Designing educational robots and IoT-based toys for multi native language acquisition

Cultivating bilingual baby or multilingual baby

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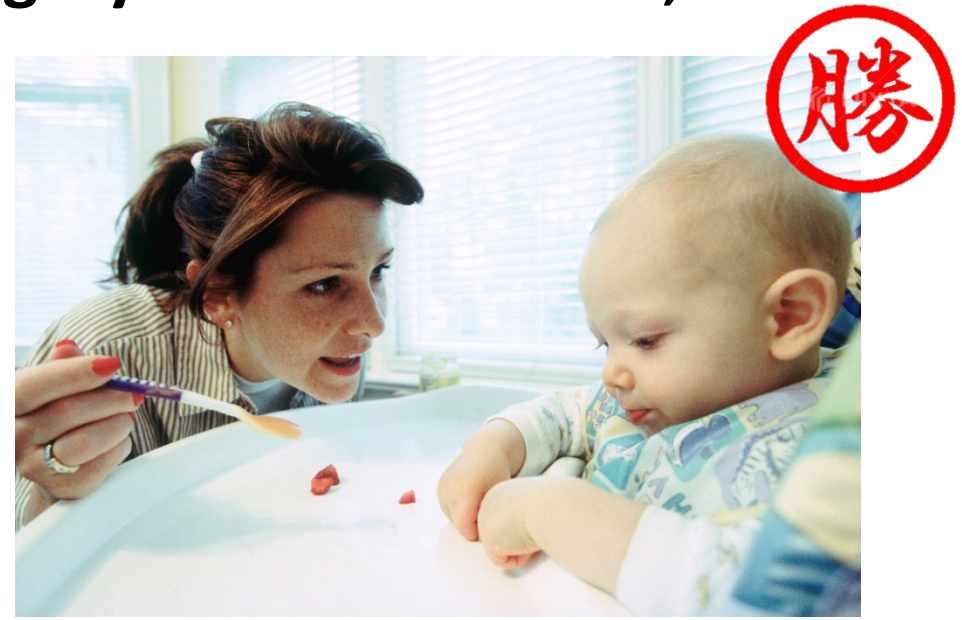
Background

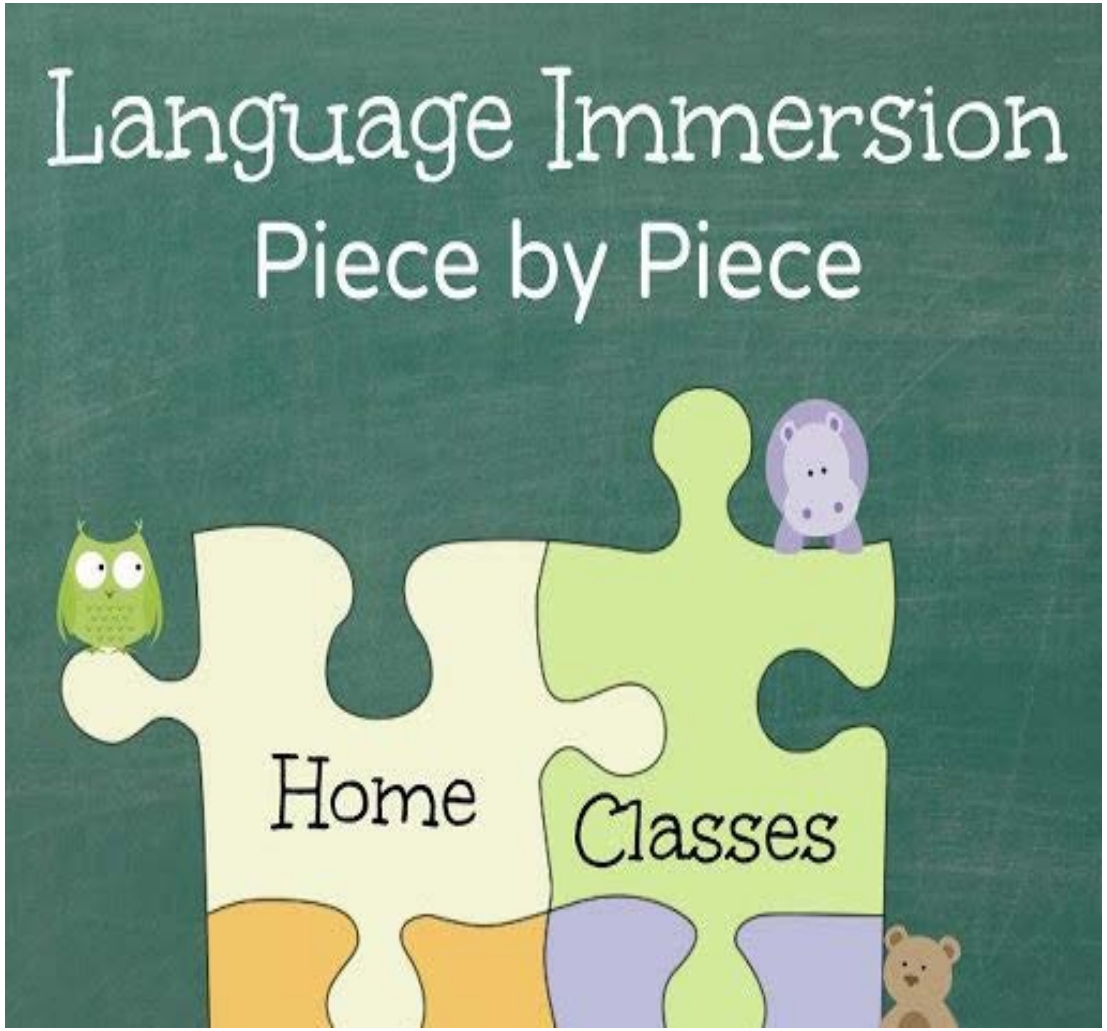
- Language is essential in our daily life. It helps to communicate, shapes ones' thoughts…but it is more than just essential.
- In the era of globalization, language is becoming an important indicator of one's own skills and being multilingual can be extremely beneficial in many ways.

- **A large body of research in language education is devoted to learning a foreign or second language, e.g. EFL or ESL.**
- **However, learning a second language through such a conscious learning process (Krashen 1982; Schmidt 1983) is known to result in less accuracy and proficiency than native language acquiring (Ellis 1994; Doughty & Williams 1998; Ellis 2002).**



What is native language and how do we acquire it?

- Native language is a language that a person naturally acquires, a language that children acquire from interacting with older family members, also known as family language (UNESCO, 2003).
- Infants acquire language in a **nature and language immersion environment**, through listening, watching, touching, smelling and playing.



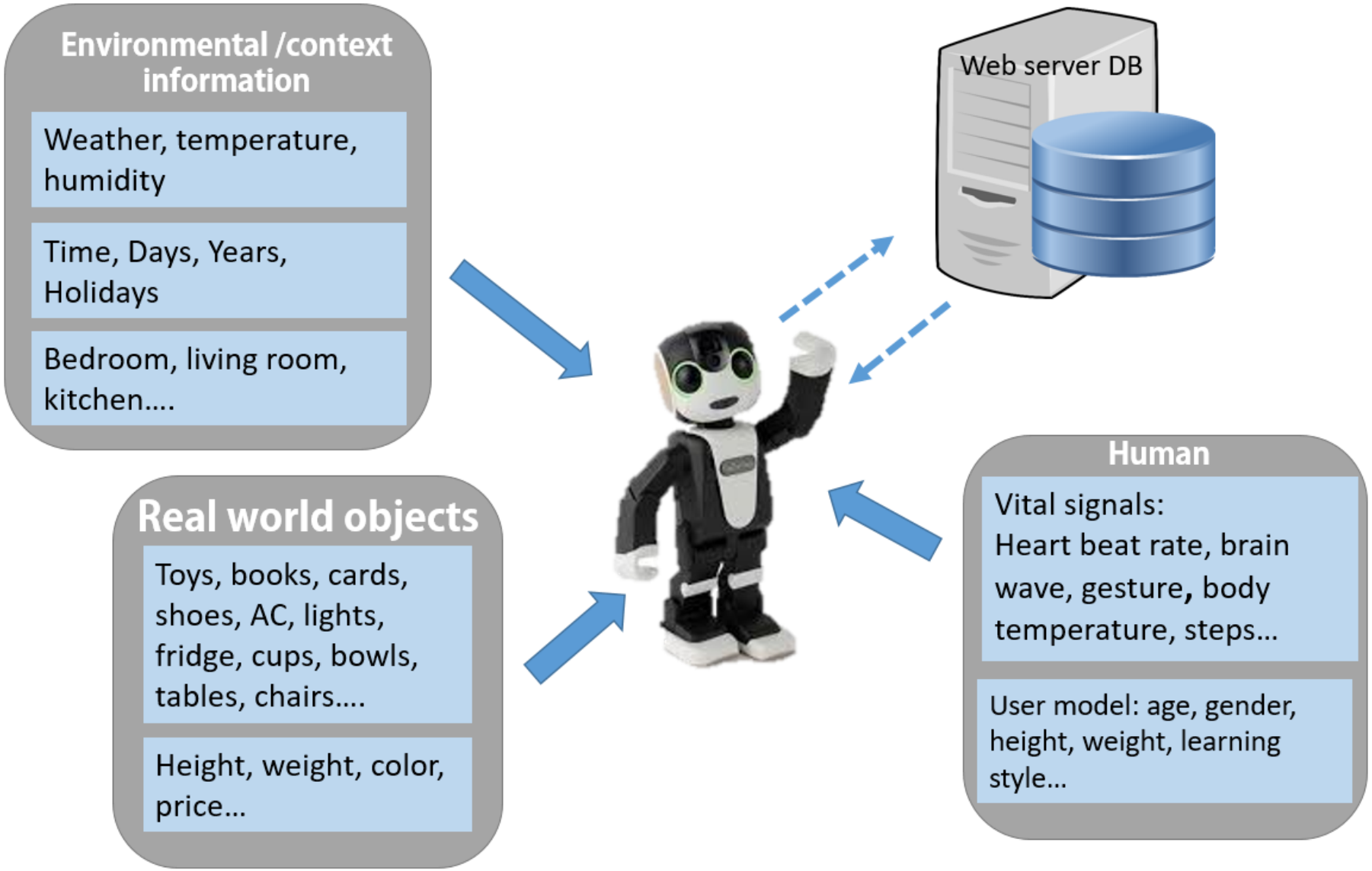
Building a Language immersion environment is essential but challenging

