ELECTRONIC SIGNALS SYSTEM FOR RAILWAYS SAFETY

- تحت اشراف /

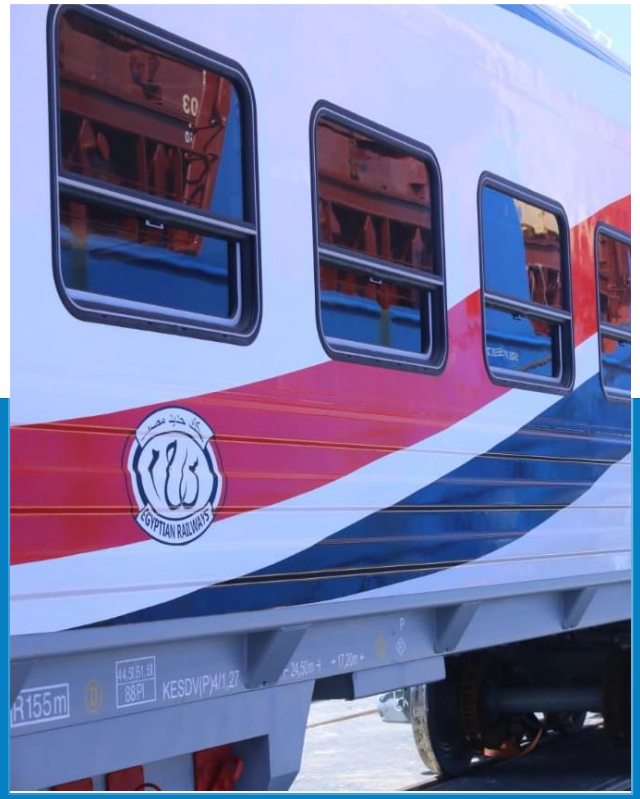
دكتور / حسين ابراهيم
مهندس / مصطفى الحاجري

الفرقة الثانية
برنامج الميكاترونيكس

OUR CONTENTS

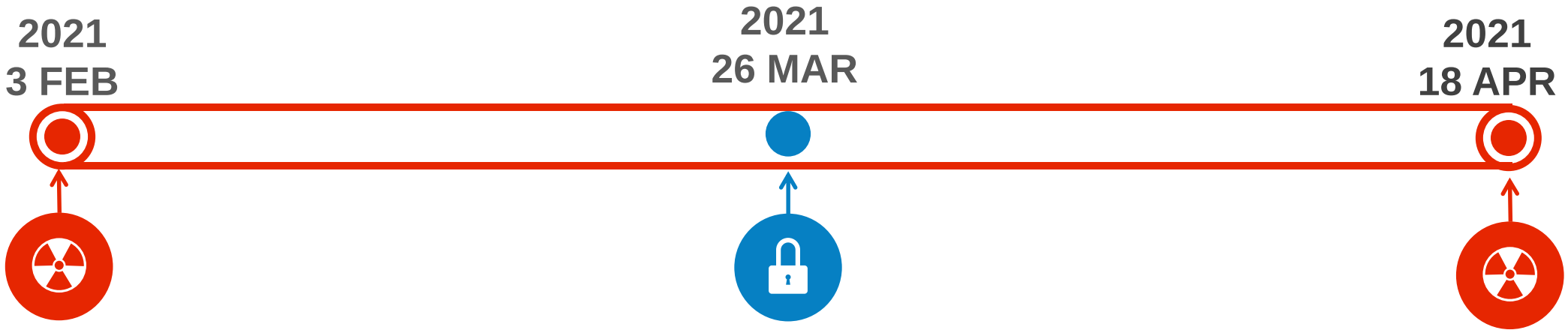
INTRODUCTION

الهيئة القومية لسكك حديد مصر (س ح م) تم تاسيسها في عام ١٨٥٣ و أشرف علي بنائها الخدويوي اسماعيل وهي شركة قطاع عام تمتلكها الحكومة المصرية بالكامل و تشغّل خطوط السكك الحديد المصرية والتي هي الثانية في العالم حيث تأسست بعد تأسيس السكك الحديد البريطانية بفترة وجيزة تعاني اليوم من خلل في منظومة الصيانة و تداعيات إهمال أصابها على مدى عقود فاتت مما يجعل معدل الحوادث عليها أعلى بكثير من نسب باقي دول العالم



