# A Prototype Development of the Smart Mousetrap System Equipped with LoRa

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*Abstract*— **In this study, a prototype of a smart mousetrap system is presented, which features that the portable remote devices based on a LoRa module plus SOC for Bluetooth attempt to lure rodents into a trap and then inform the base station. Mealtimes, all remote devices transmit information on including sensors, the battery status and the GPS coordinates to the base station. Preliminary experiments demonstrate that the system has 5260 meters long distance transmission ability under None-Line-of-Sight (NLOS) conditions**

## I. INTRODUCTION

The application and development trends in Internet of Things (IoT) have emerged, including smart city [1], medicine [2], security for the internet and even the health of the rehabilitation system [3], but there are still relatively few studies for environmental disease prevention or surveillance, especially for pest rodents. To monitor and control distributions of pest rodents, a system comprising a data collection software on the basis of PDA and GPS, information query system and information management system are implemented in [4]. The rodent killer called the Rat Zapper is manufactured by Woodstream Corporation [5]. All the cough rodents are eliminated completely, instead of analyzing the distributions of rodents or diagnosing. Based on the mentioned above, the aim of this paper is to develop a portable remote system outfitted with a LoRa module, which will be able to lure rodents into a trap. Then, a portable device transmits the capture status signal to the distant base station.

## II. THE PROPOSED HARDWARE SCHEME

In the current study, we regard a portable remote device shown in Figure 1 as a smart cage, which is able to lure rodents and communicate with base station when an interrupt on the system is triggered by a signal of Passive Infrared Sensor (PIR). The main components of the hardware blocks are a LoRa module, system-on-chip (SoC) for Bluetooth, passive infrared sensor (PIR) and a motor driver circuit for closing/opening a door of a cage, as shown in Figure1. In the system, two wireless transmission modules, Bluetooth and LoRa technologies, are employed. We can transmit GPS coordinates of the mobile phone or tablet to portable remote devices by Bluetooth interface when portable remote devices are placed in a certain position. The LoRa wireless module operating at 433/868Mhz is designed from Microchip, which has the ability to transmit data over several kilometers through the measured experiments. Both sources of data and commands transmitted are from the SOC module through a UART interface. MCU communicates with PIR by two GPIOs. One is for enabling the PIR function, and the other one is to communicate with MCU after PIR detects that an animal comes inside a cage. Not only is SOC responsible for receiving and transmitting data from LoRa module, but it also enables/disables two control circuit units for an atomization piece and the motor of a door of a cage when a rodent falls into a trap. As long as MCU makes a door of a cage closed, an atomization piece with a container sprays the atomized liquid including medicine or chemical of making rodents faint or unconscious to avoid touching viral rodents directly. An atomization piece floating on the liquid is fed 100 kHz square wave and then generates droplets. For the part of the base section, the hardware components contain a LoRa module, and a standalone SOC evaluation board, called STM32F2/4-EVB, is designed from STMicroelectronics, as shown in Figure 2. On 3.2 TFT LCD with touch screen, a base station prototype can show information on every remote devices situating at different locations, including the devices' labels, latitude and the longitude GPS coordinates, staff numbers, battery status, capture status and time indicators.

