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A Monitoring System for Precaution of Agricultural Land Fire Based on Sensors and Alarm Activation

Assa'idah, Hadi and M. Fuad
Department of Physics, Sriwijaya University, 30662 South Sumatera, Indonesia

Abstract: Agricultural land fire is a routine problem happened in Indonesia. A monitoring system to prevent the fire had been build utilised sensors and alarm activation. Sensors was used to detect the increase of temperature and vibration around plants. This procedure could activated alarm if the scale of measurement above the threshold numbers. Arduino microcontroller and Xbee moduls was functioning as transmitter and receiver between plants and user's computer. Testing had been done and the systems researched properly as well as database output recorded the monitoring process.

Key words: Wireless sensor networks, sensors, land fire, monitoring system, Indonesia

INTRODUCTION

The 'Slash-and-burn' activity have been a traditional way for Indonesian farmers and agricultural companies to clear the forests for opening farming field. But this procedure have caused fires which been getting worse every year. In 2016, this fires had produced a thick toxic haze blanket across South East Asia. Indonesia goverment had deployed >10,000 police and soldiers and water-bombing planes to overcome the problem. Still the fires affected citizens badly. Meanwhile, fire prevention expert from ACIAR (Australis's Centre for International Agricultural Research) stated that it is an essentital to quickly detect and respond to forest fires.

A solution for quick fire detection is sensor utilisation in a monitoring systems. In agricultural applications, sensors have been used for many purposes. An autonomous multi-sensor UAV (Unmanned Aerial Vehicle) has been developed recently to provide spectral information for water management in pomegranate farm field (Katsigiannis *et al*., 2016). In India, a wireless sensor networks had been applied to monitor seed germination (Upadhyay *et al*., 2016) beside for agricultural fire detection although still in a Multisim simulation scale (Shinghal, 2014). While in Pakistan, different sensors but still in wireless networks also have been used to solve problems in agricultural systems (Mahfooz *et al*., 2016).

A neural network method also had been proposed to detect forest fire in a real time againts satellite based detection approach (Yu *et al*., 2005). The recent one, a research had been done to detect land fire in Indonesia using a high-sensitivity sensor which was onboard TET-1 satellite. Yet, the data was not available in real time monitoring (Atwood *et al*., 2016).

This study will proposed sensors application in monitoring agricultural land fire in Indonesia. Sensors are attached to the plants to detect the raise of temperature and vibration values to prevent fire spreading or ilegal logging activity which usually occur before the fire start. If the data measured over a threshold value it would warn the user in remote distance by alarm notification activated by the sensors.

MATERIALS AND METHODS

The monitoring systems was designed based on flowchart in Fig. 1. Two sensors (temperature and vibration) were deployed in a microcontroller (Arduino) to process any parameters detected as its input. These data

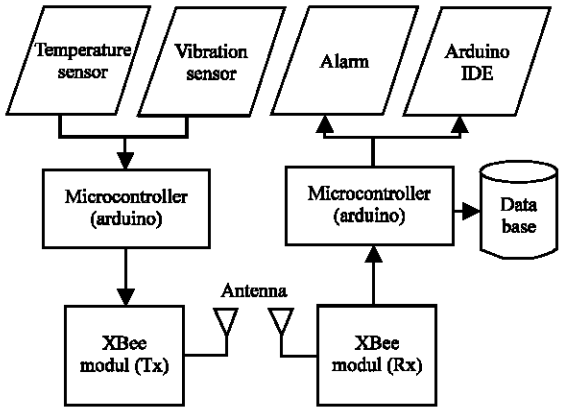

Fig. 1: Monitoring systems design

Corresponding Author: Assa'idah, Department of Physics, Sriwijaya University, 30662 South Sumatera, Indonesia

