



Srednja poklicna in tehniška šola Murska Sobota

SmartBin

Monitoring fullness of smart trash bins
with headless IoT devices

19-20.9.2016 6th eRegions Conference 2016 Castle Jable, Slovenia

Srednja poklicna in tehniška šola Murska Sobota



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Srednja poklicna in tehniška šola Murska Sobota

- › Secondary school for Vocational and Technical Education was established more than 115 years ago
- › Now it is visited by more than 800 students and there are 77 staff members, out of which 59 teachers.

Srednja poklicna in tehniška šola Murska Sobota

- › We educate our students in these major programs:
 - › **3-year-programs:**
 - › Carpenters
 - › Electricians
 - › Car mechanics
 - › **4-year-programs:**
 - › Computer technician
 - › Electro technician
 - › Mechanics technician
 - › Environmental technician

The Problem

Inefficient garbage transport

Unnecessary trips to empty trash bins

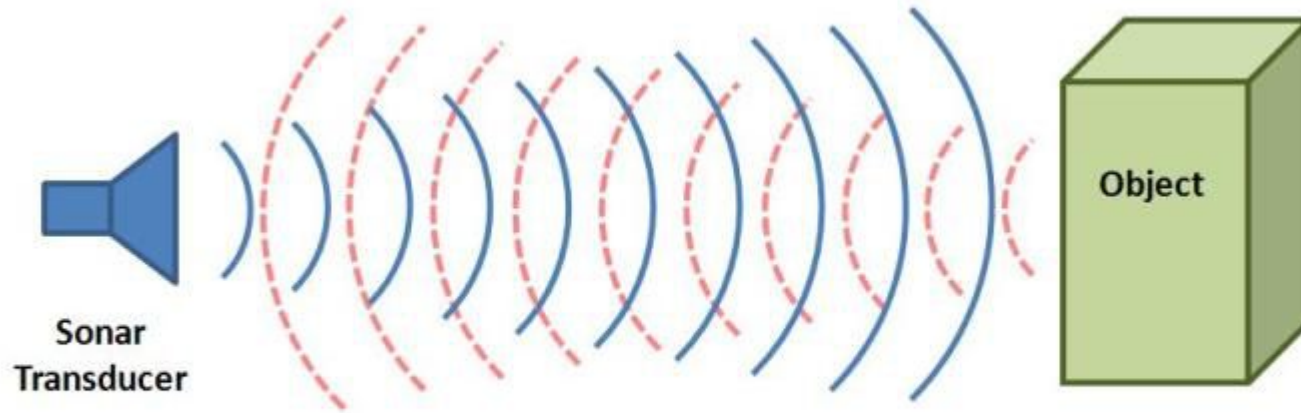
No monitoring



The Solution

- > A device
- > Trash bins fitted with sensors
- > Continuous monitoring
- > Reporting to the company
- > Remote monitoring