و يبلغ عدد المحطات والمواقف و نقط البلوك على الشبكة أكثر من ٧٠٥ محطة منها عشرون محطة رئيسية في عواصم المحافظات في الدلتا والقناة و الوجه القبلي وبذلك تربط شبكة السكك الحديدية الوادي من أقصاة إلى أدناة على طول أكثر من ١٠٠٠ كيلو متر و تصل الخطوط الحديدية بين معظم المراكز العمرانية و الاقتصادية في البلاد مثل الموانئ على البحرين الأحمر و المتوسط و مراكز الشحن الخام و المصانع فضلا عن جميع المدن و المراكز الأخرى في شبكة هائلة و متسعة من الطرق الحديدية الحديثة المجهزة لتشغيل جميع أنواع القطارات ذات السرعات العالية عليها. لتأمين السلامة ولمنع الحوادث نحتاج إلى أنظمة تحكم بمسار القطار

بعض حوادث سكك حديد مصر

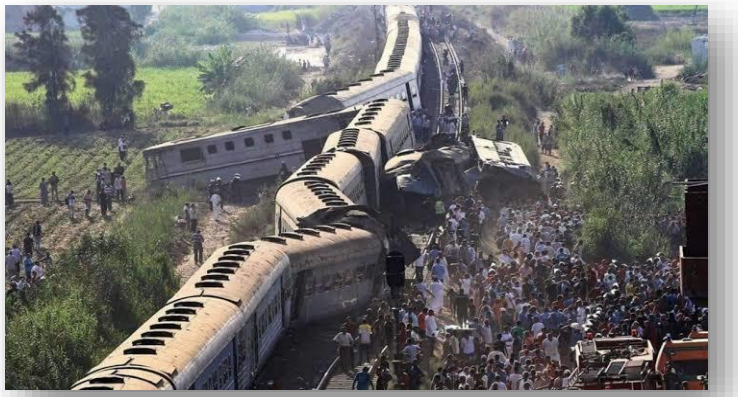


أثناء مرور قطار ٢٠١٠ «القاهرة / أسوان» على مزلقان فزارة المطور؛ بين محطتي ديروط والقوصية اقتحمت عربة نصف نقل مجهزة بونش، الحارة المخالفة للمزلقان وهو مغلق مما أدى إلى اختراق غراب الونش الموجود على العربة كابينة جرار القطار؛ ووفاة مساعد سائق القطار و٢ من عمال هندسة سكة متواجدين بالجرار.

اصطدام قطار مكيف بقطار ركاب من الخلف بدائرة مركز طهطا بسوهاج ما نتج عنه خروج ٣ عربات عن القضبان راح ضحية الحادث ٣٢ مواطنًا وأصيب ١٠٨ مواطن.

خرج قطار متجه من القاهرة الي المنصورة عن القضبان قرب محطة سكة حديد طوخ وراح ضحية الحادث عدد من المواطنين بالإضافة إلى إصابة ما يقرب من ١٠٣ أشخاص .

صور بعض الحوادث



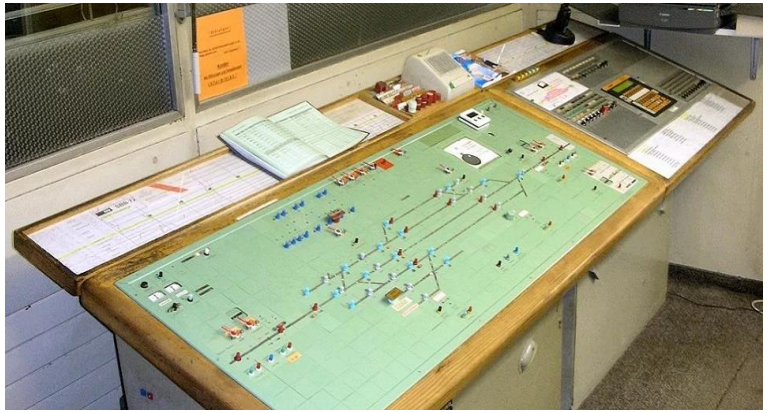
RAILWAYS

INTERLOCKING

- ☑ Mechanical
- ☑ Relay system
- ☑ Electronic

نظام التحكم الميكانيكي /

نظام التحكم الميكانيكي في السكك الحديدية هو نظام للتحكم عن بعد في التحويلات والإشارات المعدنية وكل العناصر المتحركة الأخرى التحريك عن بعد يتم بنقل القوة العضلية إلى العناصر المعنية عن طريق استخدام الأذرعة الحديدية المرتبطة ببكرات ومسننات وكابلات معدنية



نظام التحكم الكهربائي /

من مميزاته القدرة على تحويل قوانين سير القطارات إلى دارات كهربائية باستخدام الريلاي كما أن من الميزات الشاشة المعدنية رسم عليها مخطط للسكك في المحطة وزودت بمصابيح صغيرة مختلفة الألوان تساعد على تتبع حركة القطارات ومراقبة الإشارات الضوئية .