- It is essential to provide a nature and a language immersion environment for the kids to build up language skills and to master the language.
- Age 1-3 is considered “the golden window” for language acquisition.
- Due to many limitations, it is difficult to provide a such environment for kids at this age to acquire more than one mother tongue.

This study propose to …

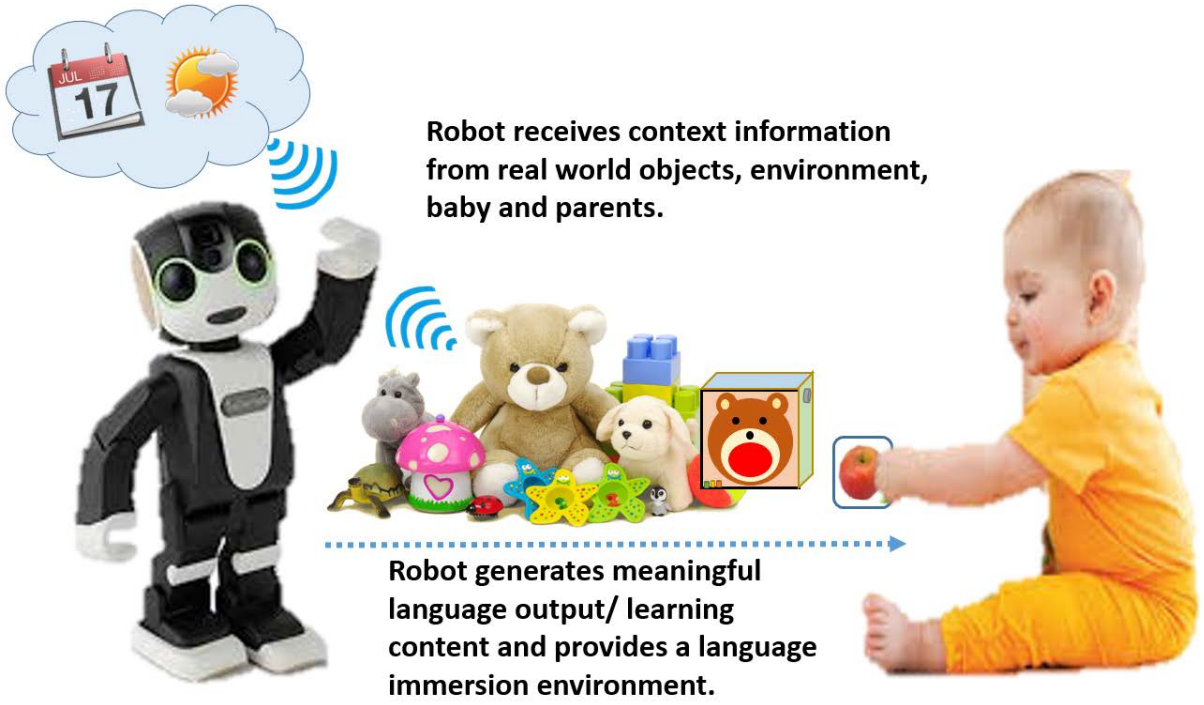
1. create an immersive multilingual environment utilizing robotic and IoT technology for toddlers aged 24-30 months, which is the naming explosion period (Lenneberg, 2016).

Robot + IoT-based Toy



2. As studies have pointed out that play is essential to toddlers through play (Goodson & Greenfield, 1975; Mueller & Brenner, 1977; Fien, 1979), **it is proposed that the immersive multilingual environment be implemented in a play scenario at home.**

As children play with their toys, the robot plays the role of a companion, providing linguistic feedback as a parents would do, but in a new language.



Scope

- Age :24-30, naming explosion period (Lenneberg, 2016).
- Scenarios: researcher summarized 11 categories of family activities serving as children's learning opportunity (Dunst, Hamby, Trivette, Raab, & Bruder, 2000).

Category	Activities	Category	Activities
1. Family routines	Household chores, cooking, caring for pets…	7. Playing activities	Art activities, playing board games..
2. Parenting routines	Child's bathtime, bedtime, meal times…	8. Entertainment activities	Dancing, listening to music, watching TV…
3. Child routines	Brushing teeth, washing hands, dressing up,…	9. Family rituals	Family talks, religious readings….
4. Physical play	Riding bike, playing ball…	10. Family celebrations	Holiday dinners, birthdays
5. Literacy activities	Reading books, telling stories, talking walk…	11. Gardening	Planting trees, growing veges…
6. Socialization activities	Family gathering, pinics…		

Purpose of this study

1. Develop a context aware robot to provide a language immersion environment.
2. Propose guidelines for future system development.
3. Assess learning performance.

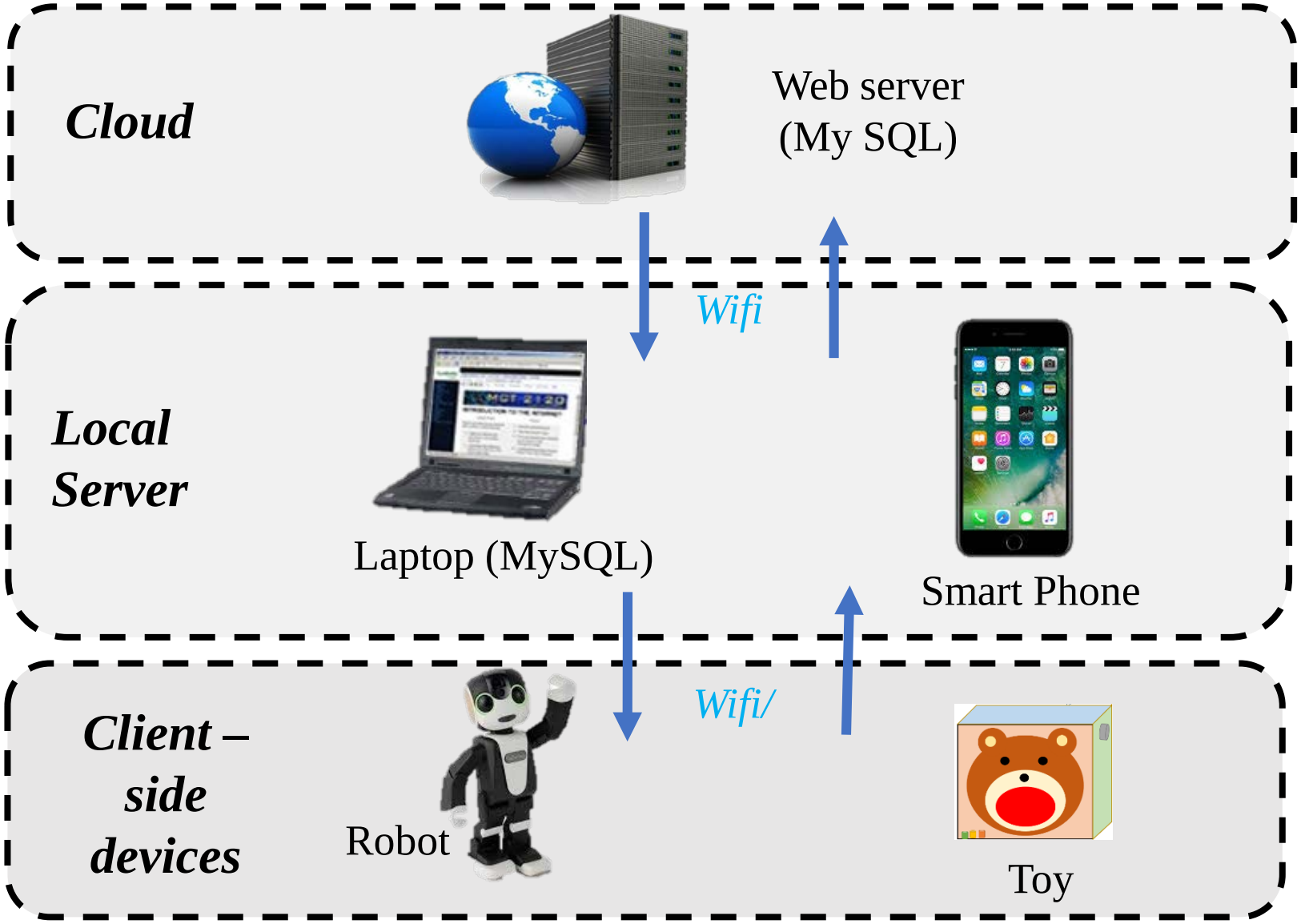
We have developed 3 sets of integrated system of a robot and IoT toys to meet the following educational purposes:

