Forestry science
Scientia silvae Sinicae
2005 Vol.41 No. P.155-162

Forest fires spread computer simulation and visualization research progress

[jade-Tang Li Feng Xiaogang Chenchong%

Picked to : Forest fires spread of forest fires is the main form of behaviour. The fire spread to various computer simulation and visualization technology to study the latest situation and development trends summarized. First, the analysis of mathematical models of forest fires spread related categories and features, model development and system formed. Secondly, For a discussion of the placenta automatic machines and the two Huyghens principle violist fire simulation with display technology and 3D virtual forest fires and built environment technology. Finally, on the spread of forest fires and simulation of the latest developments in management information systems for general. that the spread of forest fires, simulation and visualization to the research and development of high-precision, and practical direction, in the future will focus on realistic environments virtual forest landscape a multidimensional, multi-user participation in the rapid decision-making capacity (such as with fire fighting), and network information services.
Keywords : Forest fires spread; Simulation or emulation; Mathematical models; 3D virtual environment; Information Systems
Fenleihao : S762.2 **Wenxianbiaoshima :** A
The article accordingly : 1001-7488(2005)05-0155-08

Research advance in simulation and visualization of forest fire spreading via computer

Chongcheng Chen Tang Liyu Li Jianwei Feng Xiaogang

Fund projects : Major state basic research projects (973) - special studies (2002CCC01900, 2004CCA07200) funding.
Author units : Chenchong% (Fuzhou University in Fujian Province spatial information engineering research center, the Ministry of Education data on the excavation and laboratory information sharing, Fuzhou 350002)
7:00 - (Fuzhou University in Fujian Province spatial information engineering research center, the Ministry of Education data on the excavation and laboratory information sharing, Fuzhou 350002)
Tang Li-yu (Fuzhou University in Fujian Province spatial information engineering research center, the Ministry of Education data on the excavation and laboratory information sharing, Fuzhou 350002)
Feng Xiaogang (Fuzhou University in Fujian Province spatial information engineering research center, the Ministry of Education data on the excavation and laboratory information sharing, Fuzhou 350002)

References :

[1] Huangguangyuan, Zhu dated autumn. 1988. Fight forest fires and models. Systems engineering theory and practice, 8 (2) : 35-38
[2] Huang Hua States, max, Wang. 2005. For 3D toroidal million placenta automatic machine simulation models of forest fires spread. Beijing Forestry University

Journal, 27 (3) : 94-97
[3] [micro, Chenchong% of its, and so on. 2005. Virtual forest landscape, forest fires spread models and 3D visualization expression. Applications ecological Journal, 16 (5) : 838-842
[4] Shu Li Fuk, Wangmingyu, Tian Xiaorui, and so on. 2004. Forest fire burning on the calculation and interpretation of acts of parameters. Forestry Science, 40 (3) : 179-183
[5] Songweiguo, Michael Cheng, Wang Bing Wang. 2001. Integer-type model forest fires since the organization and its critical nature. Fire Science, 10 (1) : 53-56
[6] Tangxiaoyan, Mengxianyu, if Yi Gallant. 2002. Simulation models and the spread of forest fires spread of the progress of the study. Beijing Forestry University Journal, 24 (1) : 87-91
[7] Tangxiaoyan, Mengxianyu, Gehong Aguilar. 2003. Based on the structure of the forest fires spread grid simulation studies and achieved. Beijing Forestry University Journal, 25 (1) : 53-57
[8] Yinyong, a deputy gold, Renhongxiang, and so on. 2002. Real-time simulation of natural phenomena. System simulation Journal, 14 (9) : 1217-1219
[9] Zhu ground, the high-front, Zhangzhenwei. 1995. GIS support of the forest fire spread computer simulation. Remote Sensing of the Environment, 10 (2) : 81-88
[10]Abbott K, Leblon B, Staples G, et al. Use of images to map forest RAOARSAT-1 fuelmoisture over boreal forests. In : Ellsworth L. eds. Geoscience and telehealth Sensing symposium 2002,procedings, IEEE International,24-18 June,2002,1:134-136
[11]Ahrens JP, McCormick P, Bossert J, et al. 1997. Case study : wildfire visualization. In : Yagel R, Hagen H eds. Proceedings of IEEE Visualization 97 Conferene. Los Alamitos, California : IEEE Computer Society Press : 451-454
[12]Alexander M E. 1985. Estimating the length-to-breadth ratio of elliptical forest fire patterns. In : Ms. LR, Martin re eds. Proceedings of 8th Conference for Fire and Forest Meteorology, Society of American Forestry. Detroit, Mich.. : 287-304
[13]Alexander me, Keith a, Brigitte L. 2002. Use of images to map forest RADARSAT-1 moisture over boreal forests fuels. In : Ellsworth L. eds. Proceedings of International Geosciences and telehealth Sensing Symposium (IGARSS), 1 : 134-136
[14]Anderson he, Catchpole NJ, DeMestre NJ, et al. 1982. modeling the spread of root fires. Journal of Australia Mathematic Society (419-436. B), 23 : 451-466
[15]Andr y JCS, Viegas D X.1998. A unifying theory on the propagation of the fire front of surface forest fires. In : Viegas DX eds. Proceedings of the 3rd International Conference on Forest Fire Research and the 14th Conference of Fire and Forest Meteorology. Luso. Coimbra, Portugal, 1:259-279
[16]Andrews P L. 1986. Behave : fire behavior prediction and fuels modeling system-BURN subsystem, Part 1, USDA Forest Service, Intermountain Research Station, Gen Tech Rep INT-194, Ogden, Utah
[17]Andrews PL, Queen extend P. 2001. Fire modeling and information system technology. International Journal of Wildland Fire. 10 (3/4) : 343-352
[18]Andrews PL, Bevins CD, Seli R C. 2003. BehavePlus fire modeling system, version 2.0 : User 's Guide. Gen Tech Rep RMRS-GTR-106WWW. Ogden, UT : Department of Agriculture, Forest Service, Rocky Mountain Research Station
[19]Ashikhmin M. 2001. Synthesizing natural textures. In : c. eds. Proceedings of the 2001 ACM Symposium on Interactive 3D Graphics : 217-226
[20]Barros FJ, Ms. M T. 1997. Forest fire modeling and simulation in the Delta environment. Simulation Practice and Theory, 5 (3) : 185-197
[21]Beaudoin P, Paquet S, Poulin P. 2001. Title and Controllable Fire Simulation. In : c. eds. Proceedings of Graphics Interface 2001. Ottawa, Ontario, Canada : 159-166
[22]Brandis K, Jacobson C. 2003. Estimation of vegetative fuels loads using Landsat TM imagery in New South Wales, Australia. International Journal of Wildland Fire, 12 (2) : 185-194

