CREATING HIGH-PERFORMANCE/LOW-COST AMBIENT SENSOR CLOUD SYSTEM USING OPEN-FS (OPEN FIELD SERVER) AND WEARABLE SYSTEM

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ABSTRACT: Our groups have been creating various kinds of application systems and hardware, taking into consideration of increasing severe, huge disasters, those systems have been concerned with agricultural advancement recently, and security issues. To get achievements about our aims and targets, we have been proceeding a number of projects, in particular our group has been thinking about 2 directions basically. Firstly, in order to monitor outdoor field (rice field, meadow, garden, etc.) and to get environmental information over long periods of time, we have developed High-performance/Low-cost Field Server System (FS) which operates sensor units uniformly. This is a kind of Ambient Sensor Cloud System using Open Field Server. These systems are designed on the assumption that some of the components can be accessed via the Internet. With such systems, it can be possible to monitor various values from kinds of units, and to change managing schedules dynamically according to detected conditions. Experimental use of the systems has shown the validity of the Field Server System. Secondly, we have developed Wearable measuring systems, applying advanced sensors, gadgets which united module of 3D-acceleration sensor(s) and gyro-sensor(s), GPS receiver, and more, we have been analyzing users' motion from images captured by a few digital video cameras and analyzed by some methods of human – dynamics and statistics. And more, we have been connecting those isolated nodes connecting by Digi-Mesh. These works can make us possible to contribute the improvement of users agricultural jobs' skill and enhance security level in the agricultural fields, in future these technique will be applied other various areas, for instance, in factories, residential districts on purpose of diagnosing sudden accidents and crimes. Furthermore, those are economical robust, scalable, so distributed flexibly everywhere.

INTRODUCTION

Some people say that critical food shortage would occur by recent extreme population explosion, in proportion to that, the expansion and complication have been exceeding about those kinds of systems, social needs of them, methodologies to embody them (Hirafuji 2011, Jeonghwan 2010), in reality, economic and governmental demands. For future, several conventional sensing skills and general big machinery like tracks, tractors, newest IT services (Cloud Services, Data Base systems, etc.) and other tools should be combined and ubiquitous techniques breaking through. Taking those circumstances into consideration, we have been built integrated systems to raise productivity, efficiency and security in those fields, by gathering and analyzing time series of field environmental records. And more, we have been constructing original wearable systems (WS), utilize them, we should add visual - analyzing in the middle and long distance.

METHODS AND EQUATION

2.1 Creating each basic units and testing

At first hand, we have reviewed past academic and companies' results and accomplishments (including various industrial goods, patents), visited a large number of predecessors, and had meetings, discussed with them, who have engaged in primary industries or concentrating on "Information Agriculture", after that, selected some promising techniques, electronic gadgets, made approximate schedules, the whole designing, mechanical constructions of the systems, and various kinds of command-codes to process.

In the light of them, we have been proceeding some indoor experiments to estimate their utilities. Similar fixed FS(s) systems exist over and there developed by various facilities and companies, those a re plentiful in their variety and number (e.g. Yenu Wan 2010, MIT 2009), but there are not organized optimum, mobile systems constructing networking formation(s) so much,cooperating with WS(s), so we should create new integrated structures, and then, aiming to enhance the utility and flexibility against sudden accidents in real situations.

Some of them are in Figure 2 and 3, which can measure many basic time series of acceleration data, FFT-analysis data, and angular velocity data when subjects posed various daily, typical postures and did typical actions (e.g. sitting on chair, standing upright, lying, walking, running, etc.).
On the other hand, a couple of typical operating examinations have done about basic functions of FS, surrounding small solar panels to supply constant and stable electricity, and about domestic digital video cameras' (to get users motion data) . Those would be attached on the solid frames surrounding FS, adjusting various balances.

Figure1: A small wireless multiple sensor (TSND121, ATR-Promotions. Inc)

Figure2: One of subjects equipping some measuring gadgets (fixed by medical rubber belts and a common workers belt) , in some fields cultivating vegetables

Figure3: The newest FS (main body unit), in addition that we should attach original robust frame(s), digital video camera(s), small lap-top computer(s) to deal with various data 4-solar panels, and mechanism to change their position and direction.