(1) To enhance early language development for toddlers aged 24-30 months, in a play scenario.

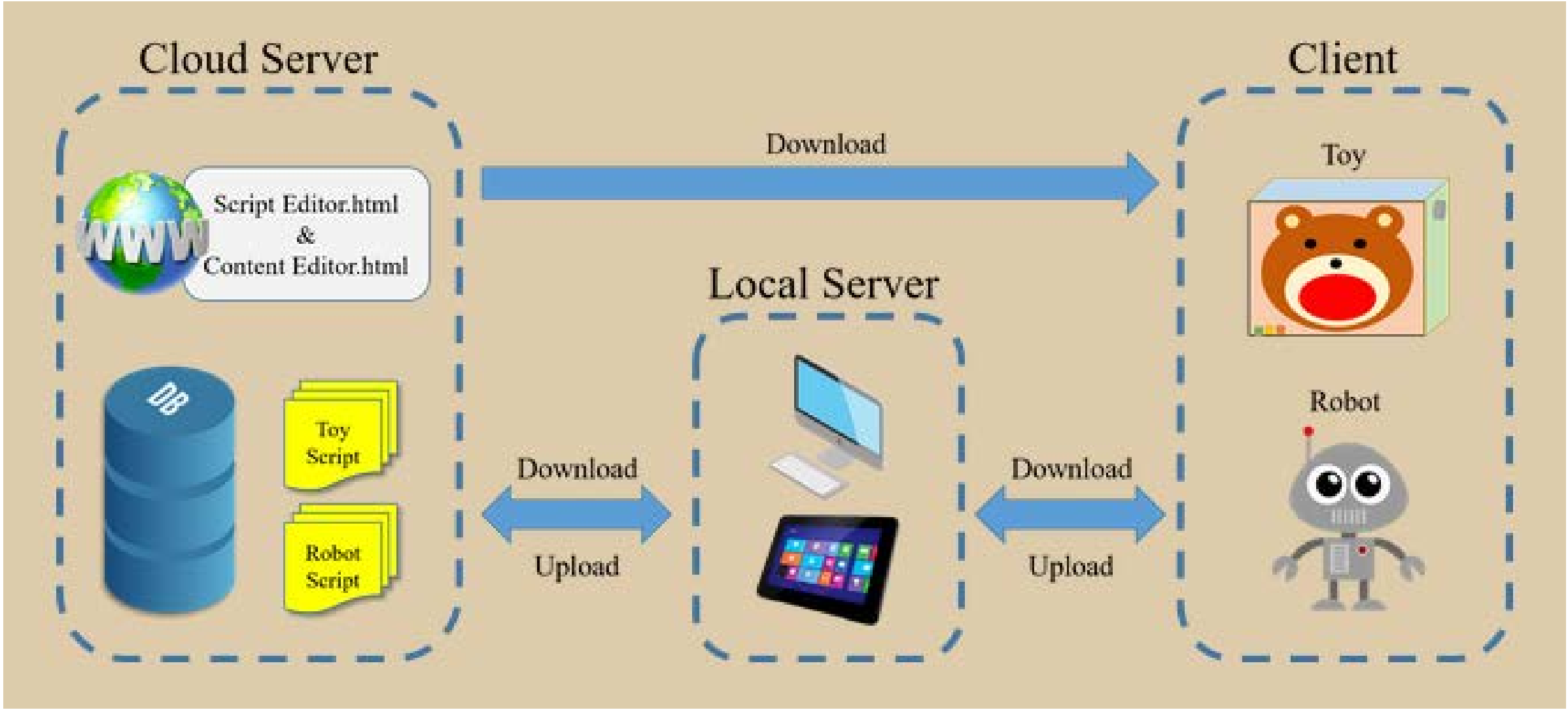
(2) To offer an immersive multilingual environment by integrating robots and IoT technology, which enables the robot to be context aware so as to provide meaningful language learning content and feedback to the learner.

(3) To develop an easy-to-use programmable script editor for educators to specify the interactions between the robot and IoT toys and to accommodate the need of creating language learning content according to different scenarios and age differences.

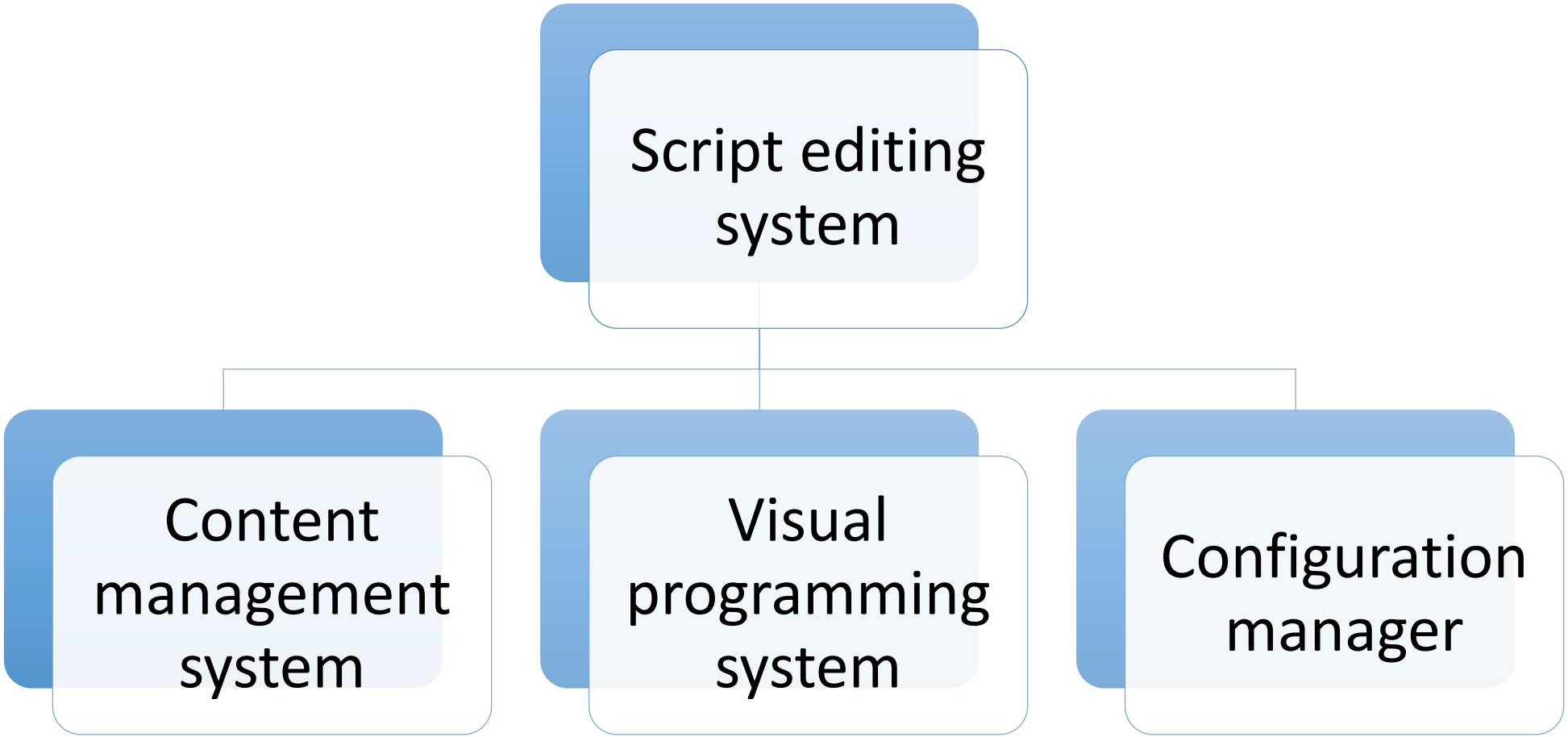
We proposed three layers system architecture