[23]Burg JV D. 2000. Building an advanced particle system. Game Developer, 7 (2) : 44-50
[24]Burgan re, Klaver RW, Klaver J M.1998. Fuel models and fire potential from satellite and surface observations. International Journal of Wildland Fire. 8 (3) : 159-170
[25]Catchpole EA, Catchpole WR, Viney Supreme, et al. 2001. Estimating response time and predicting fossil fuels moisture content from field data. International Journal of Wildland Fire. 10 (2) : 215-222
[26]Chi SD, Lim YH, Lee JK, et al. 2003. a simulation-based decision support system for forest fire Fighting. Lecture Notes in Computer Science, 2829 : 487-498
[27]Clark TL, Coen J, Mrs. D. 2004. Description of a coupled atmosphere fire model. International Journal of Wildland Fire. 13 (1) : 49-63
[28]Eklund P. 2001. A distributed spatial architecture for bush fire simulation. Journal of GIS, 15 (4) : 45-59
[29]Feldman be, O 'O'Brien JF, Arikan O. 2003. Animating suspended particle explosions. In : c. eds. Proceedings of ACM SIGGRAPH 2003, San Diego, California : 708-715
[30]Finney m a. 1998. FARSITE : fire area simulator-model development and evaluation. USDA Forest Service. Research Paper RMRSRP-4
[31]Foster N, punishable D. 1996. Realistic animation of liquids. Graphical Models and Image Processing, 58 (5) : 471-483
[32]Foster N, punishable D. 1997. Modeling the motion of a hot, turbulent gas. In : L Pocock, 67-68 R eds. Proceedings of ACM SIGGRAPH, Annual Conference Series, ACM : 181-188
[33]French I A. 1992. Visualization techniques for the computer simulation of bush Fires in Two Dimensions. Ms thesis, University of New South Wales, Australian Defence Force Academy
[34]Gollberg GE, Neuenschwander LF, Ryan K C. 2001. Introduction : Integrating spatial technologies and ecological principles for a new age in fire management. International Journal of Wildland Fire. 10 (3/4) : 263-265
[35]Hanson HP, Bradley mm, Bossert Je, et al. 2000. The potential and promise of physics-based wildfire simulation. Environmental Science & Policy, 3:161-172
[36]Holtkamper T. 2003. Real-time gaseous Phenomena : A phenomenological approach to Interactive examination and steam. In : Gain Je, Chalners a eds. Proceedings of the 2nd International Conference on Computer Graphics, Virtual Reality, Visualization and interaction in Africa, Cape Town, South Africa, 25-30
[37]Ilmonen t, Kontkanen J. 2003. The second order particle system. Journal of WSCG, 11 (1) : 1213-6972
[38]Jenkins m a. 2000. Numerical simulation of a wildfire event. In : Alexander me eds. Proceedings of Third Symposium on Fire and Forest Meteorology. Long Beach, CA : 3-6
[39]Jorba J, T Margalef, Luque E. 2001. Simulation of Forest Fire Propagation on Parallel & Distributed PVM Crimes. In : Cotronis Y, Dongarra J dds. Euro PVM/MPI 2001, Lncs 2131, 386-392
[40]Karafyllidis I, Thanailakis a. 1997. a model for predicting forest fire spreading using cellular automata. ? Modelling, 99 (1) : 87-97
[41]Karafyllidis I. 2004. Design of a dedicated parallel processor for the prediction of forest fire spreading using cellular automata and genetic algorithms. Engineering Applications of Artificial Intelligence, 17 (1) : 19-36
[42]Keane re, namely Burgan R, Wagtendonk J. 2001. Mapping wildland fuels for fire management across multiple scales : Integrating remote sensing, GIS, and biophysical modeling. International Journal of Wildland Fire, 10 (3/4) : 301-319
[43]Keramitsoglou I, Kiranoudis CT, Sarimvels H, et al. 2004. a multidisciplinary decision support system for forest fire crisis management. Environmental Management, 33 (2) : 212-225
[44]King sa, Crawfis RA, Reid W. 1999. Fast animation of amorphous and gaseous