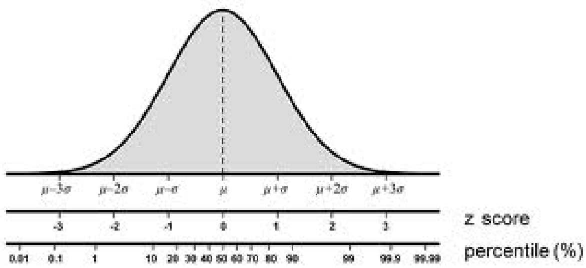
2.2 Actual experiments about measurements in fields of primary industry

In small to middle size farmland, reviewing the result data in 2.1, we have been getting and accumulating short-time data (about 1 to 10 minutes per trial) when workers were cutting onion, Japanese radish, green soybeans, and potato there, in that period, varying settings (e.g. mixing contrastive situations like immature and mature workers, and adding interventions like sudden attack(s) by outsider(s), irregular motions and unusual postures).

Coincidentally, we have captured their own visual data, which were analyzing them by techniques of statistical analysis, human-dynamics.

The basic equations and methodologies of FFT, entropy calculation, variation, percentile values are:

$$X(k)=\sum_{n=0}^{N-1} x(n)\cdot e^{-j\left(\frac{2\pi}{N}\right)nk}\quad (k=0,1,\ldots,N-1),\qquad S=-\sum_{i=1}^{n} p_i \log_2 p_i,\qquad E[u^2]=E\left[\frac{1}{n-1}\sum_i (x_i-\bar{x})^2\right]$$

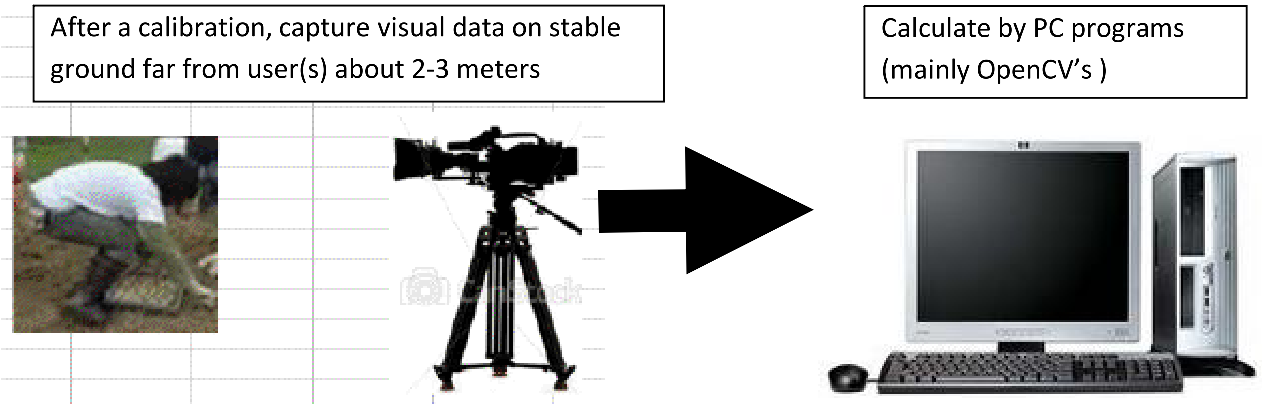


In reality, in most working fields of primary industry, we researchers should think more about the accuracy of daily running systems and effects from outside, under such unpredictable conditions to get various data like above, so we have to carry gadgets to some experimental fields, and do exams more in there, to analyze and brush up them.

Thinking about changeable (factors, points of measuring, field conditions, methodological various kinds of incidents like users' tumble, halt moving, irregular actions, etc., we are going to enhance their sensitivity and property.

Moreover, by adding variation with those experiments, we are going to do paper-based investigations and hearing researches, after that, feed back such results both to the computer systems and to users on-scene, in parallel.

Reviewing those data, we have been gathering some modules and units into one Lap-top PC, and contained those integrated systems in one casual rucksack (per one subject) considering utility and scalability. The user(s) are supposed to be gotten several instructions from one of our members before experiments by verbal communication, expecting "typical, intermediate motions" about cutting vegetables and dealing picks, in addition, attaching functions to communicate with other users or FSs by Digi Mesh (or common Wifi) little by little.