Script editing system 1


Cloud Server
Client
Download
Toy
Script Editor.html
&
Content Editor.html
Local Server
DB
Toy
Script
Robot
Script
Download
Upload
Download
Upload
Robot

Script editing system



Content management system

素材編輯器

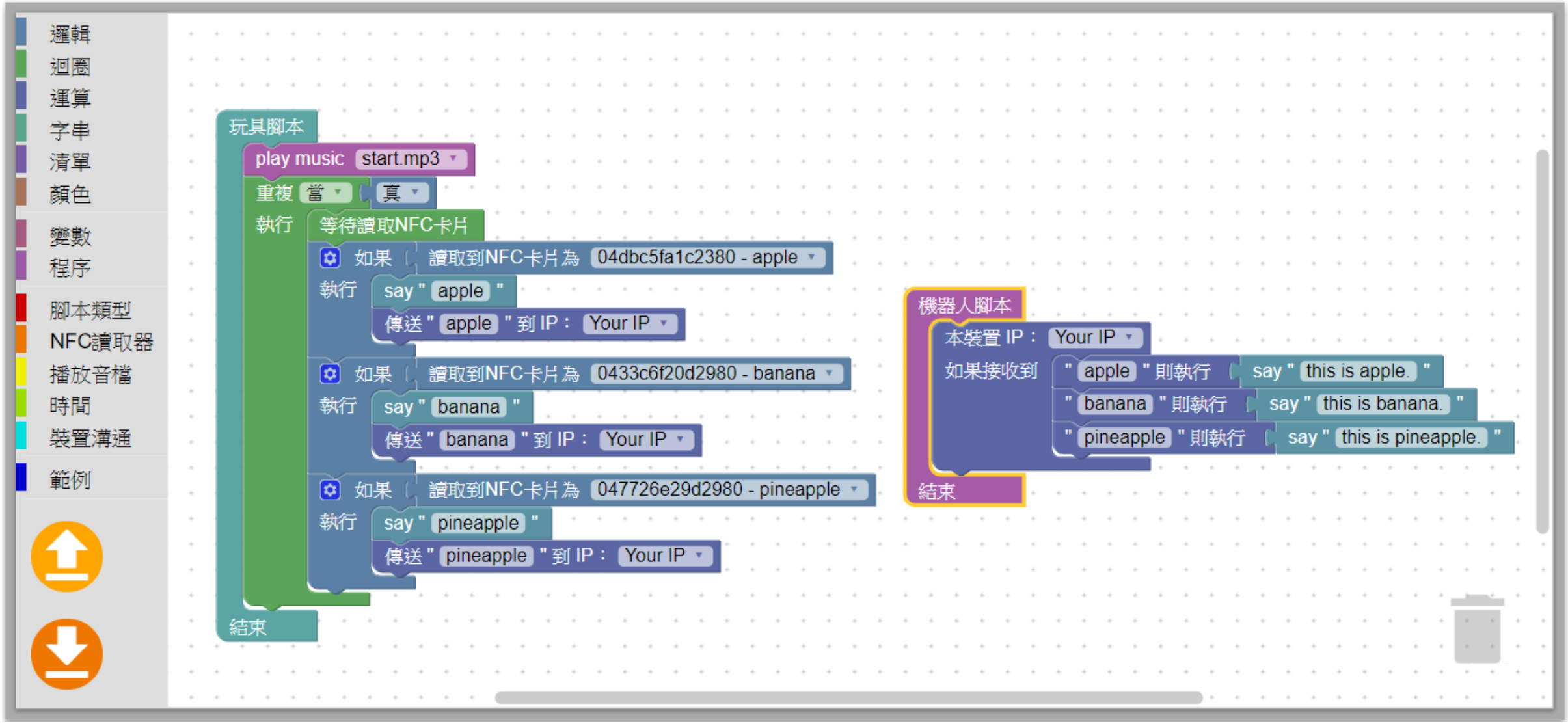
NFC Tag | Music

1 每頁： 10 筆 首頁 上頁 下頁 末頁

Add

Tag UID	Name	
04DBC5FA1C2380	apple	Edit Del
0433C6F20D2980	banana	Edit Del
047726E29D2980	pineapple	Edit Del
0443E6E29D2980	grape	Edit Del
04A23332B62880	cat	Edit Del
044BDCC2072980	dog	Edit Del
04E60672AE4F84	broccoli	Edit Del
04E50672AE4F84	potato	Edit Del

