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A design and implementation of a framework for games in IoT

Hye-Young Kim[1]

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Abstract Interconnection of the sensing and actuating devices providing the ability to share information across platform through a unified framework for enabling innovative applications. This is achieved by seamless ubiquitous sensing, data analytics and information representation as the unifying framework. Extending the current internet with interconnected objects and devices and their virtual representation has been a growing trend in recent years. Internet of Things (IoT) services are becoming a popular services. This will be supported challenges in a large of aspects such as smart health, green energy, smart home and personalized applications. So, the IoT plays more and more important issue in lifestyle through entertainment such as Games. As of yet, there has not been much research done on IoT environment games as a service. In this paper, we propose schemes of the design and implantation of IT convergence framework for games as a service of IoT. First of all, we discussed what to consider when design and implementation of IT convergence framework for games through contents using user's mobile devices and various sensors in IoT environment and suggest related techniques. Then, we showed the possibility of games in the IoT environment by creating games and measuring the interactions of users in the IoT environment.

Keywords Internet of Things (IoT) · Game · Server · Sensors · IT convergence

1 Introduction

For many years, legacy systems have been limited designed for specific purposes with limited flexibility, the current initiative on building the Internet of Things (IoT)

✉ Hye-Young Kim
hykim@hongik.ac.kr

[1] School of Games/Game Software, Hongik University, Building B, Room #211, 2639 Sejong-ro, Jochiwon-eup, Chungcheongnam-do 339-701, Korea

demands application and services. The vision of future internet based on standard communication protocols considers of computer network IoT, Internet of People (IoP), Internet of Energy (IoE), Internet of Media (IoM) and Service of Internet (IoS) into a global IT platform of seamless network. This will create new opportunities in a large aspect such as a smart health, retail, green energy, manufacturing, smart home, smart city and personal application. Benefit due to the service controlled by communication between objects is now being increased by people who use these services in real life.

The quantity of data on the Internet is growing and it is around 2.5 quintillion bytes of data and it is estimated that 90% of the data was generated in the past two years [1]. Actually, many challenging issues still need to be addressed and both technological as well as social knots have to be untied before the IoT idea being widely accepted. Central issues are making a full interoperability of interconnected devices possible, providing them with an always higher degree of smartness by enabling their adaptation and autonomous behavior, while guaranteeing trust, privacy and security. The IoT contribution is in the increased value of information created by the number of interconnections among things and the transformation of the processed information into knowledge for the benefit of society. The IoT could allow people and things to be connected anytime, anyplace, with anything and anyone and any services. This is stated as well in the ITU vision of the IoT, according to "From anytime, anyplace connectivity for anyone, we will now have connectivity for anything" [2].

Benefit due to the service controlled by communication between objects is now being increased by people who use these services in real life. In order to provide services in IoT environment, we need to manage network modules connected to IoT environment and we also need a framework for manufacturing contents for providing services.

Therefore, we propose schemes of the design and implantation of IT convergence framework for games as a service of IoT, and we showed the possibility of games in the IoT environment by creating games and measuring the interactions of users in the IoT.

The rest of the paper is organized as follows. Related works are reviewed in Sect. 2. We propose schemes of the design and implantation of IT convergence framework for games as a service of IoT in Sect. 3. First of all, we discussed what to consider when design and implementation of games through contents using user's mobile devices and various sensors in IoT environment and suggest related techniques. In Sect. 4, we showed the possibility of games in the IoT environment by creating games in the IoT environment through prototype game and result of the user's interaction. Finally, the paper is concluded in Sect. 5.

2 Related works

The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. The basic idea of this concept is the pervasive presence around us of a variety of things or objects—such as Radio-frequency identification (RFID) tags, sensors, actuators and mobile phones—which,

through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals [3].

With the widespread deployment of networked, intelligent sensor technologies, an Internet of Things (IoT) is steadily evolving, much like the Internet decades ago. One example of the widespread IoT technologies is the Google's Nest thermostat, the famous IoT gadget during 2014. Their designers disclosed that it can become carbon neutral in a period of just that were created by manufacturing and distributing the device are offset by the energy savings one obtains from using it [4].

In the literature, we have found several IoT architectures such as LinkSmart Project [5], RestThing [6], S3OiA [7], Gao [8], Wang [9] and Weiss [10].