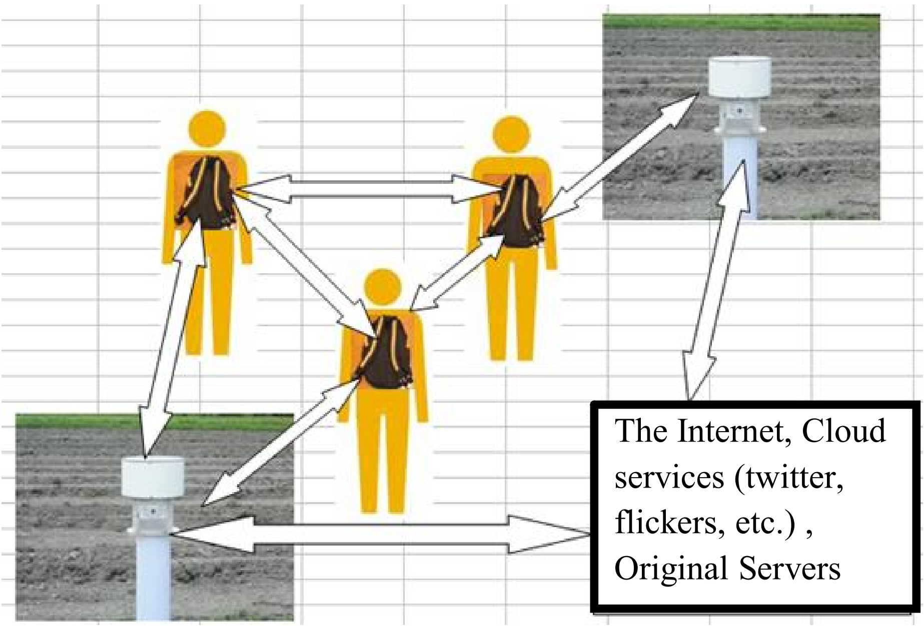


Figure 4: Recent image about local motion capturing and networking – setting(s) by a combination of WiFi-modules and Zigbees (DigiMesh)

