXAMINATIONS OF SUSTAINABLE FOOD SUPPLY, WASTE MANAGEMENT, AND PATHOGEN CONTROL, BACKED UP BY EXTENSIVE REFERENCE DATA. ONE HEALTH: HUMAN, ANIMAL, AND ENVIRONMENT TRIAD ALSO INCLUDES: THE EMERGENCE AND RE-EMERGENCE OF ZOOSES AND OTHER INFECTIOUS DISEASES THE BEHAVIOR OF MICROPLASTICS IN SOIL AND WATER ORGANIC FARMING AND ITS INFLUENCE ON SOIL HEALTH THE ROLE OF LIGHT FOR HUMAN WELL-BEING PERFECT FOR RESEARCHERS INTERESTED IN GLOBAL HEALTH, ECOLOGICAL HEALTH, MEDICAL GEOLOGY, TOXICOLOGY, EPIDEMIOLOGY, AND ZOONOTIC DISEASES, ONE HEALTH: HUMAN, ANIMAL, AND ENVIRONMENT TRIAD WILL ALSO BENEFIT PROFESSIONALS WITH AN INTEREST IN PUBLIC HEALTH AND OTHER PUBLIC SERVICES, RESOURCE CONSERVATION, WASTE MANAGEMENT, AND THE CIRCULAR ECONOMY.

📖 **MUSEUMS OF COMMUNISM** STEPHEN M. NORRIS, 2020-11-03 HOW DID COMMUNITIES COME TO TERMS WITH THE COLLAPSE OF COMMUNISM? IN ORDER TO GUIDE THE WIDER NARRATIVE, MANY FORMER COMMUNIST COUNTRIES CONSTRUCTED MUSEUMS DEDICATED TO CHRONICLING THEIR EXPERIENCES. MUSEUMS OF COMMUNISM EXPLORES THE COMPLICATED INTERSECTION OF HISTORY, COMMEMORATION, AND VICTIMIZATION MADE EVIDENT IN THESE MUSEUMS CONSTRUCTED AFTER 1991. WHILE CONTRIBUTORS FROM A DIVERSE RANGE OF FIELDS EXPLORE VARIOUS MUSEUMS AND INCLUDE NEARLY 90 PHOTOGRAPHS, A COMMON DENOMINATOR EMERGES: RATHER THAN FOCUSING ON ARTIFACTS AND HISTORICAL DOCUMENTS, THESE MUSEUMS OFTEN PRIVILEGE MEMORIES AND STORIES. IN DOING SO, THE MUSEUMS SHIFT ATTENTION FROM EXPERIENCES OF GUILT OR COLLABORATION TO NARRATIVES OF SHARED VICTIMIZATION UNDER COMMUNIST RULE. AS EDITOR STEPHEN M. NORRIS DEMONSTRATES, THESE MUSEUMS ARE OFTEN PROBLEMATIC AT BEST AND REVISIONIST AT WORST. FROM OCCUPATION MUSEUMS IN THE BALTIC STATES TO MEMORIAL MUSEUMS IN UKRAINE, FORMER SECRET POLICE PRISONS IN ROMANIA, AND NOSTALGIC MUSEUMS OF EVERYDAY LIFE IN RUSSIA, THE SITES CONSIDERED OFFER NEW WAYS OF UNDERSTANDING THE CHALLENGES OF SEPARATING MEMORY AND MYTH.

📖 **GLOBAL ANTI-TERRORISM LAW AND POLICY** VICTOR V. RAMRAJ, MICHAEL HOR, KENT ROACH, 2009-04-09 ALL INDICATIONS ARE THAT THE PREVENTION OF TERRORISM WILL BE ONE OF THE MAJOR TASKS OF GOVERNMENTS AND REGIONAL AND INTERNATIONAL ORGANISATIONS FOR SOME TIME TO COME. IN RESPONSE TO THE GLOBALISED NATURE OF TERRORISM, ANTI-TERRORISM LAW AND POLICY HAVE BECOME MATTERS OF GLOBAL CONCERN. ANTI-TERRORISM LAW CROSSES BOUNDARIES BETWEEN STATES AND BETWEEN DOMESTIC, REGIONAL AND INTERNATIONAL LAW. THEY ALSO CROSS TRADITIONAL DISCIPLINARY BOUNDARIES BETWEEN ADMINISTRATIVE, CONSTITUTIONAL, CRIMINAL, IMMIGRATION AND MILITARY