In the [5], it shows the ability to integrate heterogeneous devices even it constrained. In the [7–9], they represent the REST-based architectures, and it is simple services and applications composition. The core idea of *CoP* is to play the best strategy for a player to preserve his privacy by himself which in turn contributes to preserving other players' privacy. *CoP* considers each tuple as a player, and tuples form coalitions as described in the procedure. The efficiency of anonymization process is calculated using information loss metric [11].

Potentialities offered by the IoT make possible the development of a huge number of applications, of which only a very small part is currently available to our society. Many are the domains and the environments in which new applications would likely improve the quality of our lives such as at home, while traveling, when sick, at work, when jogging and at the gym and just to cite a few. These environments are now equipped with objects with only primitive intelligence, most of times without any communication capabilities. These can be classified into several domain such as transportation and logistics domain, healthcare domain, smart environment domain and personal and social domain [12].

The enhanced game room as well as the players are equipped with a variety of devices to sense location, movement, acceleration, humidity, temperature, noise, voice, visual information, heart rate and blood pressure. The room uses this information to measure excitement and energy levels so that to control the game activity according to status of the player [13,14]. Various objects are also placed throughout the room, and the point of the game is to crawl and jump from one to the other without touching the floor. Points are awarded for long jumps and difficult places to reach. So, there are several approaches for awarding system such as [15].

The game also puts a target on the screen. As the players work their way around the room, the game keeps track of their achievements. Their controller recognizes RFID tags on objects in the room. To score, they have to touch the object with it. As the game progresses, the system gradually makes it more difficult. At first, the objects they have to reach are nearby and easy to reach. As the players work their way around the room, the game keeps track of their achievements. As the game progresses, the system gradually makes it more difficult. The game then adapts the difficulty level and the target according to the achievements of the players so that to keep high the excitement level perceived by the console through the sensing devices [16]. Also, the existing solutions use ontology for change management, and they have been designed majorly for IT developers rather than analyst [17].

At some point, it gets too difficult and both players must touch the floor with their feet. Then, the game makes a loud noise to indicate that this was wrong. The room now notices that one player is a bit taller and faster than the other so it starts putting the objects a bit closer to him, so that he can keep up [18]. The game then adapts the difficulty level and the target according to the achievements of the players so that to keep high the excitement level perceived by the console through the sensing devices [19].

A game can capture the dynamics of interaction among players in a population explicitly. A player can observe the behavior of other players and make the best decision based on the observations and its knowledge [20].

It therefore can provide a refined solution and ensure stability by equilibrium. This leads to its growing applications beyond the biology field. For example, it has been successfully adopted to solve network selection problems in heterogeneous networks [21–23], backhaul resources allocation problems in passive optical networks (PON). These works show us a new solution to the multi-application service selection problem.

Extending the current Internet with interconnected objects and devices and their virtual representation has been a growing trend in recent years. Internet of Things (IoT) services are becoming a popular services. So, the IoT plays more and more important issue in lifestyle through entertainment such as games. As of yet, there has not been much research done on IoT environment games as a service. In this paper, we propose schemes of the design and implantation of IT convergence framework for games as a service of IoT.

3 Proposed scheme

In this paper, we showed methods that we considered as we design and implement a game using sensor module in IoT environment.

System algorithm and network environment and data flows that has been used in this experiment are illustrated in Figs. 1 and 2, respectively.

In Fig. 1, this is connected to web server through MySql based on local computer C++ language, and its purpose is to supply user a display through web page. In this game, all sensors, such as Arduino and mobile, communicate through local computer.

The following figures illustrate the control flows of local PC such as confirmation of device setting, exchanging data, processing data, and backing up the results of processing data.

At initialization part, each sensor carry out accept along with its IP address as it operates. Data exchange process is divided into three parts.