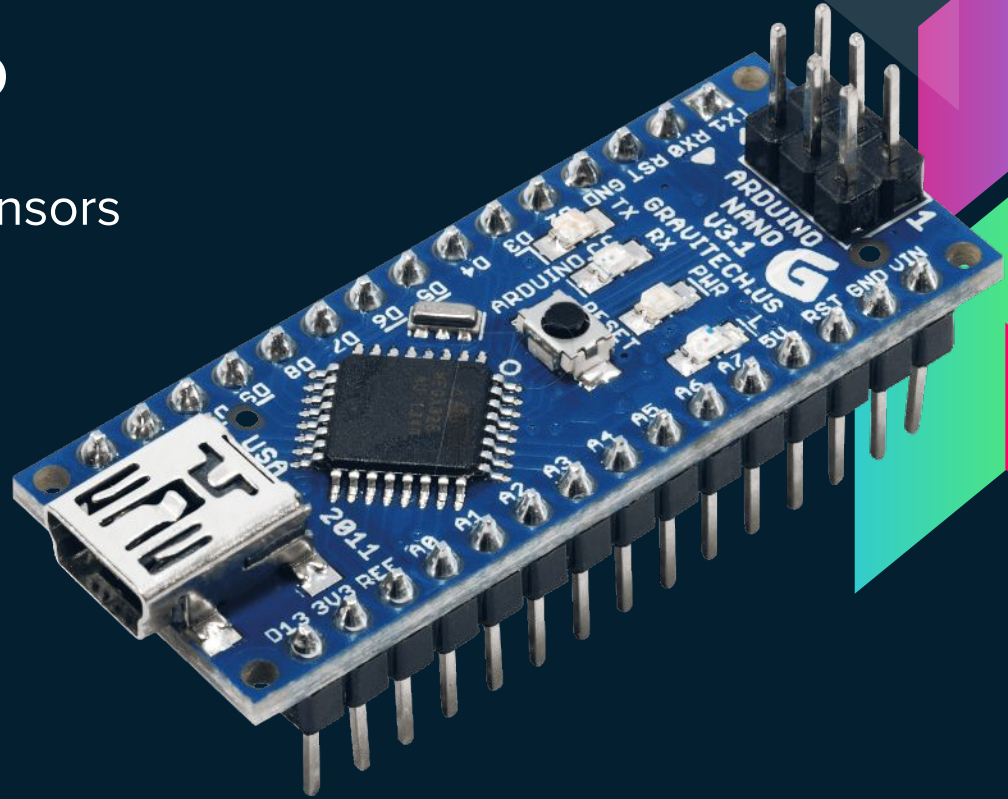
How ultrasonic sensors work



Basic sonar illustration – a transducer generates a sound pulse and then listens for the echo.

Arduino Nano

Supports different sensors
USB connectivity
Open Source
Inexpensive



Raspberry Pi

40 GPIO ports

4 USB ports

1 Ethernet port

Runs **Linux** !



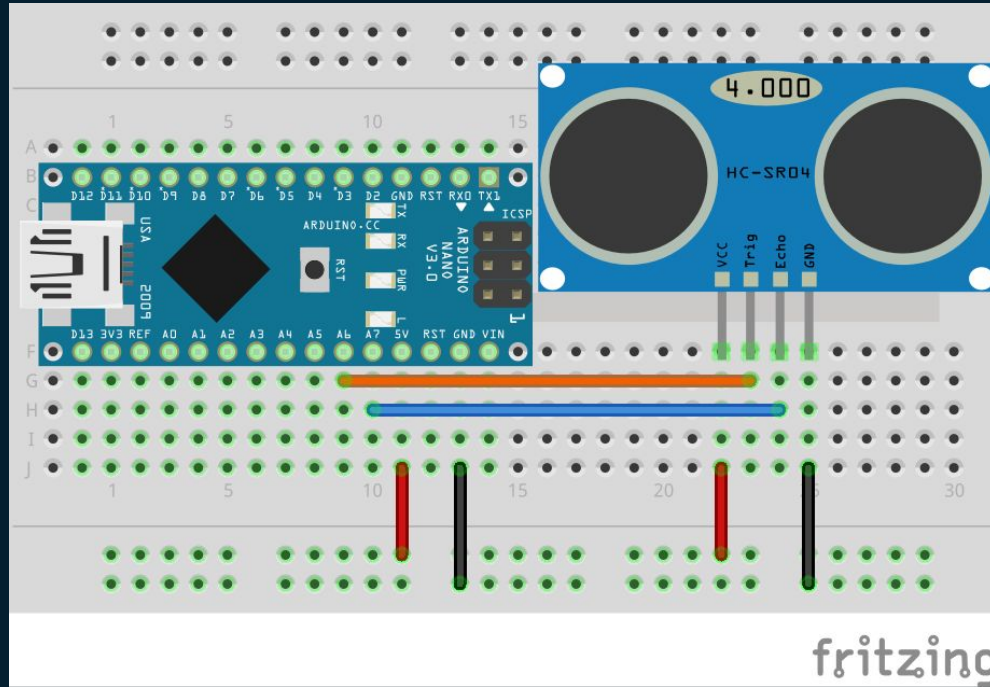
USB 3G Modem



1. Arduino collects reading from sensor

```
75 uint16_t US_getDistanceCm(){
76     US_trig();           //Trigger ultrasonic sensor
77
78     while(waitingEcho){ //Wait until ECHO pin goes LOW
79         _delay_us(10);
80     }
81
82     uint32_t ticks = TCNT1 / 2;
83     uint32_t ticks_per_us = F_CPU / 1000000;
84     uint32_t us = ticks / ticks_per_us;
85     uint32_t sound_um_per_us = 340; // um = micrometer
86     uint16_t mm = us * sound_um_per_us / 1000;
87     uint16_t cm = mm / 10;
88
89     TCNT1 = 0; //Reset Timer 0 tick count
90
91     return cm; //Return distance in centimeters
92 }
93
94 void US_init(){
95     US_DDR |= 1 << US_TRIG; //Set TRIGGER pin as output
96     US_PORT &= ~(1 << US_TRIG); //Set TRIGGER pin LOW
97
98     US_DDR &= ~(1 << US_ECHO); //Set ECHO pin as input
99     US_PORT &= ~(1 << US_ECHO); //Disable ECHO pin pull-up resistor
00 }
01 void US_trig(){
02     US_PORT |= 1 << US_TRIG; //Set TRIGGER pin HIGH
03     _delay_us(20);
04     US_PORT &= ~(1 << US_TRIG);
05 }
```