LAW, AND THE LAW OF WAR. THIS COLLECTION IS DESIGNED TO CONTRIBUTE TO THE GROWING FIELD OF COMPARATIVE AND INTERNATIONAL STUDIES OF ANTI-TERRORISM LAW AND POLICY. A PARTICULAR FEATURE OF THIS COLLECTION IS THE COMBINATION OF CHAPTERS THAT FOCUS ON A PARTICULAR COUNTRY OR REGION IN THE AMERICAS, EUROPE, AFRICA, AND ASIA, AND OVERARCHING THEMATIC CHAPTERS THAT TAKE A COMPARATIVE APPROACH TO PARTICULAR ASPECTS OF ANTI-TERRORISM LAW AND POLICY, INCLUDING INTERNATIONAL, CONSTITUTIONAL, IMMIGRATION, PRIVACY, MARITIME, AVIATION AND FINANCIAL LAW.

**P Human Rights and Disability** JOHN-STEWART GORDON, JOHANN-CHRISTIAN PDER, HOLGER BURCKHART, 2017-07-14 THE FORMERLY ESTABLISHED MEDICALLY-BASED IDEA OF DISABILITY, WITH ITS CHARITY-BASED APPROACH TO TREATMENT AND SERVICES, IS BEING REPLACED BY A HUMAN RIGHTS-BASED APPROACH IN WHICH PEOPLE WITH IMPAIRMENTS ARE NO LONGER CONSIDERED MEDICAL PROBLEMS, TOTALLY DEPENDENT ON THE BENEFICENCE OF NON-IMPAIRED PEOPLE IN SOCIETY, BUT HAVE FUNDAMENTAL RIGHTS TO SUPPORT, INCLUSION, AND PARTICIPATION. THIS INTERDISCIPLINARY BOOK EXAMINES THE DIVERSE CONCERNS THAT PEOPLE WITH IMPAIRMENTS FACE IN THE CONTEXT OF HUMAN RIGHTS, PROVIDES INSIGHTS INTO NEW DEVELOPMENTS ON IMPORTANT ISSUES RELATING HUMAN RIGHTS TO DISABILITY, AND FEATURES NEW APPROACHES AND SOLUTIONS TO VITAL PROBLEMS IN THE CURRENT DEBATE.

**P Poisoned Wells** NICHOLAS SHAXSON, 2007-03-20 EACH WEEK THE OIL AND GAS FIELDS OF SUB-SAHARAN AFRICA PRODUCE WELL OVER A BILLION DOLLARS' WORTH OF OIL, AN AMOUNT THAT FAR EXCEEDS DEVELOPMENT AID TO THE ENTIRE AFRICAN CONTINENT. YET THE RISING TIDE OF OIL MONEY IS NOT PROMOTING STABILITY AND DEVELOPMENT, BUT IS INSTEAD CAUSING VIOLENCE, POVERTY, AND STAGNATION. IT IS ALSO GENERATING VAST CORRUPTION THAT REACHES DEEP INTO AMERICAN AND EUROPEAN ECONOMIES. IN *POISONED WELLS*, NICHOLAS SHAXSON EXPOSES THE ROOT CAUSES OF THIS PARADOX OF POVERTY FROM PLENTY, AND EXPLORES THE MECHANISMS BY WHICH OIL CAUSES GRAVE INSTABILITIES AND CORRUPTION AROUND THE GLOBE. SHAXSON IS THE ONLY JOURNALIST WHO HAS HAD ACCESS TO THE KEY PLAYERS IN AFRICAN OIL, AND IS WILLING TO MAKE THE CONNECTIONS BETWEEN THE PROBLEMS OF THE DEVELOPING WORLD AND THE INVOLVEMENT OF LEADING GLOBAL CORPORATIONS AND GOVERNMENTS.