1. Initialization step: When sensor is confirmed to operate normally, initialization code is delivered to server and server, when encoded with initialization code, set each sensor state to initial state. When it is confirmed that all sensors (module and Arduino) are set to initialization step, server transfer initialization completion code packet to all connected server.
2. Data exchange step: Sensor, which received initialization code, is assumed to be ready to exchange data and transfer input value to sever. This includes various parameter value such as on/off value. Server stores transferred data vale to web

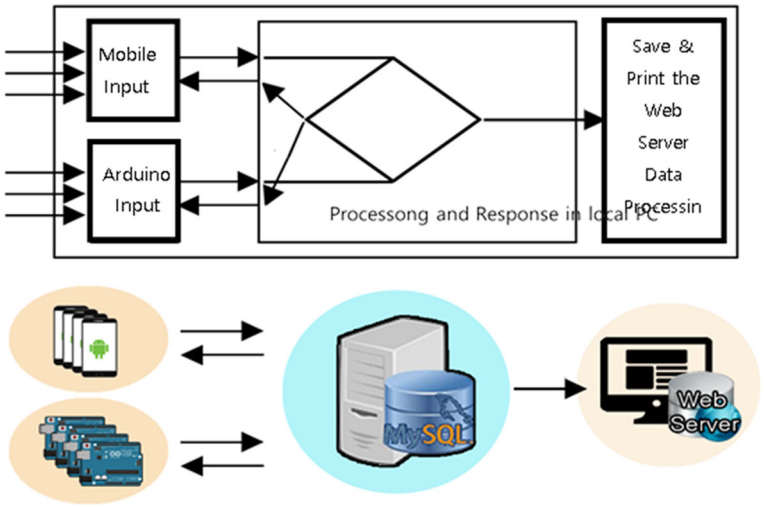


Fig. 1 System configuration in network environments

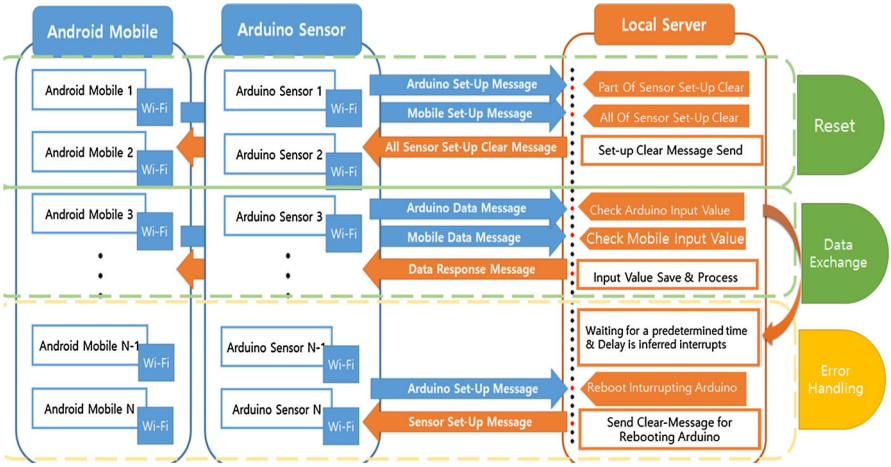


Fig. 2 Data flows in the proposed system

server. It can also analyze transferred data or process data to Arduino or mobile. Through this process, Arduino and mobile can communicate each other through local server, and all the data occurred in the process are automatically saved so that user can easily get interface, which could manage data flow more easily, from web server.

3. Error handling step: Arduino sensor is very vulnerable to change of external environment. This fact indicates that error handling process is necessary when interrupt occurs [24,25].

When data exchange occurs between Arduino, corresponding object's, Socket's limited time is renewed to arbitrary initial value.

3.1 Considerations for application implementation in mobile terminal

Proposal of mobile terminal application part in smart IT fusion framework using sensor module in IoT environment is as follows:

First, about network linkage. Basically, it does not need external internet network, and we create a closed WiFi local network and use TCP/IP protocol to connect to the server.

Second, event that takes place by packet that has been promised beforehand. Using server and asynchronous function to translate received packet as same form as Table 1. Then, we edit UI shown in Android instrument or packet the order that matches when user uses Android instrument to send it to server.

Third, developing mobile terminal application contents using various types of sensor. In our scheme, we apply a web cam, pen or finger written memo function in unity 3D.

3.2 Considerations for design and implementation of sensors

Circuit design and functions of each sensor device is explained in Figs. 3, 4, 5 and 6.

3.3 Consideration for data processing on server

Data processing for interfacing with the mobile terminal, Arduino and server were configured as shown in Table 2. Dividing the respective 3 bytes essentially bytes 9 of the length of the packet consists of a command type, command values for the Type 1, value 2 for the type of command. In this paper, we use the experiment for various types of packets. Lego-typed modules applied in this paper are four types as shown in Table 2.