Visual programming system

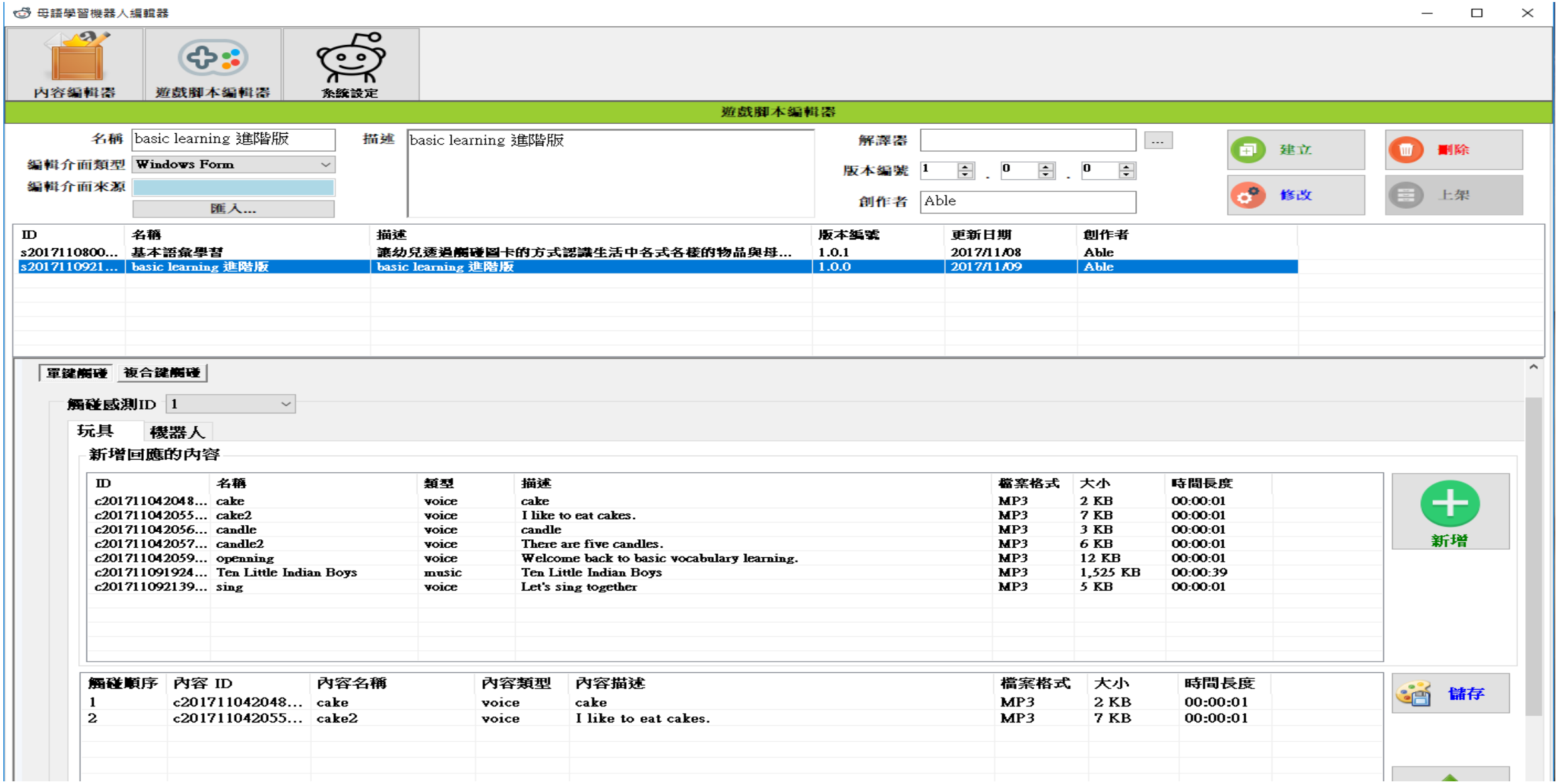


Configuration manager

管理介面

Demo
https://www.youtube.com/watch?v=jSzRV3L1sqo&feature=youtu.be

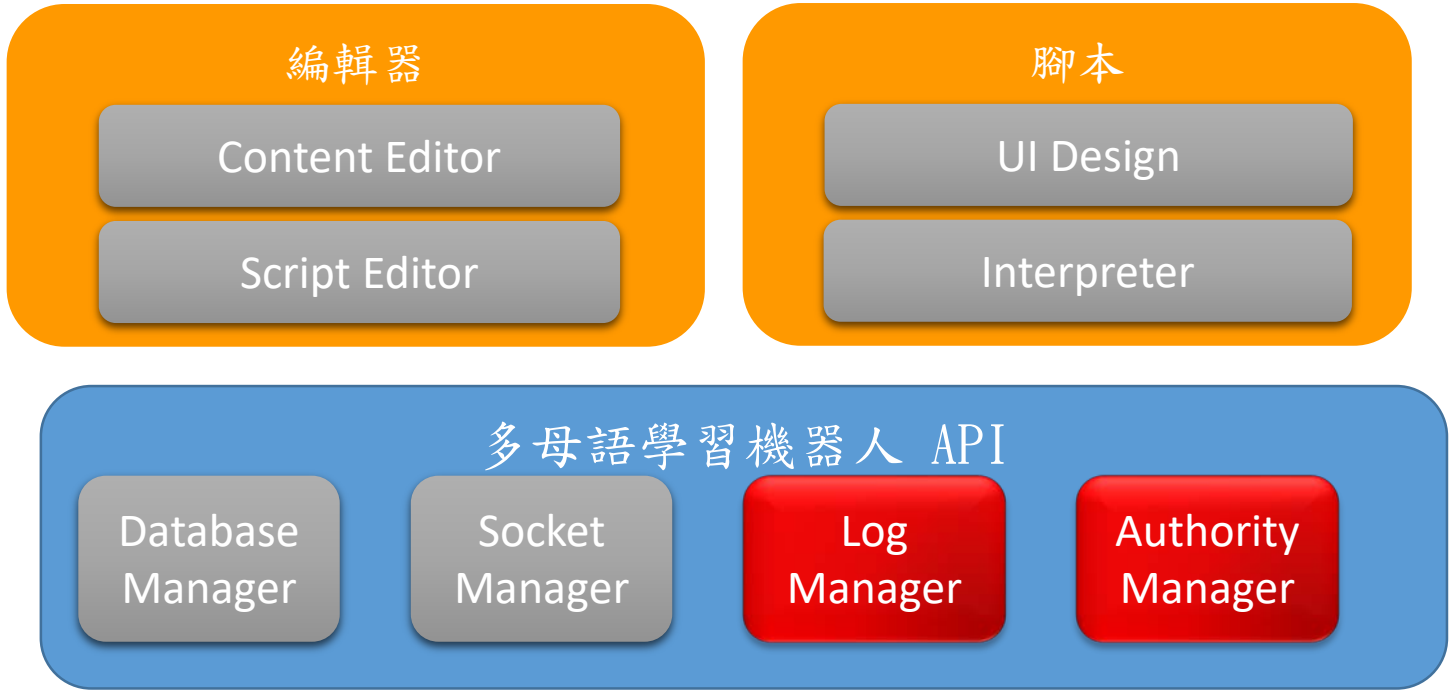
Script editing system 2



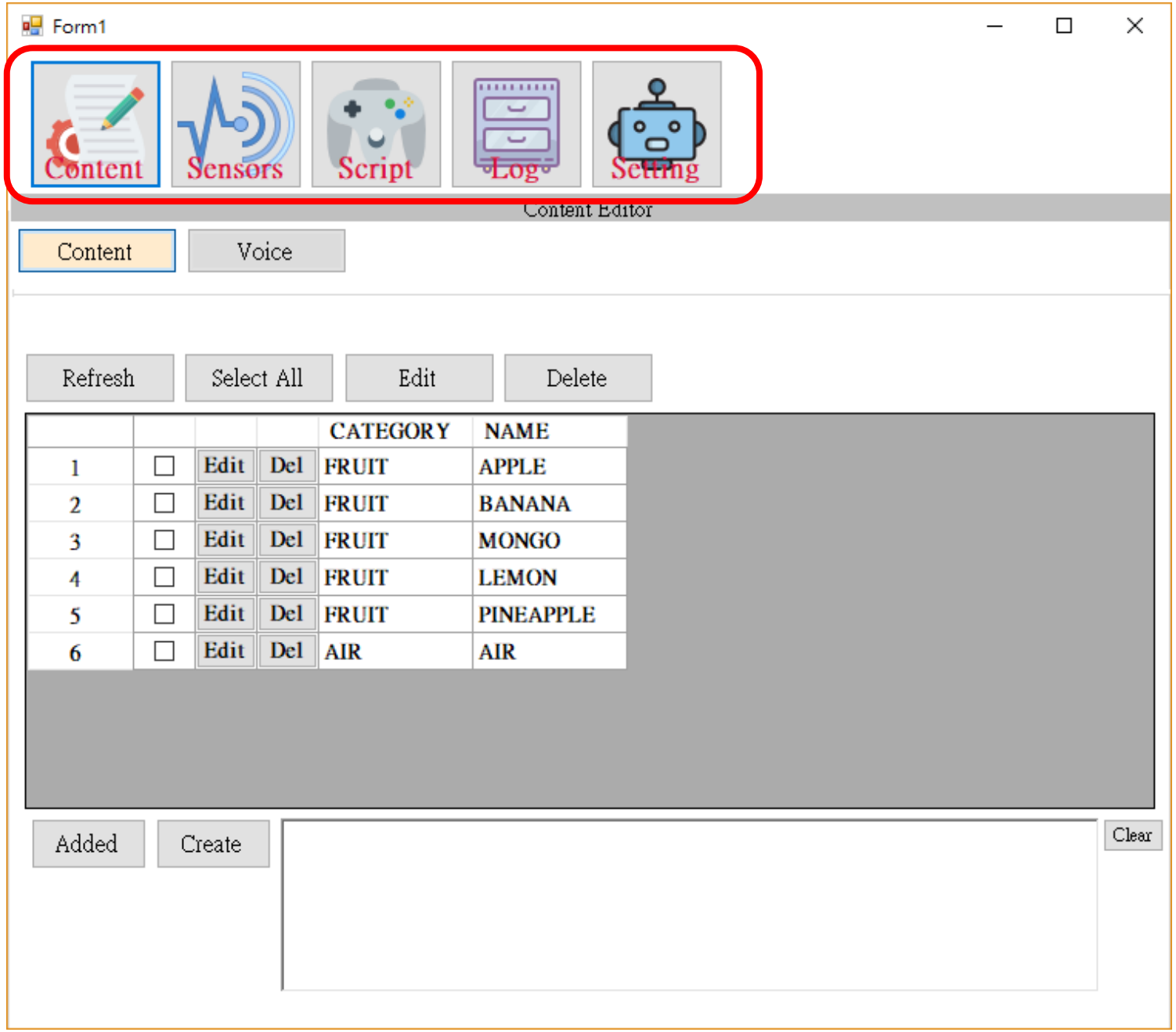
影片網址

https://www.youtube.com/watch?v=nLOS9HC8fvM&feature=youtu.be

Software architecture



Script editing system 3



1. Content editor
2. RFID tag editor
3. Script editor
4. Log management
5. Configuration management

Content editor

				VOICE_TYPE	VOICE_NAME	VOICE_DATA
12	☐	Edit	Del	WORD	Gusess_praise	You're awesome, you answered all the ans
13	☐	Edit	Del	MP3	Gusess_endSond	D:\MUSIC\RED1.mp3
14	☐	Edit	Del	WORD	New Create	New Create
15	☐	Edit	Del	MP3	New Create2	D:\MUSIC\RED1.mp3
16	☐	Edit	Del	WORD	LEMON	LEMON