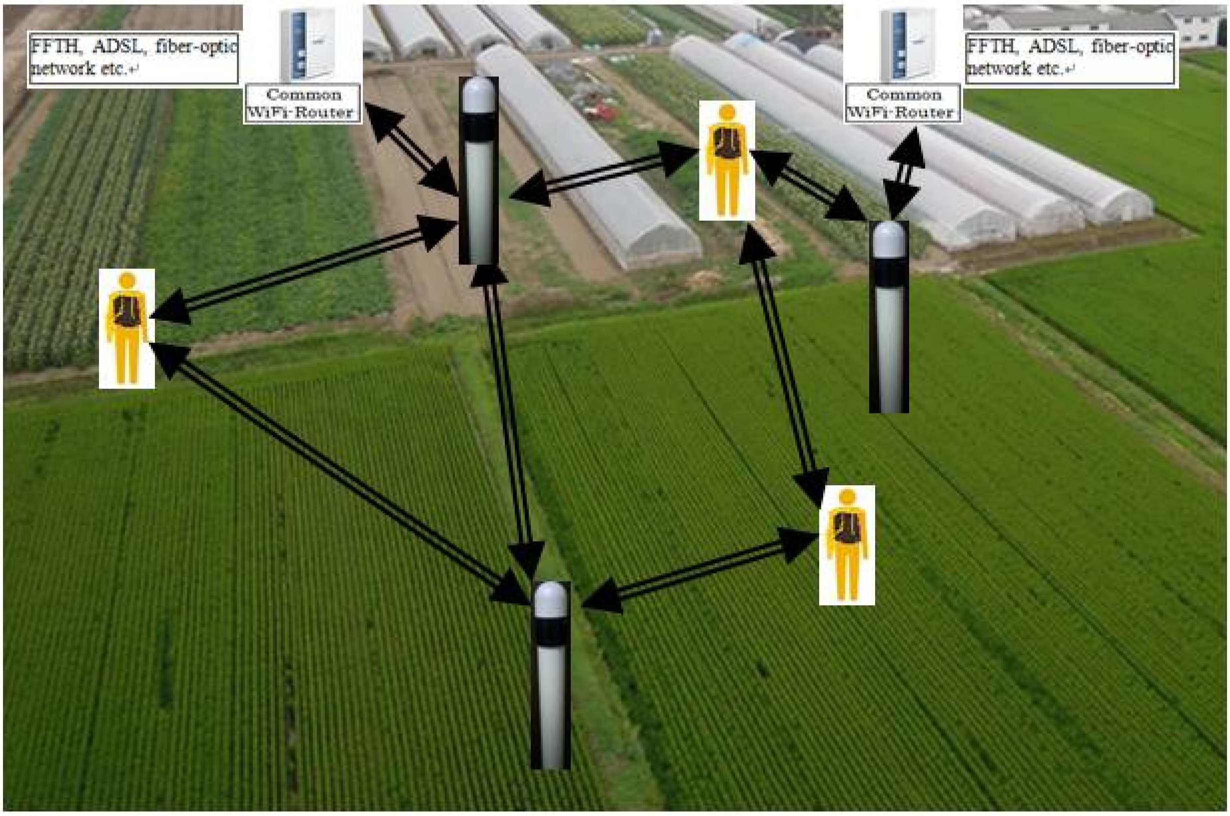


Figure5: A image of our networking plans which would be derived from the system(s) of Figure 4

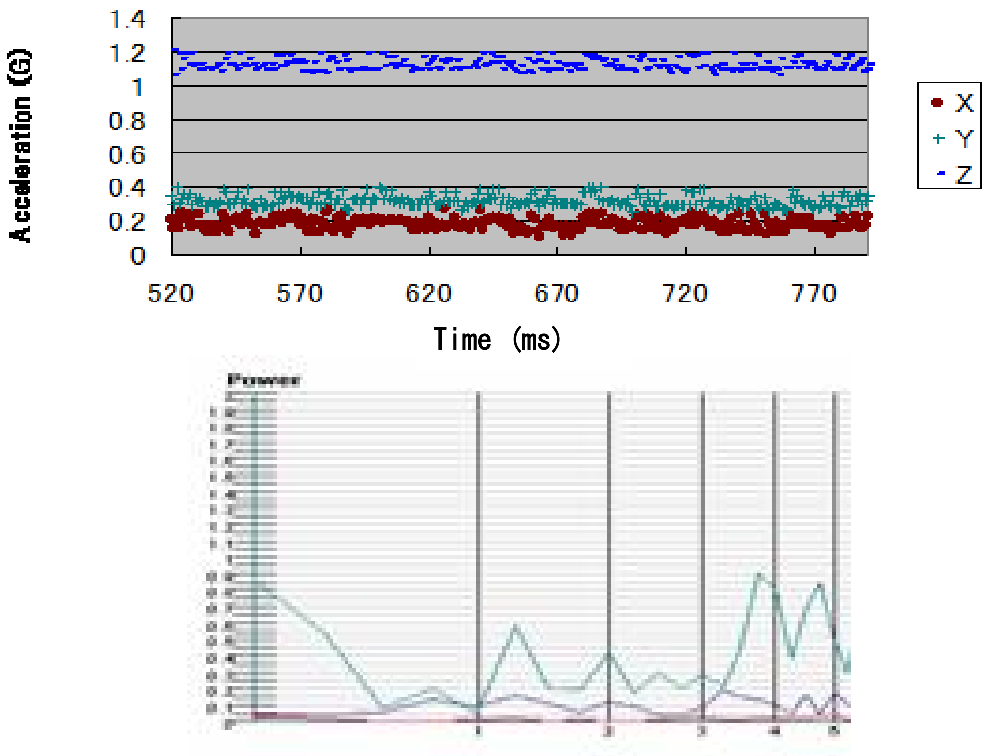


Figure 6: Samples of body accelerations' data from gadgets attached on users' waist and their calculated results from FFT-analysis