Identifier of each mobile terminal on the basis of the created socket when Accept. Sensor terminals consisting Arduino placed configured in a manner that easily scalable to manage by setting the number to the rules as shown in Table 3. Be used for each of these methods of communication with the server and a packet designed the same way as Table 3 given the sensor after the specific number.

4 Implementation and performance analyses

We implemented smart toy using lego-typed sensors in framework as described in Sect. 3. The smart toy's circuit configuration which use framework suggested in this research is shown in Fig 7. Arduino Due is used as processor, and D.C motor driver is used for driving of motor. Bluetooth HC-06 is used to communicate with smart phone.

Figures 8 and 9 show the prototype of the smart toy and game playing screen.

Figure 9 is screen of application which is shown on Android device. Bluetooth button is for interconnection. A button is to go forward, B button is to go backward, left and right button is to turn left or right and stop button is to give stop order to actuator.

Table 1 Command set of server and Android

Mobile	Command			
	Common command (server->mobile)	Common command (mobile->server)	Individual command (server->mobile)	Individual command (mobile->server)
Access	111-xxx -xxx	111-xxx -xxx	111–111 all access notice	Connect
Hearing	~	444-xxx-xxx	113–111 Hearing open	(Unused)
Diary open	444-xxx-xxx	Each mobile number	(Unused)	111–114 Diary open
Hint open	Each mobile number		114–111 hint open	(Unused)
Scientific investigation open	(Caution, 4byte for each Timer)		(Unused)	111–112 scientific investigation open
Scientific investigation finished			(Unused)	111–113 scientific investigation finished
Timer			115–0001 ~ 3600 time renewed	(Unused)
Criminal selection			111−201 ~ 205 option event	(Unused)

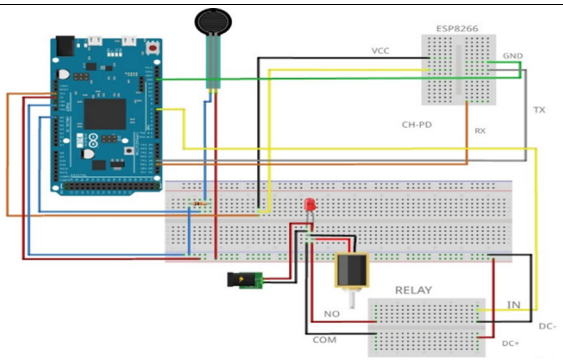
Part 1 module	
Circuit	
	FSR : pressure sensor ESP8266 : WiFi module Relay module + (LED, Solenoid) Two DC 12v power
Operation	
This module interacts with Arduino Due chipset and pressure sensor, WiFi module, LED and Solenoid. Also, it supplies power to LED and Solenoid using Relay module when pressure value is entered. This sensor is designed to get object to fall by pressure. This module uses ESP 8266 chipset model and WiFi to communicate using instruction order included in this paper	

Fig. 3 Module no. 1

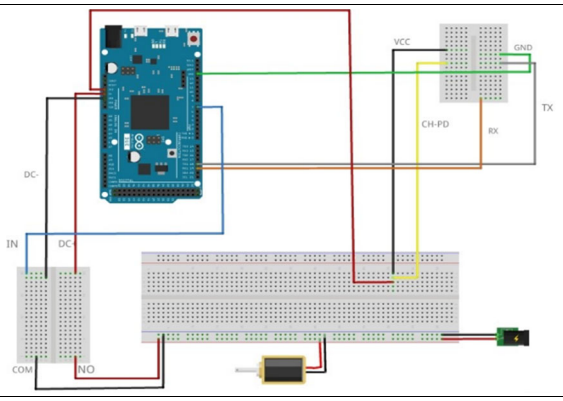
Part 2 module	
Circuit	
	ESP8266 : WiFi Module Relay Module + Solenoid Two DC 12v
Operation	
This module uses Relay module to control Solenoid when command is given through WiFi module by interaction between Aruduino Due chipset, WiFi module and Solenoid. In order to supply each sensor and Arduino Due chipset, two 12V DC power are used. This module uses ESP 8266 chipset model and WiFi to communicate using instruction order included in this paper	