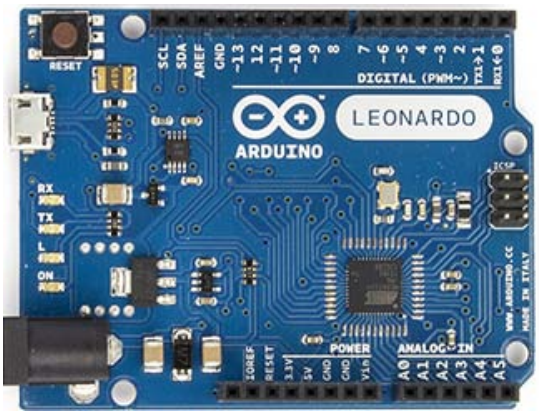

Fig. 2: Arduino microcontroller board

Table 1: Specifications of the Xbee-Pro (S2)

Performance	Details
Indoor/urban range	Up to 60 m
Outdoor RF line-of-sight range	Up to 1500 m
RF Data rate	250,000 bps
Supply voltage	3.0-3.4 V
Operating frequency band	2.4 GHz
Dimensions	2.438×3.294 cm
Operating temperature	-40° to 85°C
Supported network topologies	Point-to-point, point-to-multipoint, peer-to-peer and mesh

will be sent by antenna on XBee modul roled as Transmitter (TX) via. wireless network. All of these components were packed and attached on a palm tree among ten other trees. This tree was considered as a data source in sector P1 where all eleven trees located.

The antenna on other XBee modul-functioned as receiver in use's computer-would receive the data sent from the plant where transmitter attached on. The computer will save those datas in database while microcontroller would decide to activate alarm or not based on the threshold values declared in program embedded inside microcontroller. Arduino IDE was also an output of microcontroller to display the data of measurement by the sensors.

Sensors used in this research were LM35 to detect temperature and MiniSense 100 vibration sensor to detect any shock on the tree. These sensors were cheap and reliable enough in measuring physical parameters. For database application, Excel Microsoft Office 2010 program was utilised to simplify the monitoring process. The lists in Table 1 are detail description of XBee modul used in this research. This element is recommended for wireless communication network since it able to research in high speed data rate even for multipoint mode and has a wide range network covering area. Arduino had been chosen as microcontroller for its open source software reason. Figure 2 shows its pin configuration. Pin A1 and A3 were used as input source for temperature and vibration sensor respectively. Meanwhile, Xbee modul was inserted in Arduino board in Tx and Rx Terminal.

RESULTS AND DISCUSSION

The monitoring system had been built by following the chart in Fig. 1. We found out that the sensors had researched well for temperature and vibration detection. The calibration of this sensor had been done earlier in the laboratorium before the testing procedure in a palm field conducted.

The real test of the monitoring system had been applied on a palm tree (Fig. 3). A packed consisted of sensors, Arduino and Xbee modul powered by an external battery of 9 V were attached on the tree. We called this pack as transmitter or Tx modul.

The range of Tx network in the field test was limited to 50 m since other trees blocked the data signal. Therefore, a multipoint mode should be done for the network communication. It needs further research in configuring the points to optimize the network in communicate between moduls. We avoid Tx modul placement on each tree since it would cost much funding and inefficient for measurement it self. We decided to take one tree among 11 trees to represent the current situation of the environtment.

The data of temperature and vibration from the palm tree was succesfully sent to Rx modul on user's computer (Fig. 4). Although, sometimes the signal was lost due to an external block, still the receiver could display those data in Arduino IDE and saved them in database on a real time.

Those data were able directly saved in user's database. Table 2 is the screen captured of database on the monitor display. It recorded the real time of measurement, tree's location, temperature and vibration values detected by sensors.

A threshold number for temperature and vibration values had been set up as a limit for microcontroller to activate alarm. We simulated this number at 30° celcius for temperature limit. We didn't simulate the fire detection since it would harm the environment. We only ensured that the system would activate alarm whenever the measurement reach any limit number set in the program. Later in the real application this limit can be arranged depend on the user's requirement.