RFID editor

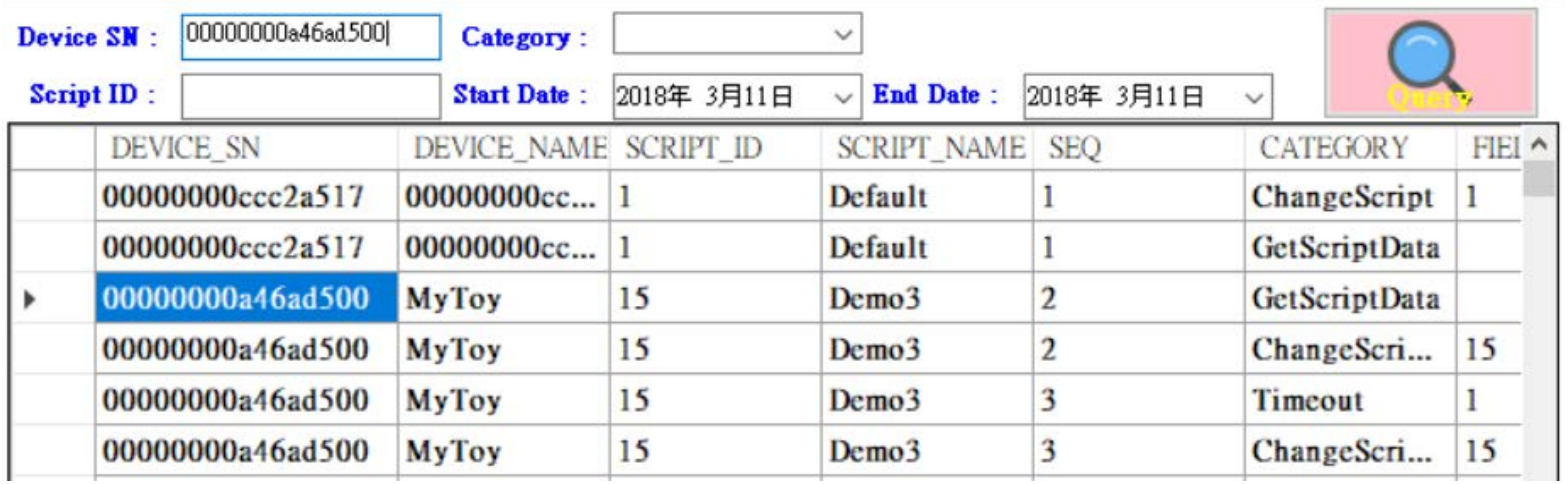
Sensors Editor

Card

				UID_1	UID_2	UID_3	UID_4	CATEGORY	NAME
▶ 1	☐	Edit	Del	97	180	128	203	FRUIT	APPLE
2	☐	Edit	Del	39	255	137	171	FRUIT	BANANA
3	☐	Edit	Del	243	54	135	217	FRUIT	MONGO

Script editor

Log management



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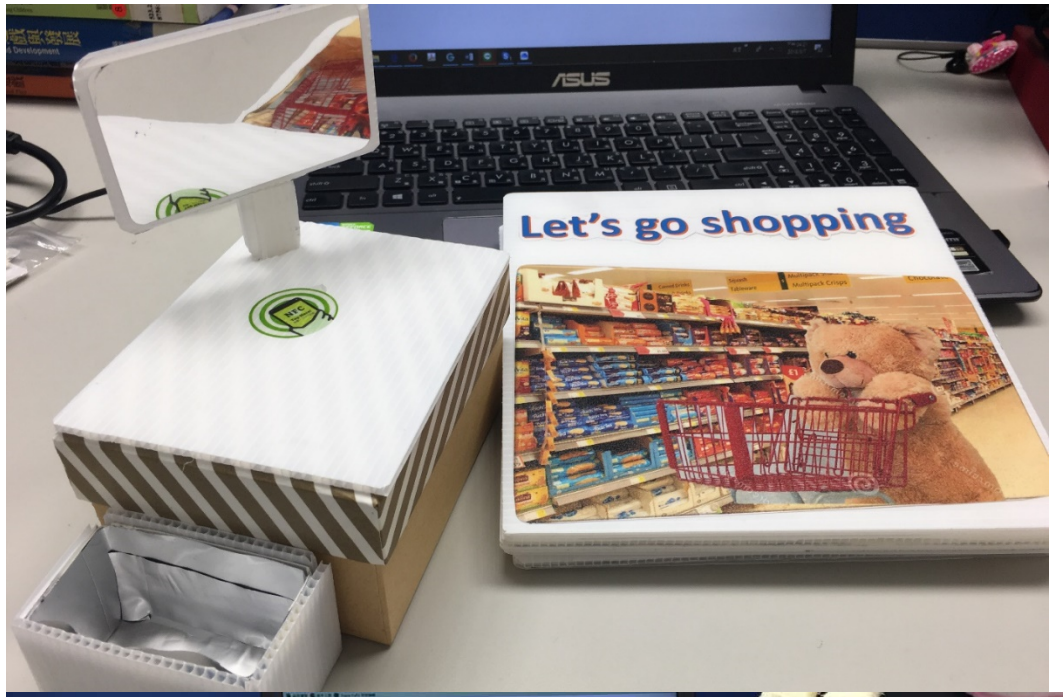
We have designed 3 toys by using 3 types of sensors