نظام التحكم الالكتروني /

في منتصف الثمانينات دخل الحاسوب عالم القطارات وظهر مايسمى بالنظام الإلكتروني للتحكم في السكك الحديدية. يتكون هذا النظام من ثلاث طوابق

طابق المراقبة -- طابق التحكم المركزي -- طابق التحكم بالعناصر الخارجية

من مزايا النظام الإلكتروني للتحكم في السكك الحديدية

صغر الحجم وأناقة التصميم

سهولة تطوير وتعديل النظام

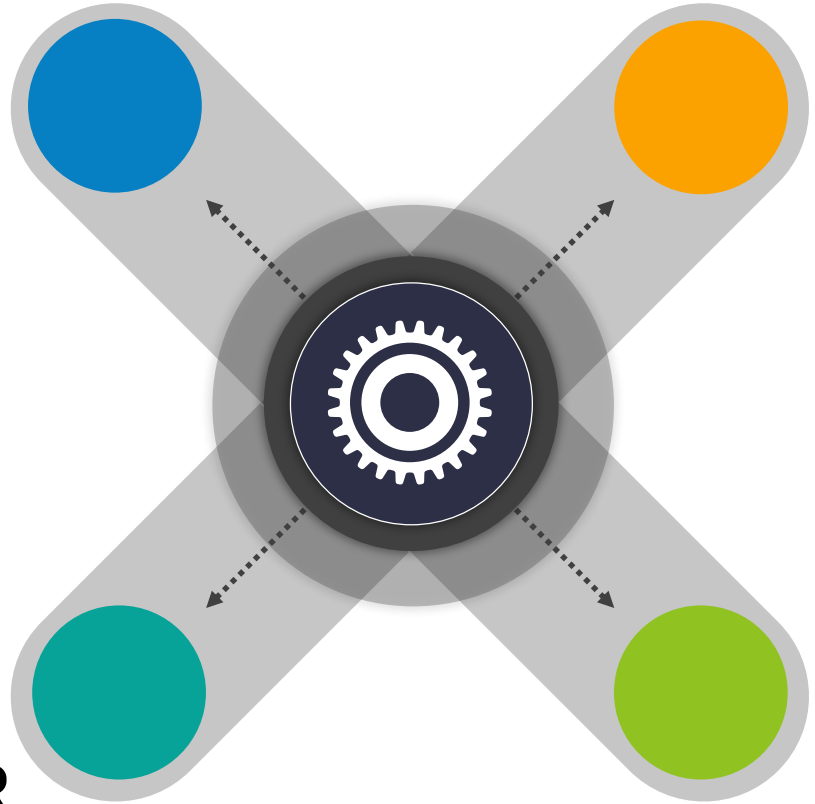
القدرة الفائقة على تزويد المراقب بالمعلومات الإضافية

ATC

و بعد كل هذه الحوادث فكرنا في تطوير شبكه السكه الحديد وعمل بعض وسائل الأمان .

