Coupling bushfire spread with a sensor network detection system

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Bushfire spread is essentially spatial and time-varying in nature. A bushfire spread simulator takes as inputs the following: the current position of the fire, the spatial variation of fuel types and slope, the temporal variation of fuel moisture and weather conditions and fire suppression activities. Fire simulation is a mathematical and computational task that applies existing fire behaviour models to the input data and projects the fire position forward through time.

The original Bushfire CRC simulator was based on the transfer of discrete packets of heat across the landscape. The landscape was divided into irregular polygons to avoid introducing directional bias via the simulation method. The simulator has been re-implemented using the contemporary programming language, Java, because of its excellent resources for developing graphical user interfaces and platform independence, while also having strong numerical capabilities. The Mk 2 simulator has kept the irregular polygonal shaped cells but, instead of the heat transfer method, adopts the more traditional propagation delay approach to simulate the spread of fire. The advantage of this approach is that fire behaviour models plug directly into the simulation engine and there is no calibration step required and therefore the simulator produces the same rate of spread as the fire behaviour meter.

The most important result from the re-development of the simulator is its extreme efficiency. Simulations that previously required several minutes to run now complete in less than a second. This quantum leap in performance will allow us to rapidly perform hundreds of simulation experiments of the same fire with different input data to factor in uncertainties in forecast weather, fuel state and the current state of a fire.

Wireless sensors can be deployed in remote areas to detect bushfires through observation of temperature, moisture, and other environmental phenomena and communication of environmental change by radio through the sensor network. The success of a bushfire sensor network is dependent on a large number of variables, most of which are difficult or impossible to test in real-world experimentation due to cost and environmental damage. Accordingly, we use a simulation environment to determine the optimal configuration of sensors in the most common scenarios. Within each scenario, we can input specific parameters such as wind, temperature, moisture, and fire spread. To generate a realistic fire spread, we can use data generated from the Bushfire CRC fire spread simulator. This combination can then be used to assess the performance of various sensor network configurations and their ability to provide adequate warning of a fire situation. The simulator will enable us to optimise the sensor network configuration for given requirements on reliability and cost.