Soirée Pratique

Bike remote project
19/10/2015

slides + extra information:
www.ieee-sb-leuven.be/soireepratique2015
Facebook group:
Soirée Pratique Leuven

IEEE Student Branch Leuven

Today's session: bike remote

- play sounds/lights on your bike using an IR remote

- today:
  - provide schematics box cover
  - adding IR remote to existing circuit
  - program sounds in arduino corresponding to button presses

Schedule sumo robot competition

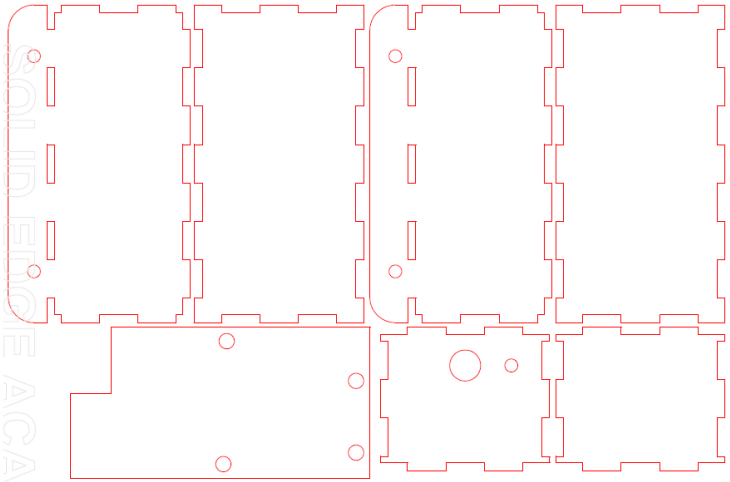
- Tuesday 3/11 at 19h30:
  - first session sumo robots: introduction arduino, information on ordering parts
- Monday 16/11:
  - motor session: the “muscles”
- Monday 30/11:
  - sensor session: the “eyes”
- Second semester:
  - frame building: the “skeleton”
  - advanced programming: the “brains”
  - training sessions + final competition

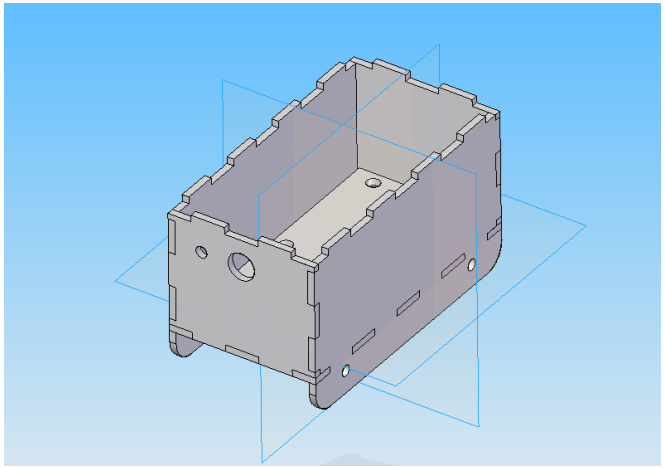
Bike remote components

- components last time:
  - arduino uno
  - leds /resistors
  - breadboard / cables
- new components:
  - **IR transmitter/receiver**
  - **buzzer**
  - **battery connector**
- components can also be used for sumo robot competition
  non-IEEE members: 15 euro
- IEEE members: **only 2 euro's!**