RF WIRELESS

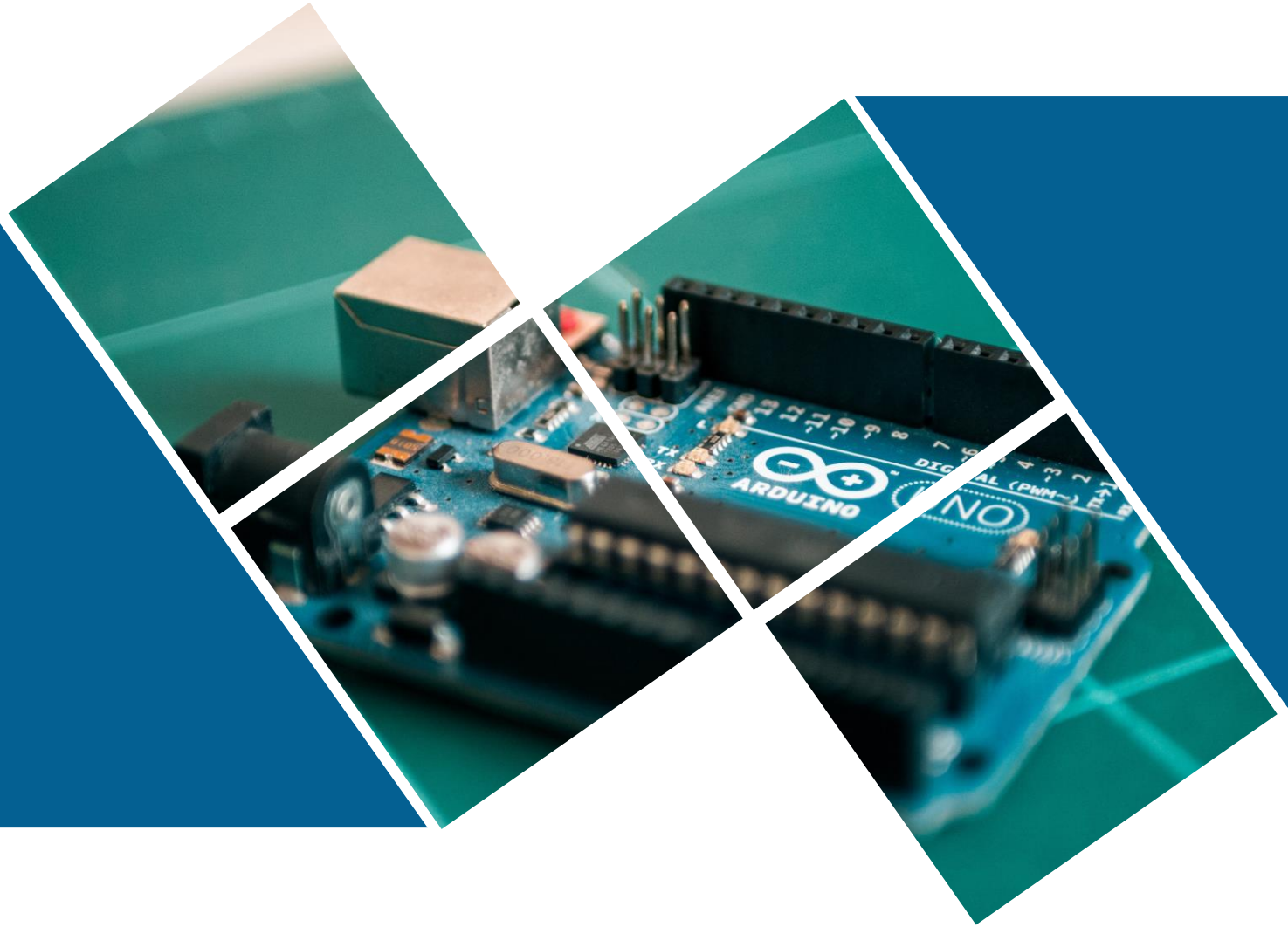
SERVO MOTOR - IR



LOAD CELL SENSOR

LED

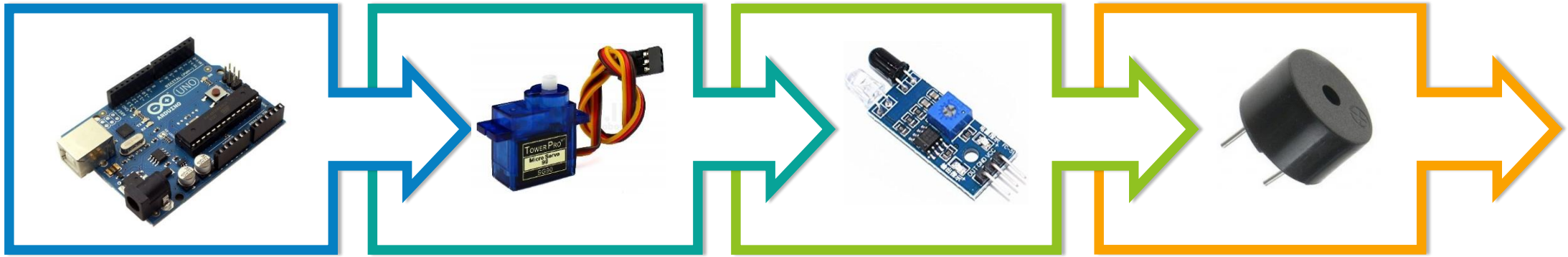
IR SENSOR - SERVO MOTOR CIRCUIT



CIRCUIT IDEA

When The Train Passes In Front Of The First Sensor, The Servo Motor Rotates 90 Degrees And An Alarm Bell Alerts Pedestrians At The Crossing. When The Train Passes Completely And The Second Sensor Receives A Physical Signal From The Movement Of The Train, The Engine Will Return To Its Normal Position And The Alarm Bell Will Stop Working.