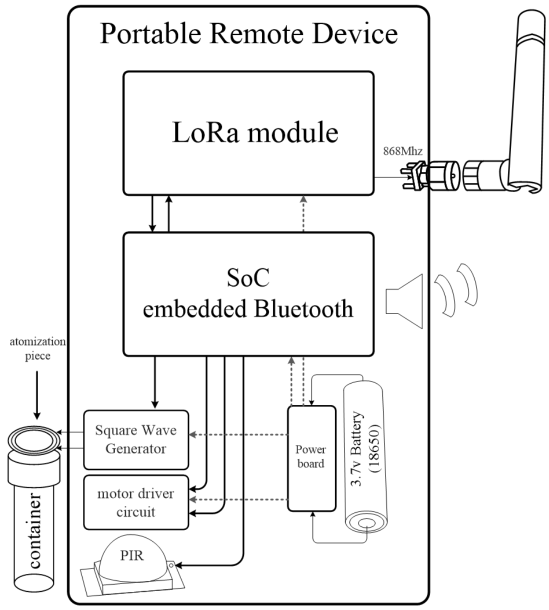


Figure1. A portable remote device

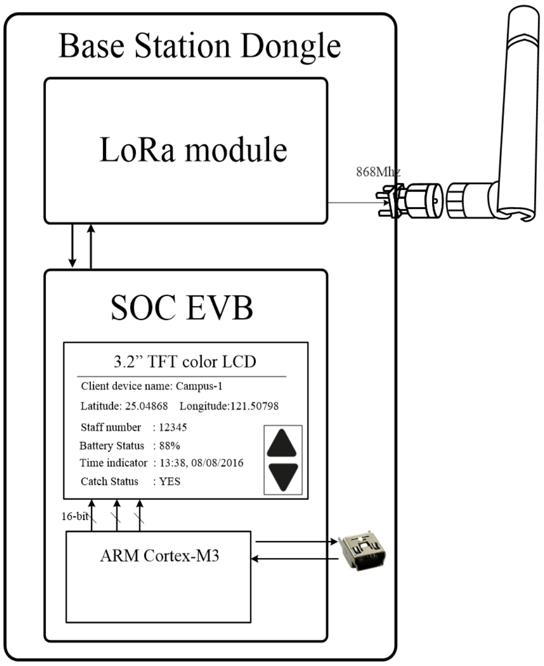


Figure2. A base station dongle

Every device has itself the device name and staff number to increase data readability and track those installing. To avoid running out of battery, a base station can monitor the battery status at all remote devices as well. When their battery power is less than 5% storage, the remote device launches an alarm signal to the base station. In addition, all time and date of installment are shown on LCD to analyze how long the rodents have been captured for, and the capture status indicates whether a door of a trap is closed or not.

Pressing up or down the triangle buttons on the LCD can select which information of the remote device is shown. All data from remote devices can be stored at 1 Megabyte Flash on SOC evaluation board. As long as a base station dongle connects to a PC via a USB connector, all the stored data are updated to cloud storage. Therefore, by gathering data at cloud storage, a developing software can figure out where the distributions of rodents are, which areas there are the most rodents to achieve the effect of preventing diseases.

### III. Demonstration

It is key performances of the system to achieve long distance transmission and pretty low power consumption at portable remote devices. The measured data of transmission in the real world are shown in Table I. The hardware components are integrated into the printed circuit board, which is preliminarily fabricated by a PCB prototyping machine. The 16850 battery supplies 3.7 voltage to circuit on a remote device so a power board converting 3.7 to 3.3 voltage is necessary. An antenna connects to LoRa module by SMA connector. To avoid performance decay, 868MHz RF signal must be routed with properly terminated 50 Ohm strip lines.

Table I. The measured data between a portable remote transmitter and receiver

| Distance (m) | Tx-data (bits) | Rx data (bit) | Bit Error Rate (%) | S.F.+ | Tx-power (dB) |
|---|---|---|---|---|---|
| 5260 | 512 | 512 | 0 | 12 | 15 |
| | | 512 | 0 | 11 | 15 |
| | | 384 | 25 | 10 | 15 |
| | | 512 | 0 | 12 | 13 |
| | | 512 | 0 | 11 | 13 |
| | | 320 | 35 | 10 | 13 |
| | | 512 | 0 | 12 | 11 |
| | | 384 | 25 | 11 | 11 |
| | | 256 | 50 | 10 | 11 |
| 38 | 512 | 512 | 0 | 12 | 15 |
| 77 | | 512 | 0 | 12 | 15 |
| 219 | | 512 | 0 | 12 | 15 |

+ S.F. is abbreviated by spread factor

All received and transmitted data are stored in the embedded memory of the SOC module. Through the results of measurement, the portable device is able to transmit 29581 times. The voltage merely drops 3.109v to 2.72v. It is unnecessary of a remote device to communicate frequently with a base station. The number of transmission times is less than ten in a day. The proposed remote device architecture can work for eight years.

### IV. Conclusion

A LoRa prototype system capable of applying to intelligent diseases prevention has been developed, which is able to perform long-distance transmission and work for several years outside to achieve reducing manpower cost. Through a series of testing and validation, the system is commercially feasible.

### V. References


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