For vibration threshold, we choose a number where the tree was indicated as 'shaking' by a logging machine. We simulated the vibration from the machine by shaking the tree while observe the measurement by the vibration sensor before finally decided what number would be chosen as the threshold to activate the alarm. Table 3

Fig. 3: A packed of transmitter system attached on a palm tree in sector P1

Table 2: Database of monitoring system

Date-time	Sector	Vibration Sensor 1	Tepmerature Sensor 1
8/30/2016 15:59	P1	Low	28.91
8/30/2016 15:59	P1	Low	28.42
8/30/2016 15:59	P1	Low	29.4
8/30/2016 15:59	P1	Low	28.42
8/30/2016 15:59	P1	Low	28.91
8/30/2016 15:59	P1	Low	28.91
8/30/2016 15:59	P1	Low	28.91
8/30/2016 15:59	P1	Low	28.42
8/30/2016 15:59	P1	Low	28.42
8/30/2016 15:59	P1	Low	28.42
8/30/2016 15:59	P1	Low	28.91
8/30/2016 15:59	P1	Low	28.91
8/30/2016 15:59	P1	Low	29.91
8/30/2016 15:59	P1	Low	28.91

Table 3: Display of vibration sensor's measurement

Date-time	Sector	Vibration Sensor 1
14/11/2016 12:42:12	P1	0
14/11/2016 12:42:13	P1	0
14/11/2016 12:42:14	P1	21
14/11/2016 12:42:15	P1	24
14/11/2016 12:42:16	P1	27
14/11/2016 12:42:17	P1	29
14/11/2016 12:42:18	P1	31
14/11/2016 12:42:20	P1	30
14/11/2016 12:42:23	P1	31
14/11/2016 12:42:24	P1	32
14/11/2016 12:42:28	P1	38
14/11/2016 12:42:29	P1	61
14/11/2016 12:42:30	P1	59
14/11/2016 12:42:31	P1	32
14/11/2016 12:42:32	P1	22
14/11/2016 12:42:33	P1	15
14/11/2016 12:42:34	P1	1
14/11/2016 12:42:41	P1	0

show, the display of real time measurement from vibration sensor on a tree. No vibration detected would result the measurement as zero while these number became increase along the shake escalated from the simulation. By observing the result from Table 3 compare to the shaking simulation on the tree, we decided that the result of vibration sensor above 30 for 5 min duration would be the correct limitation to activate alarm. It can be seen that

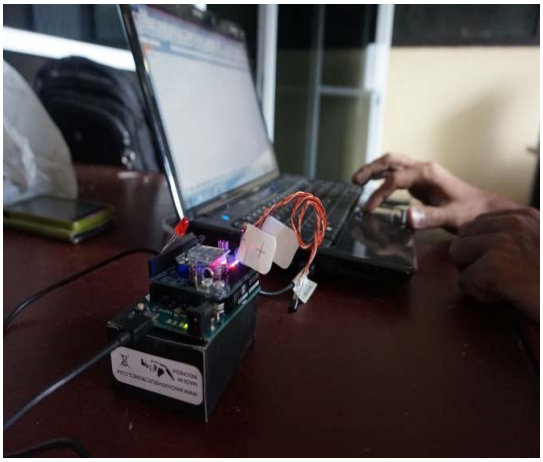

Fig. 4: Rx modul on user's computer

alarm was activated when the output status of vibration sensor is high (Table 2). This status had meaning that the tree in sector P1 received vibration over the threshold value which indicated something disturb and shocked the tree for a determined duration (in this case is 5 min).

CONCLUSION

Sensors usage in monitoring agricultural land fire in Indonesia can be applied to protect plants. Sensors were able to detect the raise of temperature and any vibration sources around the plants environtment. Simultaneously, sensors succeeded on activating alarm in remote distance control room via wireless network communication. Overall, the systems had functioned properly as the monitoring process recorded in its database for real time measurement.

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