CIRCUIT COMPONENTS



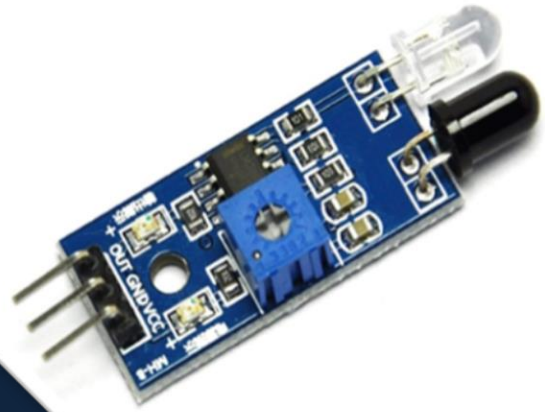
1st CONTROL UNIT ARDUINO UNO

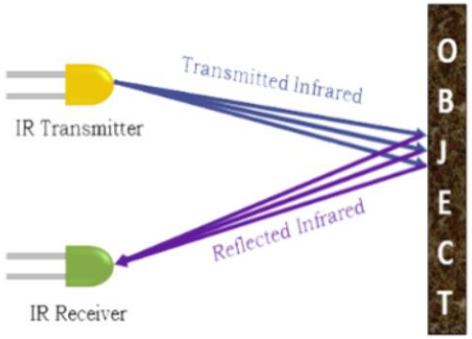
2st SERVO MOTOR

3st 2 SENSOR IR

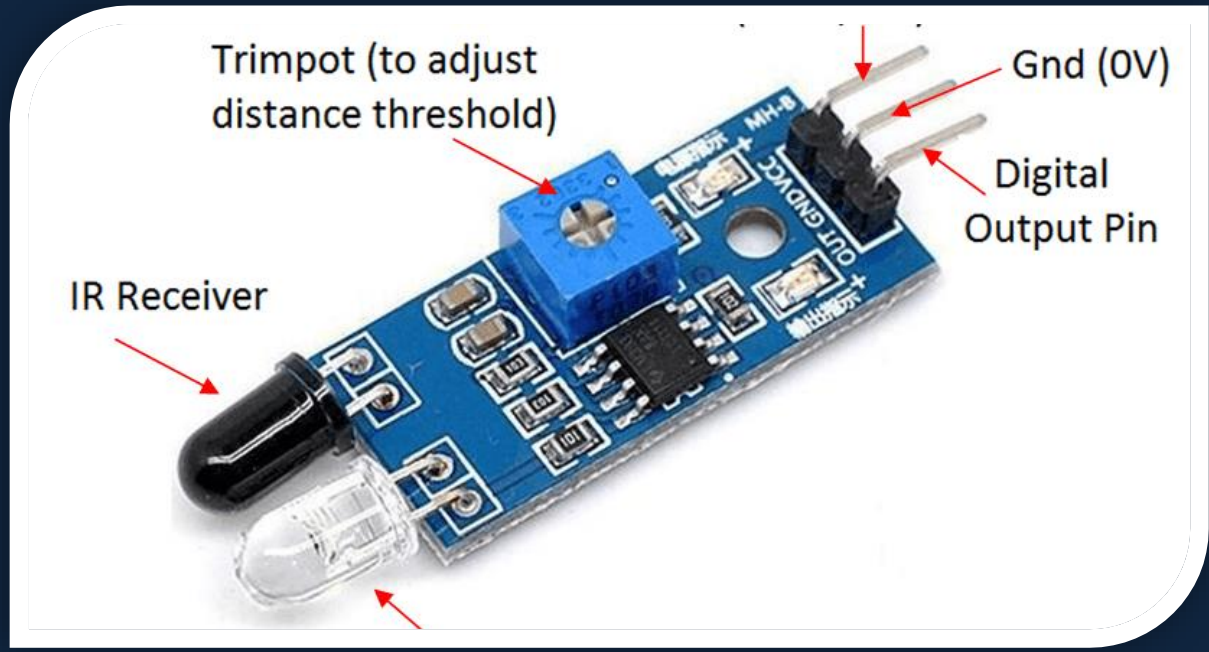
4st ALARM

Infrared IR Sensor





WORKING THEORY



CONFIGURATION

Uses

It Is Used In Motion Detectors

It Can Be Used Digitally Or Analogue

Used In Construction Services To Operate Lights And Alarm Systems

It Can Detect Colors

SERVO MOTOR

The servo motor is made up of four parts: a normal DC motor, a gear reducer, a position sensor, and a control circuit

A servo is a motor that allows precise control of angle, acceleration and speed, capabilities that an ordinary motor does not have

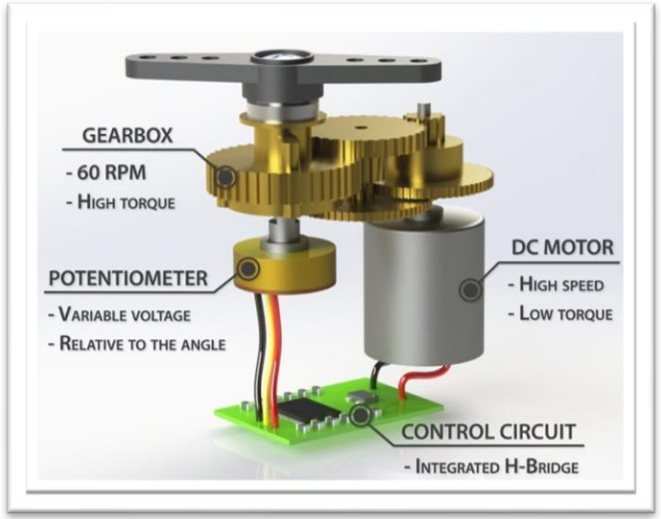
A wire (black/brown) is connected to ground, a wire (white/yellow) is connected to the console, and a red wire is connected to the power supply.