Fig. 4 Module no. 2

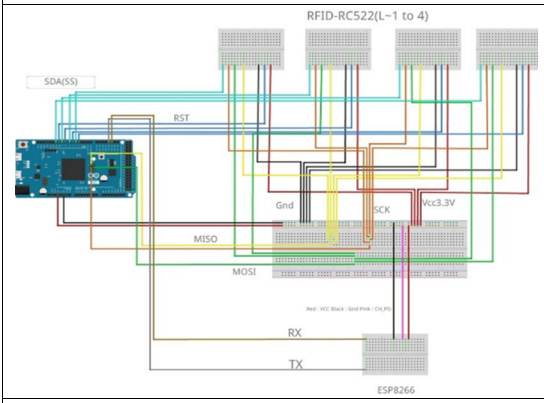
Part 3 module	
Circuit	
	ESP8266 : Wifi Module Four RFID-RC522 One DC 12v
Operation	
This module interacts with Arduino Due chipset, WiFi module and four RFID-RC522 module. RFID tag is connected to each RFID reader which acts to send specific value to server when all readers receive signal. This module decide line up of specific objects. This module uses ESP 8266 chipset model and WiFi to communicate using instruction order included in this paper. Only one DC 12V power is used.	

Fig. 5 Module no. 3

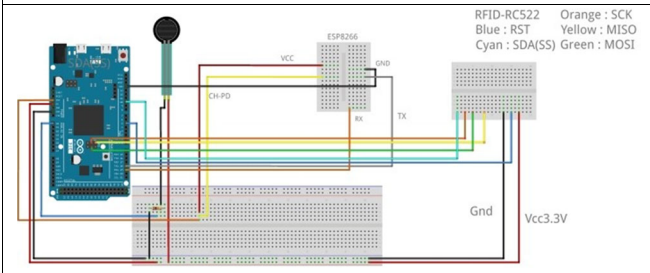
Part 4 module	
Circuit	
	ESP8266 : Wifi Module RFID-RC522 FSR (pressure sensor) One DC 12v
Operation	
This module interacts Arduino Due Chipset, Wifi module, RFID-RC522 module and pressure sensor. RFID tag is connected to each RFID reader which acts to send specific value to server when pressure value is entered. Prototype is a module that checks what object is placed at specific position.	

Fig. 6 Module no. 4

Table 2 Packet Structure

	3 bytes	3 bytes	3 bytes
Attributes	Command type	Value 1 of the command type	Value 2 of the command type

Table 3 Lego-Typed sensor's configuration and numbers

Sensor number	Type of sensors
xx1	{LED, Pressure, Lock} sensor
xx2	Lock sensor
xx3	RFID sensor * 4
xx4	{Pressure, RFID} sensor

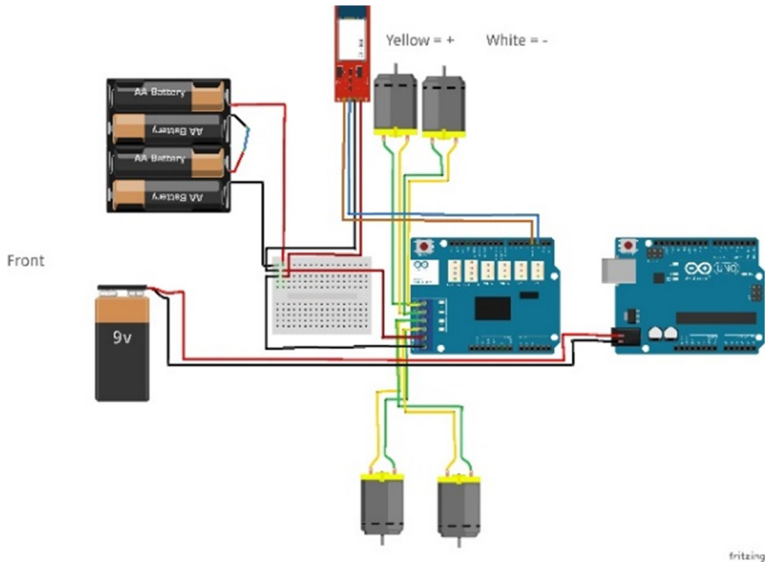


Fig. 7 Logic circuit of smart toy

We tested our game on 30 users for interest and concentration. For our experiment, we developed a game without our framework and another with it, both having the same scenario and functions. We measured the amount of game time in order to analyze the user's interest. Users who played the game with the framework shown in Fig. 10 played the game longer.

