# SCTRUCTURE FOR DATA FUSION IN AUTOMATION

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**Abstract**: The aim of this paper is to define structure that would help to perform a data fusion. In the first section we explain use of ontologies in the world today, than we introduce options of using ontologies in automation. In the second section we describe some parts of designed structure that is becoming a part of ontology for detection of sensor faults. In the last part of our paper we define methods to find sensors faults.

**Keywords**: structure, ontology, sensors faults, data fusion

## 1. INTRODUCTION

Ontologies, as parts of science, have many faces. Originally, ontology was the part of philosophy and was understood as science about "being" or as an universal system of knowledge that describes object, phenomena and regularities of the world. We can say that it is philosophy discipline which works with "being". Aristoteles named it as First philosophy.

We can find ontology in different part of science today. In our case we are taking in account definition for information technology which Gruber described in [1]:

„Ontology is explicit specification of conceptualization"

Conceptualization is an abstract model of part of real world, which identifies relevant concept of the part. Explicitly means that it clearly defines type of concept and conditions of its use. The definition is often extended about word "formal". It means that ontology can be computer-processable.

Ontologies can be used in many ways in the information technology. One of the possible uses is to use ontology in knowledge systems, where it is associated with algorithm of search, classification, categorization and it creates complex superstructure as Tax shown in [2].

The most popular use of Ontology in the information technology is a semantic web which can achieve streamlining and summarize knowledge. Semantic web has been developed by W3C consortium and it structured and saved data under standardized rules.

In our case we propose to use ontology for automation technique. Ontology is used as a knowledge system. Ontology should partially substitute the function of the semantic web. As such ontology can be used to derive data structures and organization. Our goal is to enable data fusion on process data by utilization of the proposed ontology. At first we have to study data fusion for sensor networks.

### 1.1. ONTOLOGY AND INTEROPERABILITY IN AUTOMATION

Previously in the paper we have shown that the main domain of ontology is the semantic web. However, if we look around, we find many possibilities to use Ontology in automation. For example, in the case of control production line based on multiagent systems the agents share the same ontology.

We found language, which has been developed specifically to work with sensors data. A SensorML language has been developed by Open Geospatial Consortium. It focuses on processes data visualization on web site because it was designed on XML language structure. SensorML can provide general data about sensor, processing support and measurement analysis. It provides functional properties as accuracy, threshold etc. as shown in [3].

By connecting XML language, SenzorML and ontologies we propose to create ontology providing knowledge base which should contain important information to enable data fusion.

## 2. DEFINITION OF STRUCTURE FOR AUTOMATION DEVICES

Sensors are important devices for our research because we design the structure for purposes of data fusion of sensor data. In our work we intend to achieve data fusion; therefore we have to take into consideration methods for faults detection to capture validity of the sensor data. We use general approach for data representation and diagnostic technique as it is described in ISO 13379.

To include some kind of global view to device faults, the environment influence should be taken into account as well. We started with following effects:

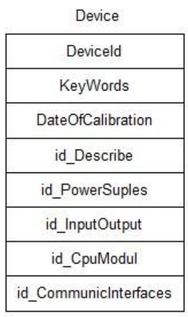
- Environment temperature [°C]
- Humidity
- Water
- Vibration

The Structure is designed as MySQL table base, which allows to keeping and reuse the data. Data types in the structure are compatible with MySQL data types.

Every table starts with the name and identification number. These elements can be later used to save and reload data.

## 3. STRUCTURE DESCRIPTION

The whole structure is based on table of a so called “Device” - table is shown in figure 1.




**Picture 1**: The device table

The first item in the table is the identification number called *DeviceId* that is used to find records associated with given device. We assume that we are using many sensors therefore we set the parameter *DeviceId* as an auto-increment.

Next item in table is *KeyWords* item, where we store general key words describing the device. For example, Item *KeyWords* is presented as type string and it contains comma-delimited text. For example in the case of a pressure sensor the item *KeyWords* can look as follows: pressure sensor, analog output, piezoresistive sensor etc.

Next items in our "Device" table  are mount-items to mount this table with other tables in structure. So we assume correct data consistency.

### 3.1. TABLE "DESCRIPTION"

A table called "Description" is intended for detailed device (sensor or actuator) description. As we can see in picture 2, we can split the table into two parts. The first part contains device description and second part maintains device fault statistics.

| Description |
|---|
| DescribeId |
| Id |
| id_TypeOfDevice |
| ShortName |
| LongName |
| id_GroupMember |
| Producer |
| StartTime |
| CountOfRepairs |
| ExternalInfluencis |

**Picture 2:** Table for device description

First item is the *Id*. The item can be found on each device and it is manufacturer identification code. Item *ShortName* gives short name of the device. For example, it can look as follows: "DS 200 pressure switch". The equivalent item is the *LongName* which describes the whole title of the device. For example, this item can be: DS 200 electronic pressure switch with analog output.