Features of the servo motor:

1- Superfast response, meaning that the engine speed reaches the required value in a short time.

2- The engine accepts repeated disconnection and connection operations, no matter how many.

3- High power for the size and power of the engine.



PROGRAMMING CODE

servo___buzzer-1

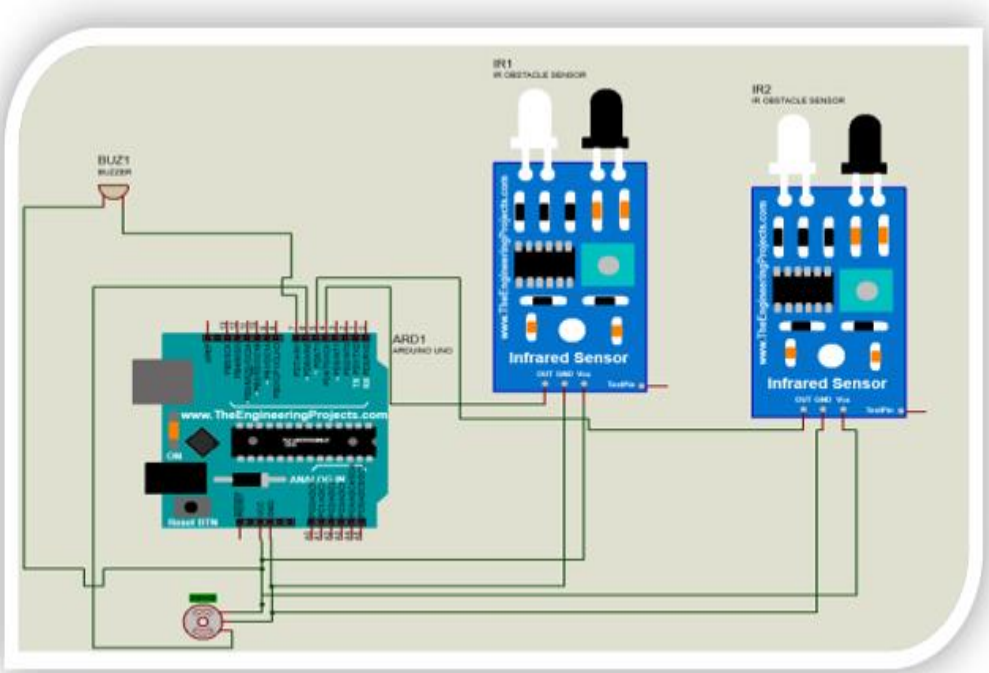
```
#include <Servo.h>
Servo tap1_servo;
Servo tap2_servo;
int IR_sensor1=3;
int IR_sensor2=2;
int val;
int val_1;

void setup() {

  pinMode(IR_sensor1,INPUT);
  pinMode(IR_sensor2,INPUT);
  tap1_servo.attach(9);
  tap2_servo.attach(8);
  pinMode ( 7 , OUTPUT);
  pinMode (0 , OUTPUT);
  pinMode (1, OUTPUT);

}
```

servo___buzzer-1 §

```
}
void loop() {
  val=digitalRead(IR_sensor1);
  if(val==0)
  {
    tap1_servo.write(0);
    tap2_servo.write(0);
     digitalWrite (0 , HIGH);
     delay (75);
          digitalWrite (0 , LOW);
     delay (100);
     digitalWrite (1 , HIGH);
     delay (75);

     digitalWrite (1 , LOW);
     delay (100);
          digitalWrite (1 , HIGH);
     delay (100);
     digitalWrite (0 , HIGH);
     delay (100);
```

servo___buzzer-1 §

```
    val_1=digitalRead(IR_sensor2);
if(val_1==0)
  {
    tap1_servo.write(90);
    tap2_servo.write(90);
      digitalWrite (0 , LOW);
      digitalWrite (1 , LOW);

  }
if( val==0)
{

    tone (7,600,250);
    delay(200);
    tone ( 7,300,150);
    delay(200);
     digitalWrite (7 , HIGH);

}
if (val_1==0){
      digitalWrite (7 , LOW);}
}
```



CONNECTION OF THE CIRCUIT

Connecting the sensor :

The two terminals, GRD, 5V are connected to the output of the GRD, 5V on the arduino. The control end is connected to an output from the digital outputs on the arduino.