Box cover to mount on bike

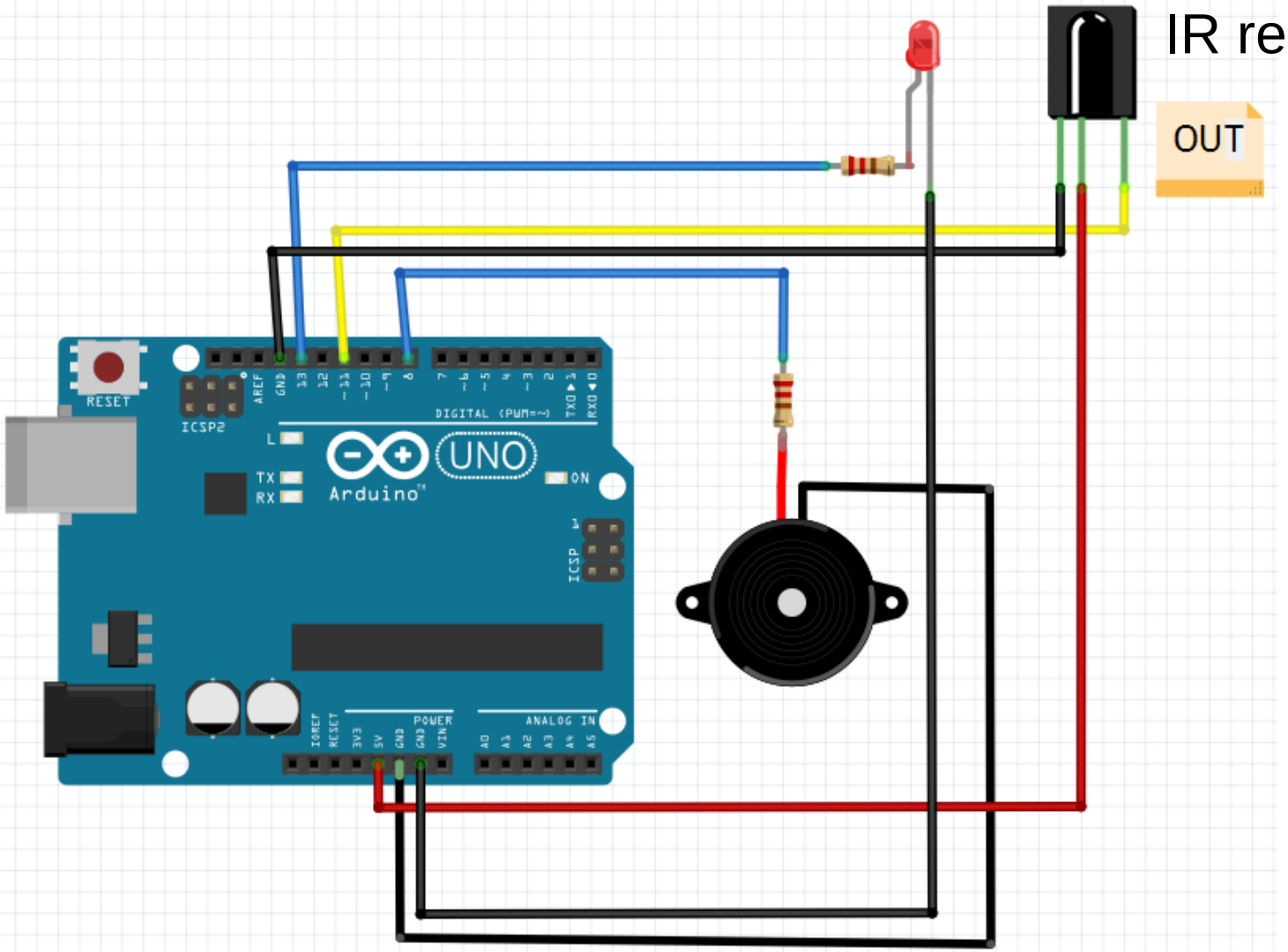
- files available at: www.ieee-sb-leuven.be/soireepratique2015
- laser cutter at FabLab (mech departm)
- material used: plexiglas 3 mm





