Review on Odor Localization

Nyayu Latifah Husni
Electrical Engineering, State Polytechnic of Sriwijaya
latifah3576@yahoo.com

Siti Nurmaini
Robotic and Control Research Lab, Faculty of Computer Science, University of Sriwijaya
siti_nurmaini@unsri.ac.id

Irsyadi Yani
Mechanical Engineering Department, Faculty of Engineering, University of Sriwijaya
yani_irs@yahoo.com

Abstract- In this paper, the importance of odor localization is explained. The researchers that investigated the experiments and applications of odor localization using static sensors, mobile sensors (that were integrated in single robot, multi robot, and swarm robot) are described. However, there are some difficulties faced by the researchers in applying the mobile robots in the real situation, such as: the speed of mobile robots are not as fast as the odor patches transporting and the use of more than one sensor in mobile robot can make noises or errors. In the future, the plume finding in the uncertain environment and the challenges mentioned above will be the authors' consideration.

Keywords: odor localization, swarm robots, plume finding, plume tracking

INTRODUCTION

Humans have been created by God as the perfect creatures with their five senses organs (ears, tongue, eyes, skin, and nose). In order to imitate these five senses organs, the scientists have done many researches. They made cameras to imitate the eyes [1], tactile sensors to imitate the skin [2], and some other sensors that are used to imitate ears, tongue [3] and also nose.

An electronic nose was studied by many researchers [4, 5, 6, 9]. A brief history of electronic noses was introduced by Julian W. Gardner and Philip N. Bartlett [5]. The development and the prospect were explained in [6]. For most of the animals, the nose is an important tool for their olfactory sensors that can be used for searching food, finding mates, exchanging information, evading predators, etc. [7].

Employing animals (dogs, rats) that have very sensitive noses to do some tasks (to search and rescue victims, to search for drugs or explosives on airports or country borders, and for humanitarian demining) [8] are already common in our daily life.

However, by Replacing animals with mobile robots could significantly reduce the cost. Some of weaknesses when employ animals in olfactory tasks are: 1. Breeding and training animals need time and resources; 2. Animals get tired; and 3. Sometimes when employ the animals in searching for explosives in dangerous areas can harm the guidance of those animals [8].

Researchers try hard to integrate the electronic noses with mobile robots in order to increase the comfort and security of the humans. They implemented electronic nose of mobile robots in odor localization.

Odor localization is developed continuously. It is hoped that it will be able to give some benefits for humans in real situation in the future, i.e. be able to search victims in the collapsed building [9], be able to assist the firefighters [10].

PROPOSED WORK

To consider that the plume finding is a crucial one, it is interesting to make a research on flume finding. This sub task still need methods and techniques that can solve the problem in plume finding. The challenges and issues mentioned in the second part of this paper will be the consideration of the future work.

REFERENCES:

[1] Dominik Honegger, Lorenz Meier, Petri Tanskanen and Marc Pollefeys. An Open Source and Open Hardware Embedded Metric Optical Flow CMOS Camera for Indoor and Outdoor Applications. ICRA. IEEE.2013

[2] Lucia Seminara et al. Piezoelectric Polymer Transducer Arrays for Flexible Tactile Sensors. ieee sensors journal, vol. 13, no. 10, october 2013. page 4022-4029.

[3] Juan Manuel Gutierrez et al. Hybrid electronic tongue based on multisensor data fusion for discrimination of beers. Sensors and Actuators B 177 (2013) 989– 996.

[4] Persaud, Krishna; Dodd, George (1982). "Analysis of discrimination mechanisms in the mammalian olfactory system using a model nose". *Nature* **299** (5881): 352–5.

[5] Julian W. Gardner and Philip N. Bartlett. A brief history of electronic noses. Sensors and Actuators B, 18-19 (1994) 211-220.

[6] M.A. Craven, J.W. Gardner and P.N. Bartlett. Electronic noses - development and future Prospects. 1996 Elsevier Science B.V. All rights reserved. *trends in analytical chemistry vol. 15, no. 9, 1996.*

[7] Li Ji-Gong et al. Odor-source Searching using a Mobile Robot in Time-variant Airflow Environments with Obstacles. Proceedings of the 33rd Chinese Control Conference. July 28-30, 2014, Nanjing, China.

[8] Thomas Lochmatter, Xavier Raemy, Lo¨_c Matthey, Saurabh Indra and Alcherio Martinoli. A Comparison of Casting and Spiraling Algorithms for Odor Source Localization in Laminar Flow. ICRA 2008. Ieeexplore.ieee.org.