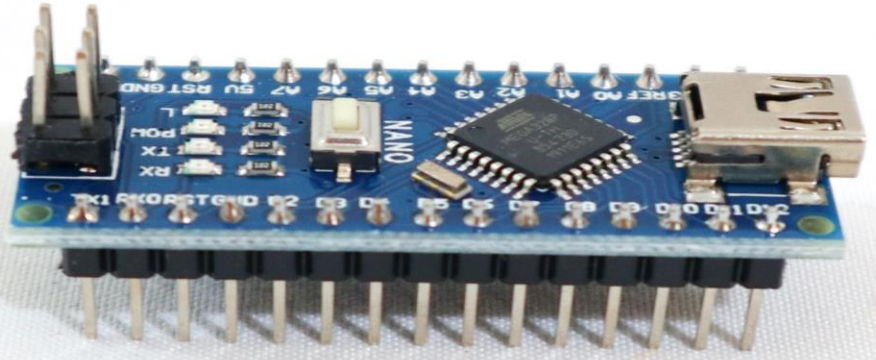
Connecting the servo motor :

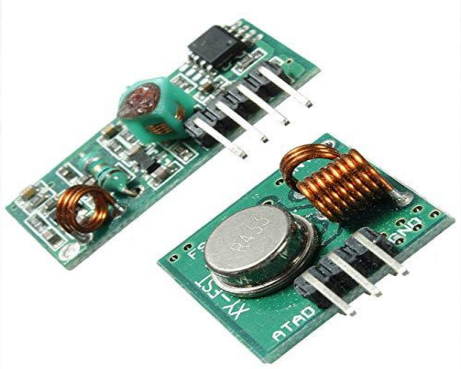
The terminals GRD, 5V, are connected to the output of the GRD, 5V on the arduino and The control terminal is output from the digital outputs in the arduino.

Connecting the alarm bell :

The positive terminal is connected to the output of the Arduino control outputs, and the negative terminal to GND.

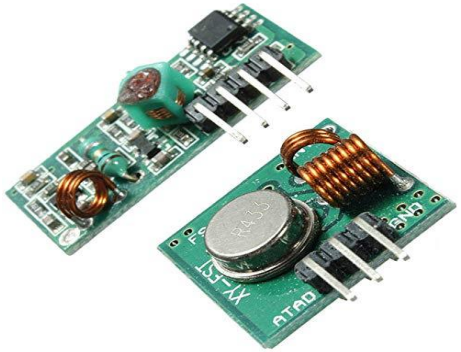
RF TRANSMITTER – RECEIVER WITH ARDUINO NANO





RF Transmitter – Receiver

It Is A Device Works To Transmitter And Receiver To Signals



How it works ?

It Works By Detecting A Change In Electromagnetic Properties

It Uses An Electromagnetic Field Rather Than A Purely Magnetic Or Electric Field

Because It Has Magnetic And Electrical Properties At The Same Time.

Why do we use it ?

If We Want To Communicate Some Devices Without Any Wire We RF Modules Is One Of The Ways.

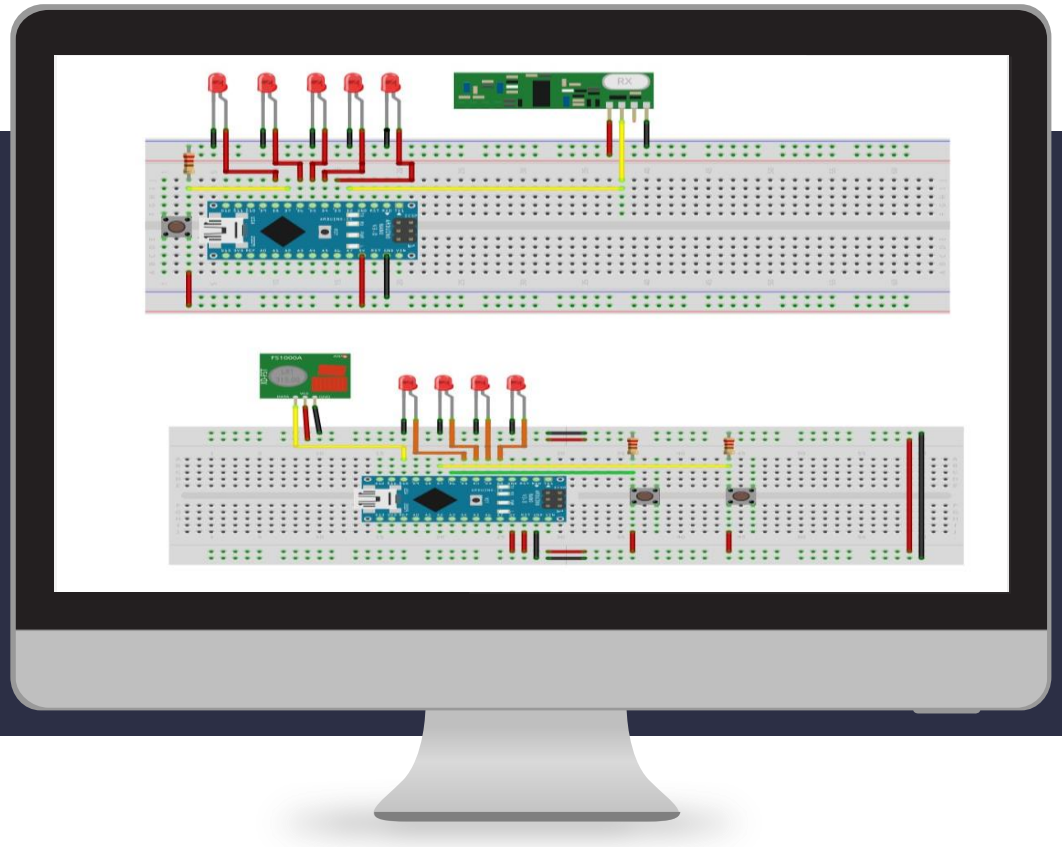
Advantages of RF :