To find out the users' concentration, we simply compared the scores by the same user in the two games. Users who played the framework shown in Fig. 11 achieved better scores. Therefore, we can learn about the user's interest and concentration in IoT environment games like those in Figs. 10 and 11.

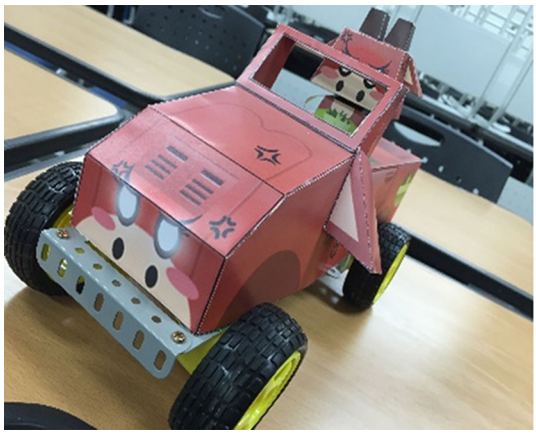


Fig. 8 Prototype of the smart toy

Fig. 9 App. of the implemented game

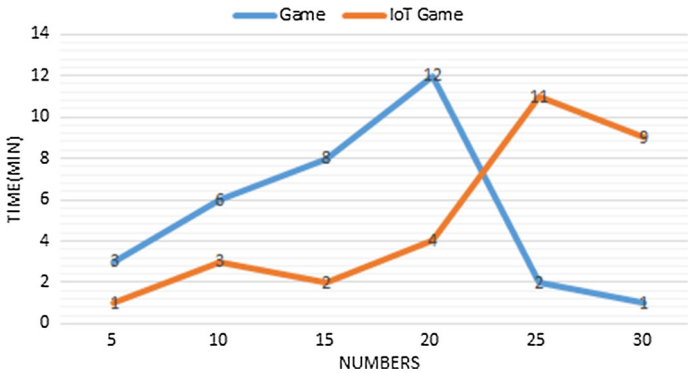


Fig. 10 The level of interest of game players

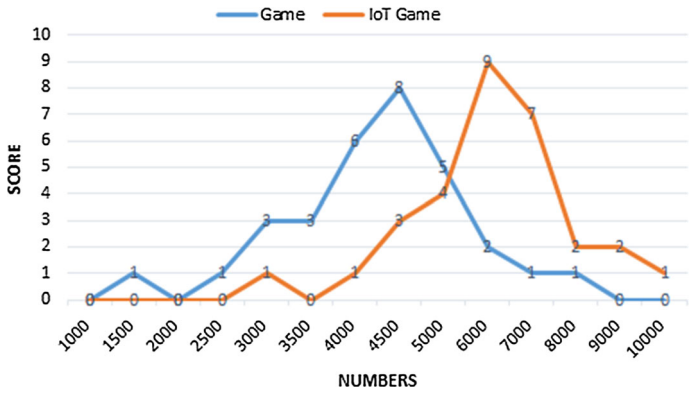


Fig. 11 Concentration of game players

5 Conclusion and future works

In order to develop framework that can be efficiently used to create variety of contents in IoT environment using lego-typed sensor module, we suggested options that framework must have for implementation of communication between server, sensor module, and mobile in IoT environment.

In this paper, we design and implement a game that need to communicate between server, sensor module and mobile in IoT environment as a pre-research for using lego-typed sensor module in IoT environment to effectively manufacture variety of contents. First of all, we discussed what to consider when design and implementation of games through contents using user's mobile devices and various sensors in IoT environment and suggest related techniques. Also, we show the prototype of the game as a service of IoT. Finally, we showed the possibilities of games in the IoT environment by creating games and measuring the interactions of users in the IoT environment.

As henceforth task, we plan to develop for automatic kit design part for manufacturing sensor device as lego-typed sensor so we can develop technique that could interact with other objects and possible for user to developed as personalized custom and could insert wanted function.

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