phenomena. Volume Graphics' 99, Swansea, Wales : 333-346
[45]Kwatra V, Schodl a, Essa I, et al. 2003. Graphcut textures : Image and video synthesis Using graph cuts. ACM Transaction of Graph, 22 (3) : 277-286
[46]Lamorlette a, Foster N. 2002. Structural modeling of flames for a production environment. ACM Transaction of Graph,21 (3) : 729-735
[47]Lander J. 1998. The ocean spray in your face. Game Development, 5 (4) : 13-18
[48]Lee H, Kim L, Meyer, M., Desbrun M. 2001. Meshes on fire. In : c. eds. Proceedings of the Eurographic Workshop on Computer Animation and Simulation : 75-84
[49]Leech JP, Taylor R M. 1993. Interactive modeling using particle systems. Computer and Graphics,24 (6) : 105-116
[50]Linn RR, Harlow F H. 1998. FIRETEC : A transport description of wildfire behavior. In : c. eds. Proceedings of 2nd Symposium on Fire and Forest Meteorology, AMS 78th Annual Meeting, Phoenix, Arizona : 11-16
[51]Malamud B, D Turcotte. 2000. Cellular automata models applied to natural hazards. Computing in Science & Engineering, 42-51
[52]Morgan P, Hardy CC, Swetnam TW, et al. 2001. Mapping fire regimes across time and space : Understanding coarse and fine scale fire patterns. International Journal of Wildland Fire, 10 (3/4) : 329-342
[53]Muzy a, Marcelli t, Aiello a, et al. 2001. Application of Devs formalism to a semi-physical model of fire spread accross a fireproof bed. In : Giambiasi N eds. Proceedings of 85th des Simulation Symposium and Exhibition 13. Marseilles, France,October 18-20,641-643
[54]Muzy a, Wainer G, Innocenti e, et al. 2002a. CELL-DEVS quantization techniques in a fire spreading Application. In : Y More cesan e eds. Proceedings of the 2002 Winter Simulation Conference : 542-549
[55]Muzy a, Wainer G. 2002b. Comparing simulation methods for fire spreading across a fossil bed. In : Barros FJ and Giambiasi N eds. Proceedings of Ai, Simulation and Planning in High ed Systems, AIS '2002 Lisbon, Portugal, 219-224
[56]Nelson R M. 2002. An effective wind speed for models of fire spread. International Journal of Wildland Fire, 11 (2) : 153-161
[57]Nguyen DQ, Fedkiw RP, H W Jensen. 2002. Physically Based beginners and Animation of Fire, ACM Transactions on Graphics, 21 (3) : 721-728
[58]Oswald B P. 1999. Classifying fuels with aerial photography in East Texas. International Journal of Wildland Fire, 9 (2) : 109-113
[59]Pastor E, Z ? rate L, Planas e, et al. 2003. Mathematical models and calculation systems for the study of wildland fire behavior. Progress in Energy and Combustion Science. 29 (2) : 139-153
[60]Paz C, Fuentes F, Garcia s. 2001. Numerical simulation of forest fire.In : Marson DM eds. International Symposium on multi-Phase flow and Transport Phenomena. Antalya, Turkey,November,5-10:505-512
[61]Perminov V. 2002. Numerical solution of Reynolds equations for forest fire spread. Lecture Notes in Computer Science, 2329 : 823-842
[62]Perry Ch, Picard R W. 1994. Synthesizing flames and their spreading. In : c. eds. Proceedings of Eurographics Workshop on Animation and Simulation. Olso, Norway,Sept 12-13:105-117
[63]Rasmussen N, Nguyen D, Geiger W, et al. 2003. Smoke Simulation for large scale phenomena. ACM Transaction of Graph, 22 (3) : 703-707
[64]Reeves W T. 1983. Particle Systems -A technique for modeling a class of fuzzy objects. Computer Graphics, 17 (3) : 359-376
[65]Reich RM, Lundquist Je, Bravo v a. 2004. Spatial models for estimating fuels loads in the Black Hills, South Dakota. USA. International Journal of Wildland Fire, 13 (2) : 119-129
[66]Richards G D. 1990. An elliptical growth model of forest fire fronts and its numerical solution. International Journal Numeric Math Engineering, 30:1163-1179
[67]Richards G D. 1995. A general mathematical framework for modeling two