**P Sign Languages** DIANE BRENTARI, 2010-05-27 WHAT ARE THE UNIQUE CHARACTERISTICS OF SIGN LANGUAGES THAT MAKE THEM SO FASCINATING? WHAT HAVE RECENT RESEARCHERS DISCOVERED ABOUT THEM, AND WHAT DO THESE FINDINGS TELL US ABOUT HUMAN LANGUAGE MORE GENERALLY? THIS THEMATIC AND GEOGRAPHIC OVERVIEW EXAMINES MORE THAN FORTY SIGN LANGUAGES FROM AROUND THE WORLD. IT BEGINS BY INVESTIGATING HOW SIGN LANGUAGES HAVE SURVIVED AND BEEN TRANSMITTED FOR GENERATIONS, AND THEN GOES ON TO

ANALYSE THE COMMON CHARACTERISTICS SHARED BY MOST SIGN LANGUAGES: FOR EXAMPLE, HOW THE USE OF THE VISUAL SYSTEM AFFECTS GRAMMATICAL STRUCTURES. THE FINAL SECTION DESCRIBES THE PHENOMENA OF LANGUAGE VARIATION AND CHANGE. DRAWING ON A WIDE RANGE OF EXAMPLES, THE BOOK EXPLORES SIGN LANGUAGES BOTH OLD AND YOUNG, FROM BRITISH, ITALIAN, ASIAN AND AMERICAN TO ISRAELI, AL-SAYYID BEDOUIN, AFRICAN AND NICARAGUAN. WRITTEN IN A CLEAR, READABLE STYLE, IT IS THE ESSENTIAL REFERENCE FOR STUDENTS AND SCHOLARS WORKING IN SIGN LANGUAGE STUDIES AND DEAF STUDIES.

📖 **DEMOGRAPHIC PERSPECTIVE OF CHINA'S ECONOMIC DEVELOPMENT** FANG CAI, 2020-05-17 CHINA IS HISTORICALLY FAMOUS FOR ITS HIGH DEMOGRAPHIC DIVIDEND AND ITS HUGE WORKING POPULATION, AND THIS HAS DRIVEN TREMENDOUS ECONOMIC GROWTH OVER THE PAST FEW DECADES. HOWEVER, THAT POPULATION HAS BEGUN TO SHRINK AND THE LEWIS TURNING POINT WHEREBY SURPLUS RURAL POPULATION HAS BEEN ABSORBED INTO MANUFACTURING IS ALSO APPROACHING, LEADING TO GREAT CHANGE IN THE CHINESE LABOR MARKET. WILL THIS NEGATIVELY AFFECT CHINA'S ECONOMIC GROWTH? CAN THE MIDDLE-INCOME TRAP BE AVOIDED? WHAT REFORMS SHOULD BE MADE ON THE LABOR SUPPLY SIDE? THIS BOOK TACKLES THESE KEY QUESTIONS. THIS BOOK IS A COLLECTION OF 14 PAPERS PRESENTING THE AUTHOR'S OBSERVATIONS, ANALYSIS, AND OPINIONS OF CHINA'S LONG-TERM ECONOMIC DEVELOPMENT FROM THE DEMOGRAPHIC PERSPECTIVE, WHILE ANALYSING REAL ECONOMIC PROBLEMS FROM THE PAST AND INCLUDING POLICY RECOMMENDATIONS. IT PROVIDES A CRITICAL REFERENCE FOR SCHOLARS AND STUDENTS INTERESTED IN CHINESE ECONOMIC DEVELOPMENT AND DEMOGRAPHIC PERSPECTIVES ON ECONOMIC DEVELOPMENT.