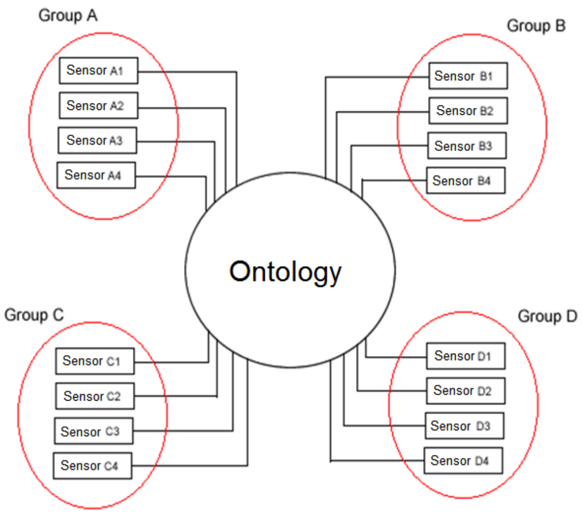
Second part of table describes device faults. Item *StartTime* is is used to store the time the device was switched on or when it was reconnected after repair. To better achieve data fusion we have table item called *CountOfRepairs*. The item determines number of failures of device. Last item in this table includes external environmental influences. For example, it can look as follows: *ExternalInfluencis: AL*. "AL" is abbreviation for exposure of animals as shown in ČSN 33200.

Next items in table are *id_TypeOfDevice* and *id_GroupMember* which are to link tables with table "Description".

### 3.2. TABLES "TYPEOFDEVICE" AND "GROUPMEMBER"

These two tables added information about device. Table "TypeOfDevice" contain only two items: Actuator and Sensor. These two items are type Bool. If we write true or false value to these items we determine type of device (sensor or actuator).

"GroupMember" is table which it ensures spilt devices to design work groups. Sensors are split to work groups as shown in picture 3.




**Picture 3:** Split sensors to groups

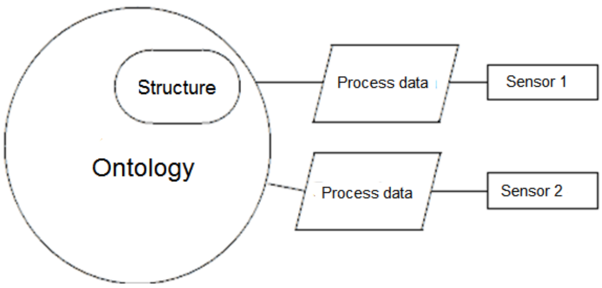
### 3.3. POWER

We have tree tables for power. First table is called "PowerSuplies" which work as navigation for other two tables. First table "TypeOfPowerSuplies" where we have two choices: Battery or Mains. If we have battery we select true value of the item Battery. If we have mains we select type of electrical network. For example: TNC.

Table "Enviroment" contains three items. Every item is type bool and we select type of environment where source work.

## 4. REAL WORK

Previously in the article we show parts of structure which include to ontology which it is deal with problem data fusion as follows:




**Picture 4:** Structure involved in the ontology

### 4.1. DATA FUSION

We write that data fusion is generally defined as the use of techniques that combine data from multiple source and gather that information in order to achieve inferences, which will be more efficient and potentially more accurate than if they were achieved by means of a single source.

Our structure collects information on sensors. It serves in ontology as a source of information. Whole system works as a big analyzer of state of sensors and process data.

### 4.2. SENSOR FAULTS

There are many methods to sensor faults identify. These methods we intend to include to our system and we intend to achieve detection of these faults as Sharma and Golubchik have shown in [4]. They defined four methods for detection of faults:

- Rule-based methods leverage domain knowledge about sensor readings to develop heuristic rules/constraints that the sensor readings must satiry
- Estimation methods define “normal” sensor behavior by leveraging spatial correlation in measurements at different sensors
- Time series analysis-based methods leverage temporal correlations in measurements collected by the same sensor to estimate the parameters of an (a priori selected) model for these measurements
- Learning-based methods infer a model for the normal and faulty sensor readings using training data, and then statistically detect and identify classes of faults

We intend to link these methods with our ontology aiming to achieve sensor fault detection.

## 5. CONCLUSION

The paper is introduction to my dissertation. The aim of my work is fusion on obtained data to detect sensor faults. Using ontology and above described obtained data we intend to detect sensor faults. We intend to achieve partial or full auto-detection of faults and partial auto-calibration of sensors.

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