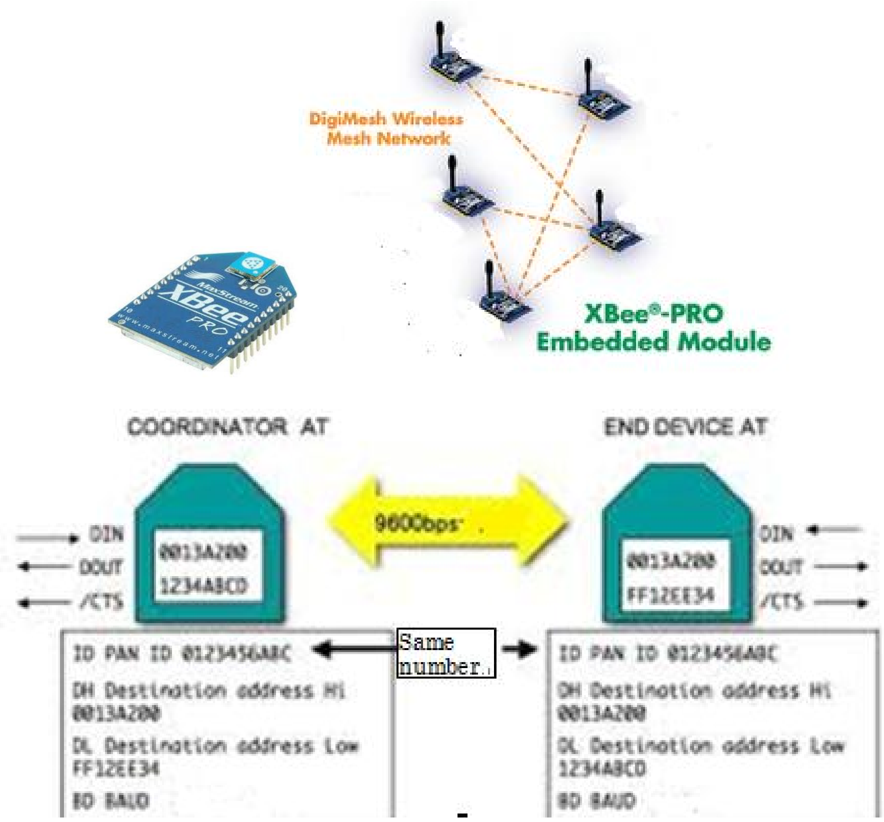


Figure7 : The basic specifications of Zigbee

Table: 1 measuring factors and gadgets

Targets	Values to be measured	Gadgets	Methodology
① Workers in primary industry	acceleration data and angular velocity (lower arms' and side waist)	small wireless multiple sensors (TSND121)	DC-values, FFT results (peak – power values, and their frequencies), entropies , etc.
	total amount of the whole body movements and distinctive values	Web camera, Jpeg camera with micro-computers, common digital video camera(CANON)	multi – purpose analyzing method (OpenCV – programs, etc.)
② General fields in primary industry	temperature, humidity, location of users and FS, strength of natural light(including sunlight), distance between FS(or WS) and obstacles, etc.	general sensors (temperature sensors, GPS-sensors, infrared sensors, etc.)	correlative analysis, t-test, using gotten data(especially each momentary values when characteristic changes occur), etc.

RESULTS

In this study, thinking of the tributions to workers of primary industries, we have been creating FSs, WSs, and real time wireless networking - systems to measure and upload data to our original server(s) and general cloud service(s), and we are going to do some inspection of the various scenes from time to time, and accumulating a lot of promising data. Reviewing those results, as a consequence, the accuracy of detecting critical, fatal situations, and the stability of the hole system would be raised in future.

DISCUSSION

From these recent trials, we have gotten some basic data from several digital gadgets above, but their accuracy, endurance, validity should be confirmed after, and more, many methodology of visual data analysis could be tried, estimated on such specific studies, we have to seek more suit and valid methods.

CONCLUSIONS & RECOMMENDATIONS

Throughout those studies, we have recognized the first step of the integrated measuring systems and gotten the prospects of future scalability and schedules. The rest problems are to attain more accurate estimations and trials about searching, monitoring, and thinking more various situations (cf. breeding farms, plastic farms, construction sites, more intense, harsh sudden troubles, etc.), considering fiber and stability.
In addition, utilizing those results and experimental evidences, we have been planning consultation and supporting projects to heighten their security and to enhance their productivity, for real workers on those fields
Taking our future prospects into consideration, we should try developing them in more common, concrete fields, and after gathering such real data, we hope to start launching some kinds of practical consulting and proposals to real users, 10 – 20 years after, in view of global agricultural dynamics, we have been planning to embark on other countries.

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