2. Readings are sent to RPi



3. Report is sent to the server

```
51 ✓ while True:
52 ✓     for i in range(0, measurements_per_report):
53         time.sleep(tBetweenMeasurements)
54         measure()
55
56         average = sum(measurements) / float(len(measurements))
57         percentage = average / bin_depth * 100
58         measurements = []
59
60         print(" => Reporting {} %".format(round(percentage)))
61 ✓     try:
62         fullURL = endpoint + "/api/stats/bin/{id}/report"
63         report = requests.post(fullURL.format(id=bin_id), {
64             'value': round(percentage)
65         })
66 ✓     except:
67         print("error")
68
```

4. Data is displayed in a web application

The screenshot displays the 'SmartBin Panel' web application. The top navigation bar includes the application name, a user profile for 'Tadej Šinko', and a notification icon. The main dashboard features six summary cards: 'Number of bins' (9), 'Empty bins' (2), 'Full bins' (4), 'Unresponsive' (1), 'Total collection trips' (126), and 'Collection trucks available' (2). Each card includes a trend indicator (up or down arrow) and a time period (e.g., 'From last Week' or 'From an hour ago').

Below the summary cards is a table titled 'List of smart bins'. The table has columns for ID, Location, Online status, Fullness percentage, Ready for collection status, and Action. The data is as follows:

ID	Location	Online	Fullness	Ready for collection	Action
1	Classroom/Test bin 1	✓	10%	✗	View
2	Classroom/Test bin 2	✓	0%	✗	View
3	Classroom/Test bin 3	✓	75%	✓	View
4	Classroom/Test bin 4	✓	44%	✗	View
5	Classroom/Test bin 5	✓	5%	✗	View
6	Classroom/Test bin 6	✓	88%	✓	View
7	Classroom/Test bin 7	✓	100%	✓	View
8	Classroom/Test bin 8	✗	7%	✗	View
9	Classroom/Test bin 9	✓	89%	✓	View

The left sidebar contains navigation options: Home, Dashboard, Statistics, SmartBin management, User management, and Preferences. The bottom of the page features a footer with the text 'Centelejo - Bootstrap Admin Template by Colorlib'.