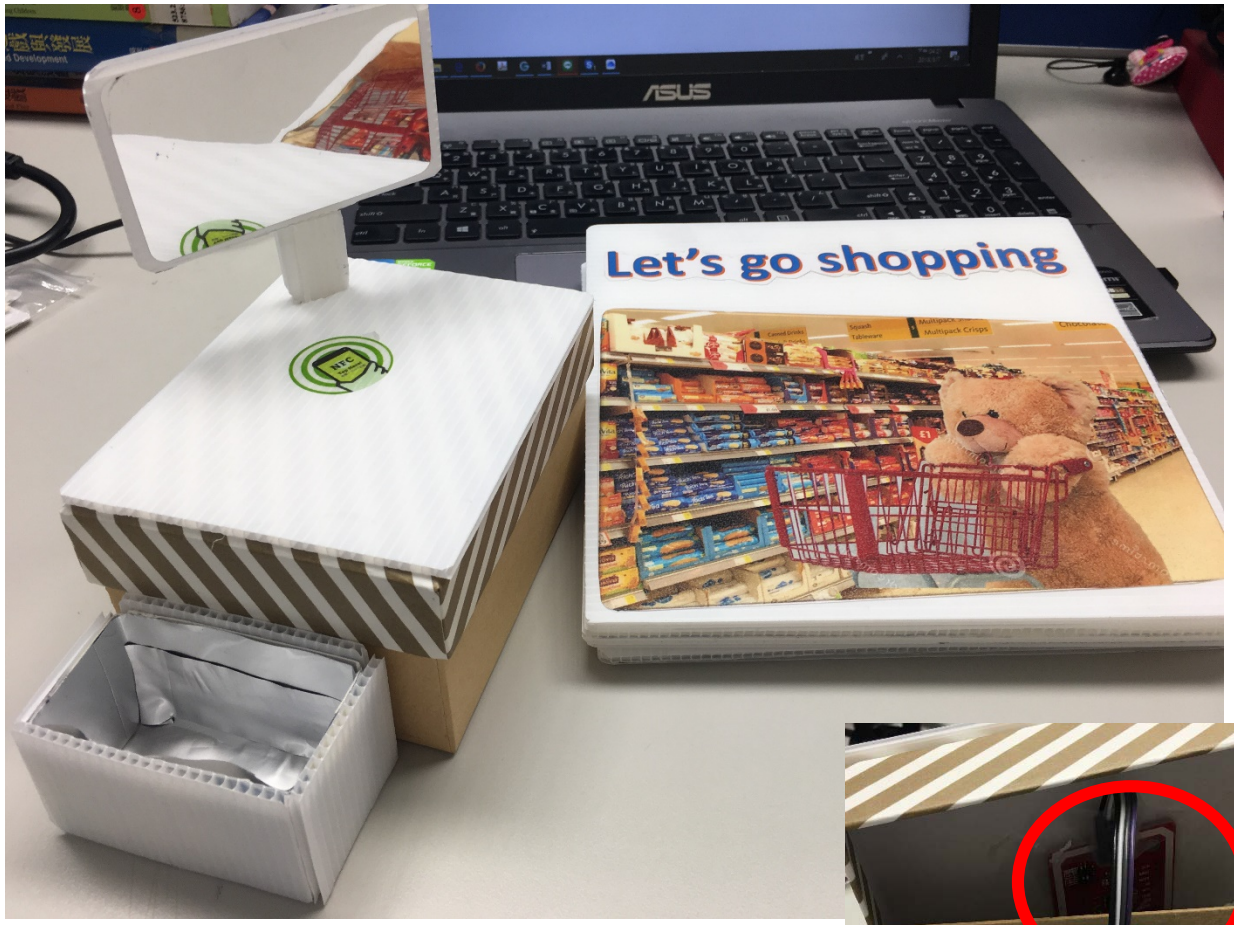
1. NFC reader and tags

2. Touch sensors

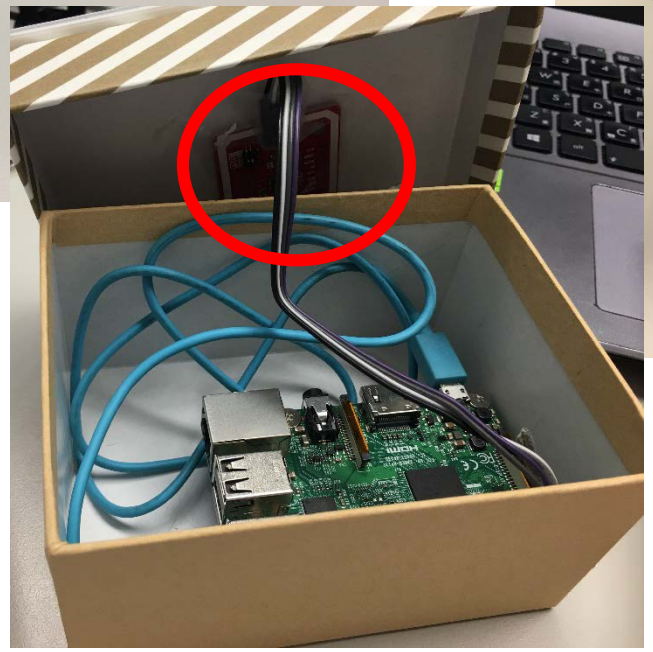
3. RFID reader and tags

1. NFC reader and tags





新的腳本是以去超級市場購物為主題。整套玩具包括一本書、一個收銀機以及一個購物籃。



NFC reader放在盒子的蓋子內部，當作收銀機的讀卡機

樹梅派，可以從盒子的旁邊直接開關玩具。

一本書的形狀，可以打開，
共四個頁面。

每一個商品都是獨立的NFC tag，貨架上也有標商品的名稱以及價格

餅乾、早餐以及生活用品、玩具、蔬果

Background。有商品原始圖當背景，讓小朋友玩完玩具以後，可以把圖卡歸回原處。

NFC tag 圖卡，可移動抽取

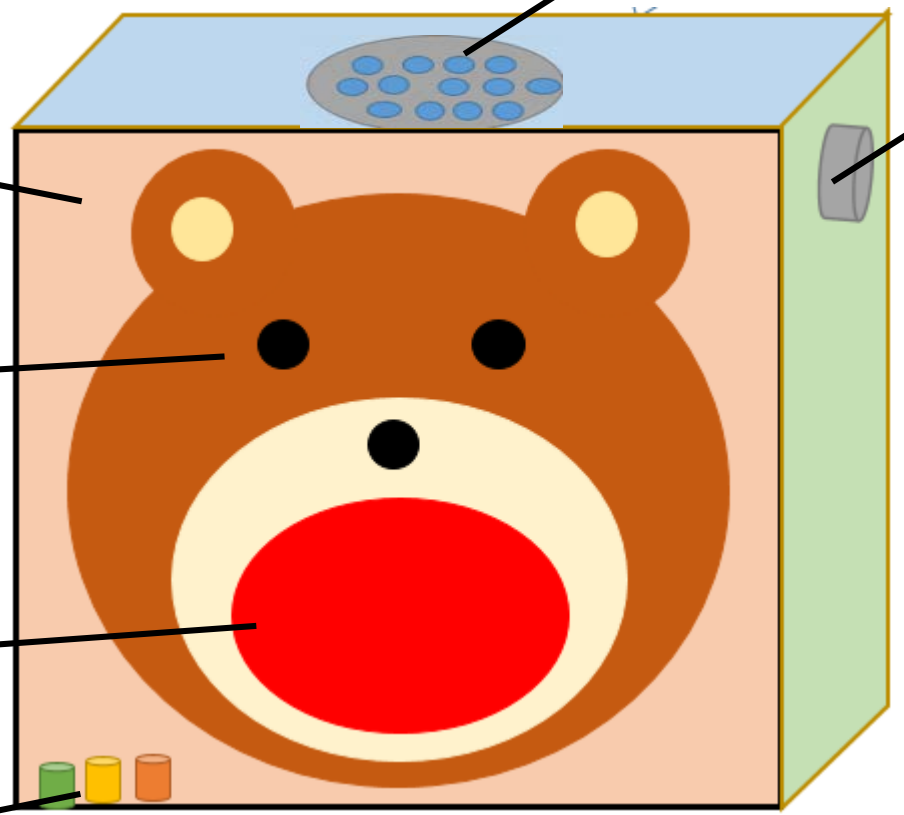
Speaker

Raspberry Pi：
fixed inside the toy box

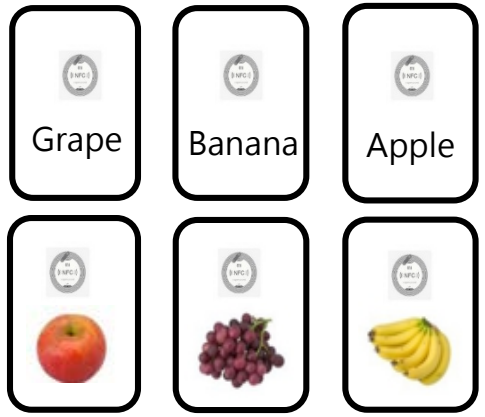
Servomotor：
to make the bear blinking

NFC Reader:
To read NFC tags

LED：
to indicate a wrong or correct answer



Power switch



Cards with NFC Tag

Devices and sensors

Device & sensor	Function	Cost (NT)
Raspberry Pi 3 Model B	Computing	$1800
Lipo Battery Shield	Power supply	$480
PN532 NFC Module V3	Read NFC Tag	$400
NFC Tag	Carry the learning content	$50 /tag
SG90 Servo Motor	Control	$100
LED	To indicate a correct or a wrong answer	$3
Bluetooth Speaker	Speaker	$300

Interaction Design(1/2)

Level 1. from vocabulary to sentence

Trigger	Output
Frist time reads the card	Reads the vocabulary, e.g., “apple”
The second time	Reads a sentence, e.g., “This is an apple.”
The third time	Reads a complex sentence, e.g., “Apple is sweet and sour.”
The fourth time	Play music

Interaction Design(2/2)

Level 2. Quiz

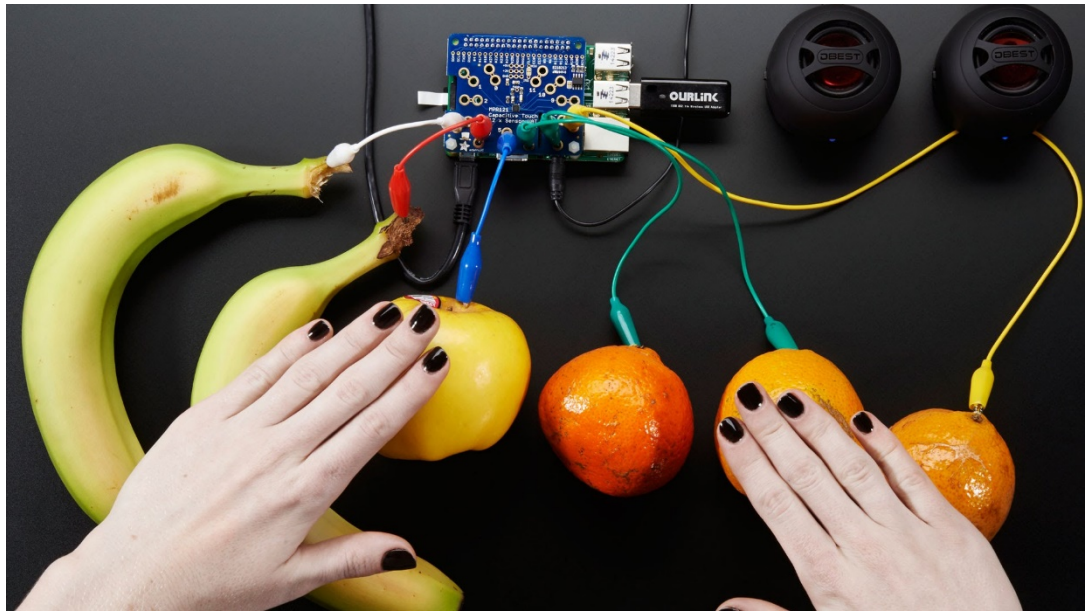
Trigger	Output
Reads the card	Asks questions, e.g., “which one is apple”
	Reply to the answer, e.g., “correct! You are great!”/ “No, this is not an apple, try again.”