dimensional wild-land fire spreading. International Journal of Wildland Fire. 5 (2) : 63-72
[68]Richards G D. 1999. The mathematical modeling and computer simulation of wildland fire perimeter growth over a 3-dimensional surface.International Journal of Wildland Fire. 9 (3) : 213-221
[69]Rothermel R C. 1972. A mathematical model for predicting fire spread in wildland fuels. USDA Forest Service, Research Paper INT-115
[70]Sandberg inclination, Ottmar Rd, Cushon G H. 2001. Characterizing fuels in the 21st Century. International Journal of Wildland Fire. 10 (3/4) : 381-387
[71]Simeoni, a, Santoni PA, Larini M, et al. 2001. Proposal for improvement of theoretical models thanks to a semi-physical forest spread multi-phase approach : application to a fire spread model across a fossil bed. Combustion Science and Technology, 162:59-83
[72]Simeoni a, Santoni P, Balbi J H. 2002. a strategy to elaborate forest fire spread models for management tools including a computer time-saving algorithm. International Journal of modeling and Simulation, 22 (4) : 1-12
[73]Simeoni a, Santoni PA, Larini M, et al. 2003. Reduction of a multiphase formulation to include a simplified flow in a semi-physical model of fire spread across a fossil bed. International Journal of Thermal Sciences, 42:95-105
[74]Sims K. 1990. Particle animation and rendering using data parallel computation. Computer Graphics, 24 (4) : 405-413
[75]Stam J, Fiume e. 1995. Depicting fire and other gaseous phenomena using diffusion processes. In : Wesley a eds. Proceedings of SIGGRAPH '95, Los Angeles, CA, August 9-11, 129-136
[76]Stam J. 1999. Stable Fluids. In : Warren W eds. Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques. ACM Press : 121-128
[77]Stam J. 2000. Interacting with detectors and fire in real time. Communications of the ACM, 43 (7) : 76-83
[78]Stolk J, van Wijk J J. 1992. Surface particles for 3D flow visualization. In : Post FH, AJS Hin eds. Advances in Scientific Visualization. Springer, Berlin
[79]Vakalis D Sarimveis H, Kiranoudis C, et al. 2004a. a GIS based operational system for wildland fire crisis management I. Mathematical modeling and simulation. Applied mathematical modeling, 28 : 389-410
[80]Vakalis D Sarimveis H, Kiranoudis C. 2004b. a GIS based operational system for wildland fire crisis management II. System architecture and case studies. Applied mathematical modelling. 28 : 411-425
[81]Viegas DX, Ribeiro PR, Maricato L.1998. An empirical model for the spread of a fireline inclined in relation to the slope gradient or to wind direction. In : Viegas DX eds. Proceedings of the 3rd International Conference on Forest Fire Research and the 14th Conference of Fire and Forest Meteorology. Luso. Coimbra, Portugal, 1 : 325-342
[82]Viegas DX, Garcia (n~) ol BJ, Viegas M T. 2001. Estimating live fine fuels moisture content using, meteorologically-based indices. International Journal of Wildland Fire, 10 (2) : 223-240
[83]Wei X, Li W, Mueller K, et al. 2002. Simulating fire with texture splats. In : c. eds. Proceedings of 13th IEEE Visualization 2002 Conference, 227-234
[84]Wybo J L. 1998. Minder : a decision support system for forest fire prevention and Fighting. IEEE Transactions on Engineering Management, 45 (2) : 127-131
[85]Zeigler,BP, Moon Y, Kim D.1996. DEVS-C++ : A high performance modeling and simulation environment. In : c. eds. Proceedings of 29th Hawaii International Conference on System Sciences (Hicss' 96), 1 : Software Technology and Architecture,Maui, Hawaii

1994-1995 Date : June 15, 2004

Publication date : September 1, 2005

Look at PDF text