📖 **IMPACT OF NATURAL RESOURCE MANAGEMENT TECHNOLOGIES**, 2006 THIS PAPER REVIEWS THE IMPACT OF AN IMPROVED FALLOW FERTILIZER TREE SYSTEM ON LIVES AND LANDSCAPES IN EASTERN ZAMBIA. IT DRAWS ON A NUMBER OF ANALYSES CONDUCTED BOTH BY THE WORLD AGROFORESTRY CENTRE (ICRAF) STAFF AND BY OTHER SCIENTISTS. THE AUTHORS DESCRIBE THE DIAGNOSIS OF PROBLEMS THAT LED TO THE USE OF THE FERTILIZER TREE SYSTEM AS AN INTERVENTION. THEY ALSO HIGHLIGHT ICRAF'S ROLE IN PROMOTING FERTILIZER TREES IN ZAMBIA. THE PAPER THEN ASSESSES THE FACTORS ASSOCIATED WITH ADOPTION OF THE IMPROVED FALLOW SYSTEM, ITS BIOLOGICAL, ECONOMIC AND ENVIRONMENTAL IMPACTS AT THE FARM LEVEL, AND THEN ITS WIDER IMPACT ON LIVELIHOODS AND LANDSCAPES IN EASTERN PROVINCE, ZAMBIA.

📖 **PARTY SYSTEM CHANGE IN SOUTH INDIA** ANDREW WYATT, 2009-12-16 THIS BOOK PROVIDES A SYSTEMATIC EXPLORATION OF PARTY SYSTEM CHANGE. BY APPLYING THE CONCEPT OF POLITICAL ENTREPRENEURSHIP AND USING A DETAILED CASE STUDY OF THE SOUTH INDIAN STATE OF TAMIL NADU, IT DEMONSTRATES HOW PARTY LEADERS CAN EXERCISE THEIR AGENCY AND DRIVE PARTY SYSTEM

CHANGE. RECENT DEVELOPMENTS IN TAMIL POLITICS ARE TAKEN INTO ACCOUNT IN THE LIGHT OF THE LITERATURE ON PARTY SYSTEMS, ACHIEVING A CLASSIFICATION OF THE PARTY SYSTEM AND REVEALING PATTERNS OF CHANGE. THE AUTHOR EXPLAINS THE PROCESS OF THE CHANGE BY COMPARING THE CAREERS OF SUCCESSFUL AND FAILED PARTY LEADERS, THUS IDENTIFYING THE FACTORS THAT ENABLED SOME POLITICAL ENTREPRENEURS TO SUCCESSFULLY FOUND POLITICAL PARTIES AND CONTRIBUTE TO THE PROCESS OF PARTY SYSTEM CHANGE. EXAMINING ISSUES SUCH AS REGIONAL PARTIES, POLITICAL ENTREPRENEURSHIP, SOCIAL CHANGE, CASTE AND RELIGIOUS NATIONALISM, THE BOOK ILLUSTRATES THE KEY FORCES SHAPING CONTEMPORARY INDIAN POLITICS, AND PRESENTS AN EXAMPLE OF HOW THE TREND TOWARD IDENTITY POLITICS AND THE RISING INFLUENCE OF REGIONAL POLITICAL PARTIES ARE FASHIONING A NEW INDIAN POLITY. WITH A BROAD CROSS-DISCIPLINARY APPEAL, THE BOOK WILL BE OF INTEREST TO STUDENTS OF SOUTH ASIAN POLITICS, COMPARATIVE POLITICS, SOCIOLOGY AND ANTHROPOLOGY.