Software

Operating System

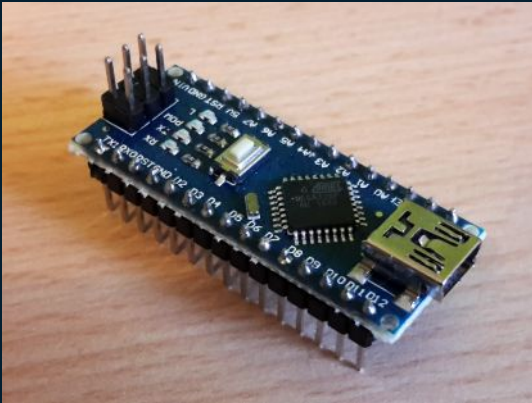


Database



Web application





Arduino Nano



Ultrasonic Sensor



Raspberry Pi Model B+



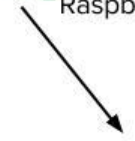
Huawei 3G Internet Modem

Our Hardware

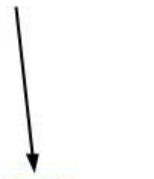
Arduino Nano



Raspberry Pi



3G Modem



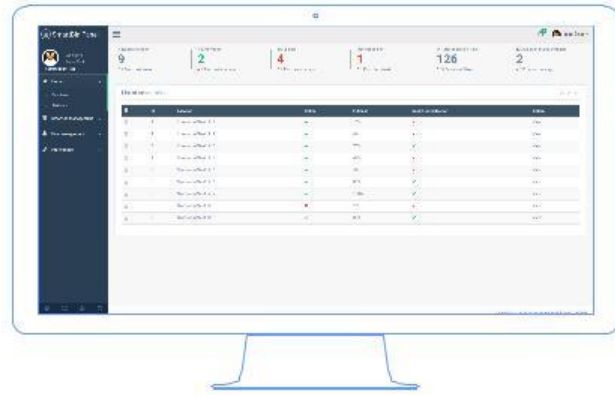
Cellular network



Server



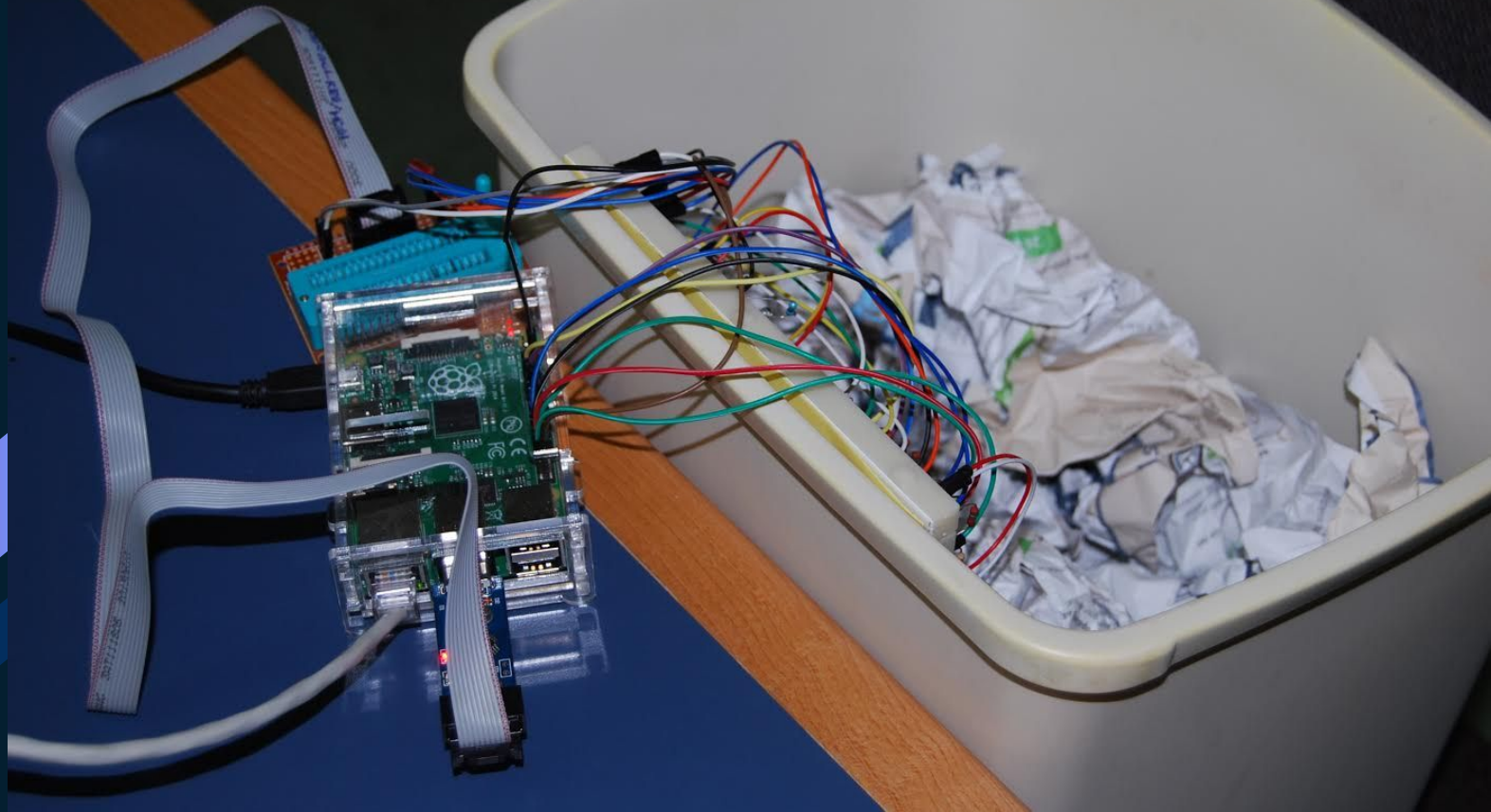
Web Application



Ultrasonic sensor



Early prototype



Questions ?

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