Demo

- Video 1：interaction design, level 1 & 2

URL：https://youtu.be/PPdsKb1p3FM

2. Touch sensors



A picture of a cake,
With a touch sensor
on the back

Raspberry Pi

Touch sensor board

Learning content

Learn vocabularies by themes
Theme: birthday party

- ✓蛋糕 (Cake)
- ✓蠟燭 (Candle)
- ✓生日快樂帽 (Hat)
- ✓禮物 (Gift)
- ✓生日快樂歌(Happy birthday song)

Interaction design (1/2)

Leve l. Learn vocabularies and sentences by touching the sensors

simple

complex

Trigger	Output
Touch the sensor 1 time	Toy box reads the vocabulary, such as “cake”
2 times	Toy box reads a sentence
3 times	Reads another sentence
When all the sensors have been touched	Play “happy birthday song”

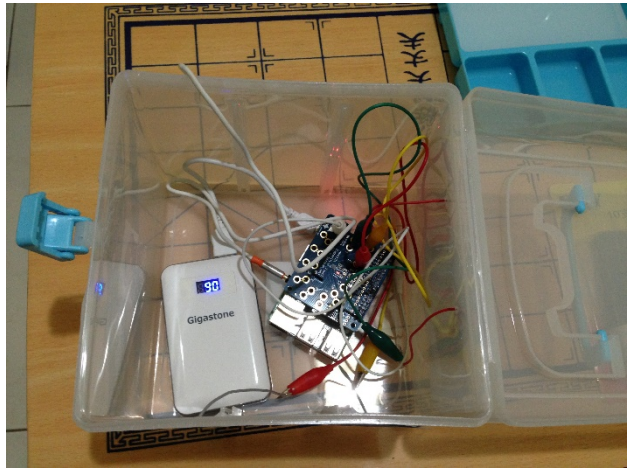
Interaction Design (2/2)

Leve 2. quiz

Trigger	Output
Touch the picture	The toy box asks a question: where is the xxx?
When kids touch the right picture	「Bingo! You are great」
When kids touch a wrong picture	「No, try again」
Got the right answers for 4 times	Play “happy birthday song”

Demo

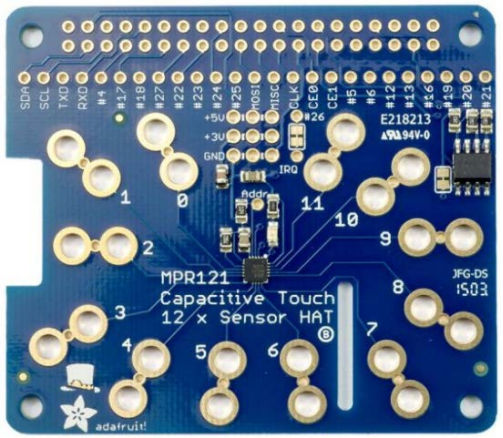
https://www.youtube.com/watch?v=6z1PrA2EfBU



Video 1：basic level
https://www.youtube.com/watch?v=SOwWdDG8bPc

Video 2: quiz
https://www.youtube.com/watch?v=gDp0b-_sHiU

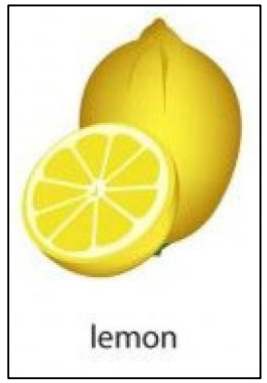
Touch sensor



Name	Adafruit MPR121 Touch Sensor 12x電容式觸控擴展板
introduction	This touch-able add on HAT for Raspberry Pi will inspire your next interactive project with 12 capacitive touch sensors. Capacitive touch sensing works by detecting when a person (or animal) has touched one of the sensor electrodes. Capacitive touch sensing used for stuff like touch-reactive tablets and phones, as well as control panels for appliances, which is where you may have used it before. This HAT allows you to create electronics that can react to human touch, with up to 12 individual sensors.
Size and other information	• 57mm x 65mm x 3mm / 2.2" x 2.6" x 0.1" • Weight: 10g
Price(US dollar)	$14.95

3. RFID reader and tags

1. Read vocabularies



RFID

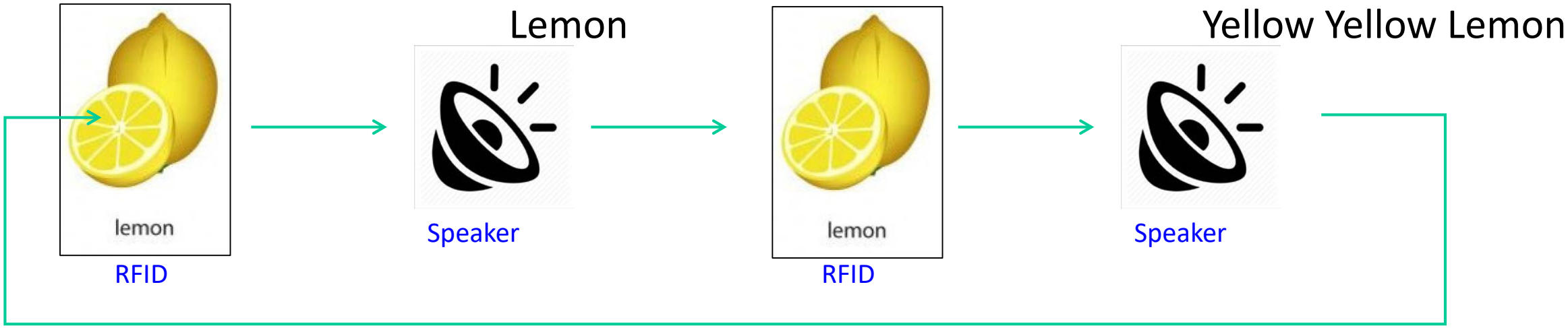
Lemon

Speaker

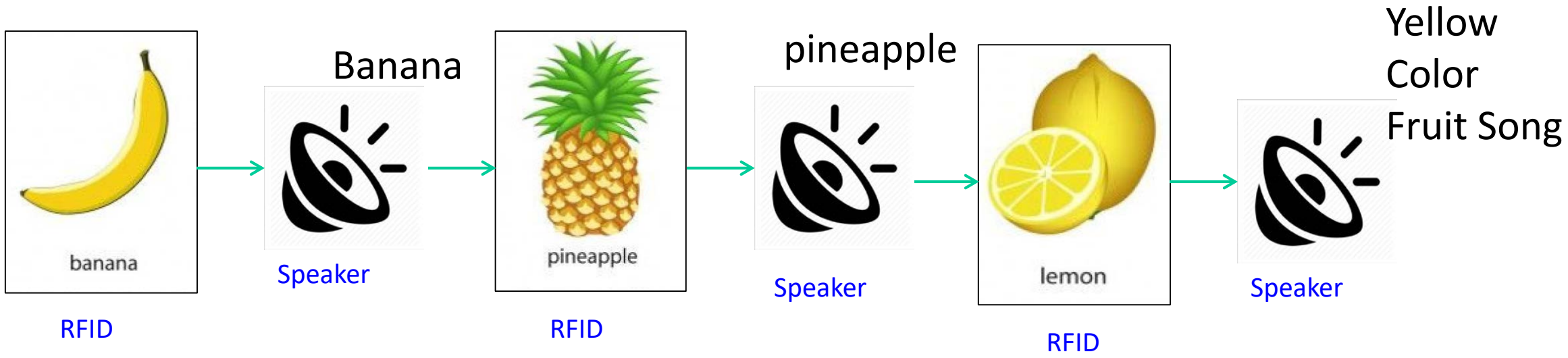
https://www.youtube.com/watch?v=6eemTowEFZw

2. Read a same card for the second time

https://www.youtube.com/watch?v=3C6V3FZmyXk



3. Play music



https://www.youtube.com/watch?v=yrsdnN0yXb4

Components	Function	Price(NT)
Raspberry Pi 3 Model B	Data and logic processing , Database Server	1200
RC522 RFID module	RFID Reader	150
RFID Mifare 13.56MHz	Provide UID	15
Bluetooth Speaker	Voice Player	395
PiBorg BattBorg	DC to DC Converter	450
8xAA battery packs (Contains the battery)	Power	100

Robot is under designing

Components
Raspberry Pi 3 Model B
Bluetooth Speaker
Logit Web camera (with microphone)
External battery for Pi
7 inch digital display for Pi
Power bank

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