- glue (at FabLab) or tape sides together

Circuit schematic bike remote



IR receiver

solder 220Ω resistor to led

220Ω resistor for buzzer is optional

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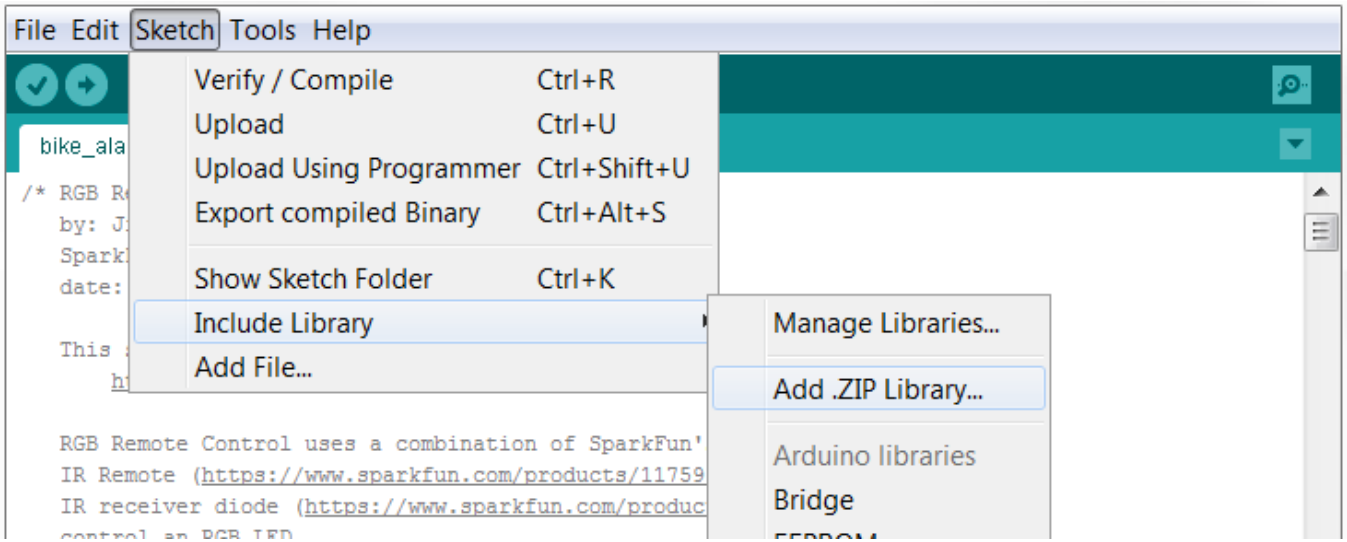
Arduino library for IR remote

- "bike alarm basic" code available at www.ieee-sb-leuven.be/soireepratique2015
- add library "IRremote" in Arduino:



- navigate to folder "IRremote", then press "Open"

IR remote code: basic

- start from downloaded “bike alarm basic” code

- program yourself:
  1. turn led on with one button, off with another
     hint: use variable “ledState”
  2. play different tones with different buttons
     hint: use variables “playnote” and “this_note”
  3. play the defined “melody” using a button

- problem:
  - melody can’t be interrupted since we’re using delays

IR remote code: advanced

- add **interrupts** to code in order to stop melody during play
  - also useful for sumo robots to interrupt current behaviour
- this uses timer of the microcontroller

- Important F_CPU = 16MHz

IR remote code: interrupts

- Pause current actions and respond to “external” event
- Used for critical actions that need to be performed immediatly
- There is a hierarchy in interrupts
- We will look at timers only
- Powerful tool, if used carefully!!

IR remote code: interrupt timer

- Arduino Uno has 3 timers: named 0, 1 and 2
- If you start programming interrupts on a timer, other function who use that timer will no longer work 2
- ATTENTION: delay(), millis, micros() uses timer0, IRreceiver uses timer1, tone uses timer 2

IR remote code: timers

- Timer 0 and 2 have 8bit resolution (can count till 255 (zero included))
- Timer 1 is a 16bit resolution timer: can count untill 65535
- 2 timer interrupts possible:
  - Overflow: when counter overflows (255 for timer 0 and 2)
  - Compare: compare against a value (most be smaller than the overflow)

IR remote code: timer setup

- X indicates timer number: 0, 1 or 2
- TCCRxA / TCCRxB: Timer/Counter Control Register: set type of timer, how fast it works …
- TCNTx Timer/Counter Register: the current timer value
- OCRxA/B: Output Compare Register A/B
- TIMSKx: Timer/Counter Interrupt Mask Register to enable which interrupts are used

IR remote code: Timer/Counter Control Register

TCCRxA								
Bit	7	6	5	4	3	2	1	0
0x80	COMxA1	COMxA0	COMxB1	COMxB0	-	-	WGMx1	WGMx0
ReadWrite	RW	RW	RW	RW	R	R	RW	RW