❏ *SHATTERED HOPES* JOSH RUEBNER, 2013-09-10 PRESIDENT BARACK OBAMA'S FIRST TRIP ABROAD IN HIS SECOND TERM TOOK HIM TO ISRAEL AND THE PALESTINIAN WEST BANK, WHERE HE DESPONDENTLY ADMITTED TO THOSE WAITING FOR WORDS OF ENCOURAGEMENT, IT IS A HARD SLOG TO WORK THROUGH ALL OF THESE ISSUES. CONTRAST THIS GLOOMY ASSESSMENT WITH OBAMA'S OPTIMISM ON THE SECOND DAY OF HIS FIRST TERM, WHEN HE APPOINTED FORMER SENATE MAJORITY LEADER GEORGE MITCHELL AS HIS SPECIAL ENVOY FOR MIDDLE EAST PEACE, BOLDLY ASSERTING THAT HIS ADMINISTRATION WOULD ACTIVELY AND AGGRESSIVELY SEEK A LASTING PEACE BETWEEN ISRAEL AND THE PALESTINIANS. HOW IS IT THAT OBAMA'S ACTIVE AND AGGRESSIVE SEARCH FOR PROGRESS HAS BECOME MIRED IN THE STATUS QUO? WRITER AND POLITICAL ANALYST JOSH RUEBNER CHARTS OBAMA'S JOURNEY FROM OPTIMISM TO FRUSTRATION IN THE FIRST HARD-HITTING INVESTIGATION INTO WHY THE PRESIDENT FAILED TO MAKE ANY PROGRESS ON THIS CRITICAL ISSUE, AND HOW HIS UNWILLINGNESS TO CHALLENGE THE ISRAEL LOBBY HAS SHATTERED HOPES FOR PEACE. WRITTEN IN A CLEAR AND ACCESSIBLE STYLE BY THE ADVOCACY DIRECTOR OF A NATIONAL PEACE ORGANIZATION AND FORMER MIDDLE EAST ANALYST FOR THE CONGRESSIONAL RESEARCH SERVICE, *SHATTERED HOPES* OFFERS AN INFORMED HISTORY OF THE OBAMA ADMINISTRATION'S POLICIES AND MAPS OUT A TRUE PATH FORWARD FOR THE UNITED STATES TO HELP ACHIEVE ISRAELI-PALESTINIAN PEACE.

❏ *PRINTERS' MARKS* WILLIAM ROBERTS, 1893

❏ *THE HEGEMON'S TOOL KIT* REBECCA DAVIS GIBBONS, 2022-07-15 AT A MOMENT WHEN THE NUCLEAR NONPROLIFERATION REGIME IS UNDER DURESS, REBECCA DAVIS GIBBONS PROVIDES A TRENCANT ANALYSIS OF THE INTERNATIONAL SYSTEM THAT HAS, FOR MORE THAN FIFTY YEARS, CONTROLLED THE SPREAD OF THESE CATASTROPHIC WEAPONS. *THE HEGEMON'S TOOL KIT* DETAILS HOW THAT REGIME



WORKS AND HOW, DISASTROUSLY, IT MIGHT FALTER. IN THE EARLY NUCLEAR AGE, EXPERTS ANTICIPATED THAT ALL TECHNOLOGICALLY-CAPABLE STATES WOULD BUILD THESE POWERFUL DEVICES. THAT DID NOT HAPPEN. WIDESPREAD DEVELOPMENT OF NUCLEAR ARMS DID NOT OCCUR, IN LARGE PART, BECAUSE A GLOBAL NUCLEAR NONPROLIFERATION REGIME WAS CREATED. BY THE LATE-1960S, THE UNITED STATES AND THE SOVIET UNION HAD DRAFTED THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS (NPT), AND ACROSS DECADES THE REGIME HAS EXPANDED, WITH MORE AGREEMENTS AND MORE NATIONS PARTICIPATING. AS A RESULT, IN 2022, ONLY NINE STATES POSSESS NUCLEAR WEAPONS. WHY DO MOST STATES IN THE INTERNATIONAL SYSTEM ADHERE TO THE NUCLEAR NONPROLIFERATION REGIME? THE ANSWER LIES, GIBBONS ASSERTS, IN DECADES OF PAINSTAKING EFFORTS UNDERTAKEN BY THE US GOVERNMENT. AS THE MOST POWERFUL STATE DURING THE NUCLEAR AGE, THE UNITED STATES HAD MANY TOOLS WITH WHICH TO PERSUADE OTHER STATES TO JOIN OR OTHERWISE SUPPORT NONPROLIFERATION AGREEMENTS. THE WANING OF US GLOBAL INFLUENCE, GIBBONS SHOWS IN THE HEGEMON'S TOOL KIT, IS A KEY THREAT TO THE NONPROLIFERATION REGIME. SO, TOO, IS THE DEEPENING GLOBAL DIVIDE OVER PROGRESS ON NUCLEAR DISARMAMENT. TO DATE, THE CHINESE GOVERNMENT IS NOT TAKING SIGNIFICANT STEPS TO SUPPORT THE NUCLEAR NONPROLIFERATION REGIME, AND AS A RESULT, THE REGIME MAY FACE A HARMFUL LEADERSHIP GAP.

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