[9] H.Ishida et al. Three Dimensional Localization and Mapping for Mobile Robot in Disaster Environment. Proceedings of the 2003

IEEE/RSJ Intl.Conference on Intelligent Robots and Systems. Las Vegas, Nevada. October 2003

[10] Ali Marjovi, Lino Marques, and Jacques Penders. Guardians Robot Swarm Exploration and Firefighter Assistance. 2009. IEEE/RSJ Int. Conf. on Intelligent Robots and System (IROS).

[11] H.Ishida et al. Chemical Sensing in Robotic Applications: A review. IEEE Sensors Journal, Vol.12, No.11, November 2012.

[12] H. Ishida, Takamichi Nakamoto and Toyosaka Moriizumi. Study of Odor Compass. Proceedings of the 1996 IEEEISICEiRSJ International Conference on Multisensor Fusion and Integration for Intelligent Systems. P.222-226.

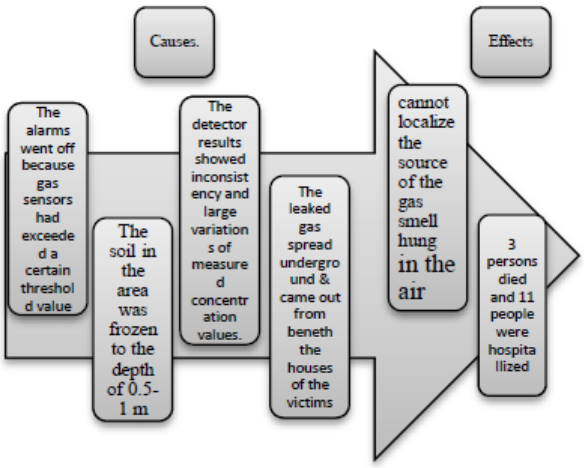

Fig. 1. The Causes and Effects of poison gas tragedy due to slow response of gas localization described by H. Ishida et al [11].

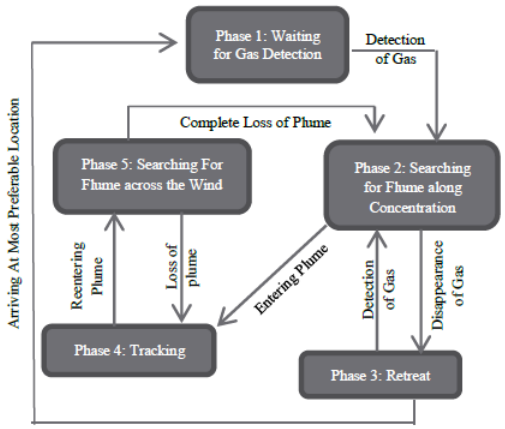

Fig. 2. Phases of explanatory algorithm explained by H.Ishida et al. (Taken from [12]).

TABLE 1 SUB TASKS TRENDS AND SOME ISSUED IN RECENT YEARS

NO	Year	Author	Type of Sub Task	Techniques/methods	Issues/Future works
1.	2010 - 2014	Ali Marjovi et al	①and ②	Line configuration toward cross wind direction	The proposed technique in real situation still required Outdoor experiments.
2	2011 - 2013	Goncalo Cabrita et al	②and ③	Swarm based algorithm.	Divergence is a robust odor source localization estimator but it still depended on the quality of the data collected by the sensors.
3	2014	Hai-Feng Jiu et al	②	Effective olfactory based planning and search algorithm .	Some of the failures in the experimental data were caused by communication problems between the sensors and the PC.
7	2011 - 2013	Li Ji Gong	②	Zigzagging and upwind methods	In an outdoor environment, the wind transporting the odor patches usually changes much faster than the motion speed of mobile robots.
8	2013	Meng-Li Cao et al	②, ③	Adapted ant colony optimization algorithm and flux divergence based idea for plume tracing and source declaration.	real experiments in natural ventilated environments and adapt other searching methods to Multi-OSL problems
9	2011 - 2013	Patrick P. Neumann et al	②, ③	Novel pseudo gradient plume tracking algorithm and a Particle filter based source declaration approach.	It is difficult to locate gas sources in scenarios with changing wind conditions and high turbulence.
10	2010 - 2014	Siti Nurmaini et al	②	Simple form of cooperation between Fuzzy Logic control and Particle Swarm Optimization (PSO)	Use more than one substances/gas sources and develop a large real testing setup.
11.	2014	Siqi Zhang	②	A Swarm olfactory	Self changing temperature

				search methods	
12	2011	Wisnu Jatmiko et al	②	Particle Swarm Optimization	Distributed communication module with multi transmittes can be considered as an option to overcome the data collision.
13	2011 - 2014	Qian Lu et al	②	Learning Particle Swarm Optimization Shannon's Entrophy.	Wind plays an important role on the shape of the plume, especially in outdoor environment.

Note.
① Plume Finding
② Plume Transversal (Tracing/Tracking/mapping)
③ Plume Declaration