TCCRxB								
Bit	7	6	5	4	3	2	1	0
0x80	ICNCx	ICESx	-	WGMx3	WGMx2	CSx2	CSx1	CSx0
ReadWrite	RW	RW	RW	RW	R	R	RW	RW

IR remote code: Timer/Counter Control Register

- Clock selectbit:

CSx2	CSX1	CSX0	Description
0	0	0	no clock
0	0	1	clock/1
0	1	0	clock/8
0	1	1	clock/64
1	0	0	clock/256
1	0	1	clock/1024
1	1	0	ext clock falling
1	1	1	ext clock rising

IR remote code: Timer/Counter Control Register (example)

- We wish a 1s timer with timer1 (16bit)
  - CPU frequency = 16MHz
  - Take 1024 as prescaler: 1 0 1
  - To increment counter takes 1/16e6*1024 s = 64 microseconds
  - 1second / 64 microseconds = 15625
  - 16 bit = 65535 so counter does not overflow (ok)

IR remote code: Timer/Counter and Output Compare Register

- TCNTx contains the current timer value,
- Can also be preset if needed (timer starts from preset value

- OCRxA contains the value of the timer/counter we wish to compare too

IR remote code: Timer/Counter Interrupt Mask

- TIMSKx: set what kind of interrupt should be active:
  - TOIEx: if this bit is set: overflow interrupt is active
  - OCIExA: if this bit is set: interrupt is send when OCRxA is equal to the timer register TCNTx

IR remote code: Timer/Counter Interrupt Mask

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IR remote code: now implement the interrupt handle

- Use following function
- TOIEx: ISR(TIMERx_OVF_vect){
  }
- OCIExA: ISR(TIMERx_COMPA_vect){
  }
- Any variable inside this ISR functions need to be declared ‘volatile’ at beginning of file

IR remote code: how to set the right bits to timer registers?

- Use bitwise operators: |= (bitwise OR); &= (bitwise AND); ~ (NOT)
- Set timer to prescaler 1024: TCCR0B |= (1 << CS00 | 1 << CS02);
- Set timer to Clear Timer on Compare (reset when compared): TCCR0B |= (1<<WGM02);
- Stop timer: TCCR0B &= ~((1 << CS00) | (1 << CS01) | (1 << CS02))

IR remote code: interrupt code

```
// these variables will be used in program
volatile uint16_t counter = 1;
volatile uint16_t thisNote = 0;
volatile uint16_t counter_des = 0;

void setup() {
  cli(); // Disable all interrupts
  TCCR0A = 0;
  TCCR0B = 0;
  OCR0A = 156;
  TCCR0B |= (1<<WGM02);
  TIMSK0 |= (1 << OCIE0A);
  sei(); // Enable all interrupts
}

// Put this code where you want to start the melody
tuneSize = sizeof(melody2) / sizeof(int);
TCCR0B |= (1 << CS00);
TCCR0B |= (1 << CS02);

// Put this code where you want to stop the melody
TCCR0B  &= ~((1 << CS00) | (1 << CS01) | (1 << CS02))
```

IR remote code: interrupt code

```
ISR(TIMER0_COMPA_vect){ // Timer Interrupt Call (this code is executed when the interrupt is triggered)
  cli(); // disable all interrupts (we don't want other interrupts to interfere)

  if(counter >= counter_des){
    counter = 0;
    int noteDuration = (int)((1000 * (60 * 4 / tempo)) / durations2[thisNote] ); //duration in ms
    tone(buzzerPin, melody2[thisNote],noteDuration); // play tone(pin, note, duration)
    counter_des = (uint16_t) (noteDuration * 0.090); // next desired counter: the duration of the next note
is counted with timer0 this can count untill 156*1024/16*1 microseconds
    thisNote++; // increase note (next note of melody will be played)
    digitalWrite(LEDPIN,!digitalRead(LEDPIN)); // change led status (led will change according to melody

    if(thisNote > tuneSize){
      thisNote = 0; //reset note when melody is finished
    }
  }
  else{
    counter++; // increase counter
  }
  sei(); // enable all interrupts again
 }
```

Next Soiree Pratique

- Tuesday 3/11 at 19h30:
  - first session sumo robots: introduction arduino, information on ordering parts