It has a high signal-to-noise ratio which can be maximized by optimizing the sensor design for a particular application.

Unlike inductive sensors its output is speed-independent

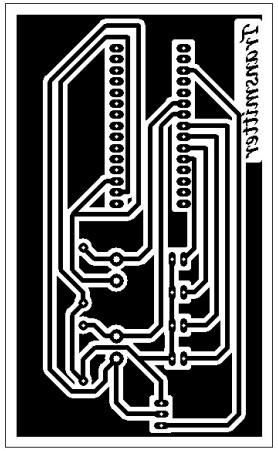
APPLICATIONS

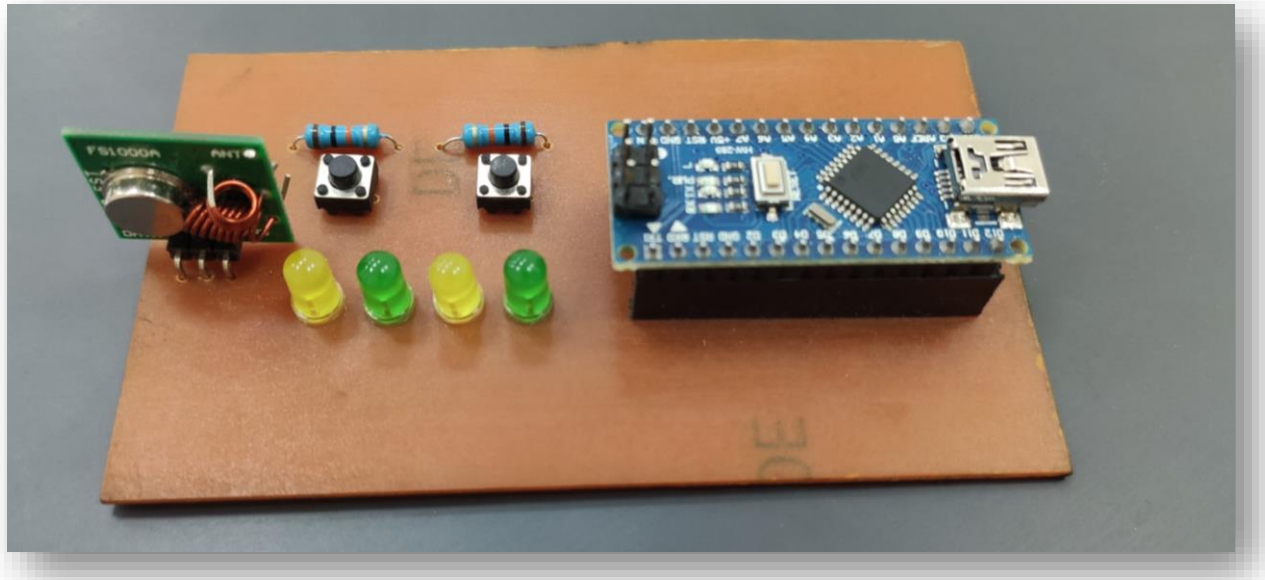
- ☑ Smart home
- ☑ Material recycling
- ☑ Our project /
- ☑ Connected to two trains if they are within 500 meters of each other and on the same rails the train will be stopped

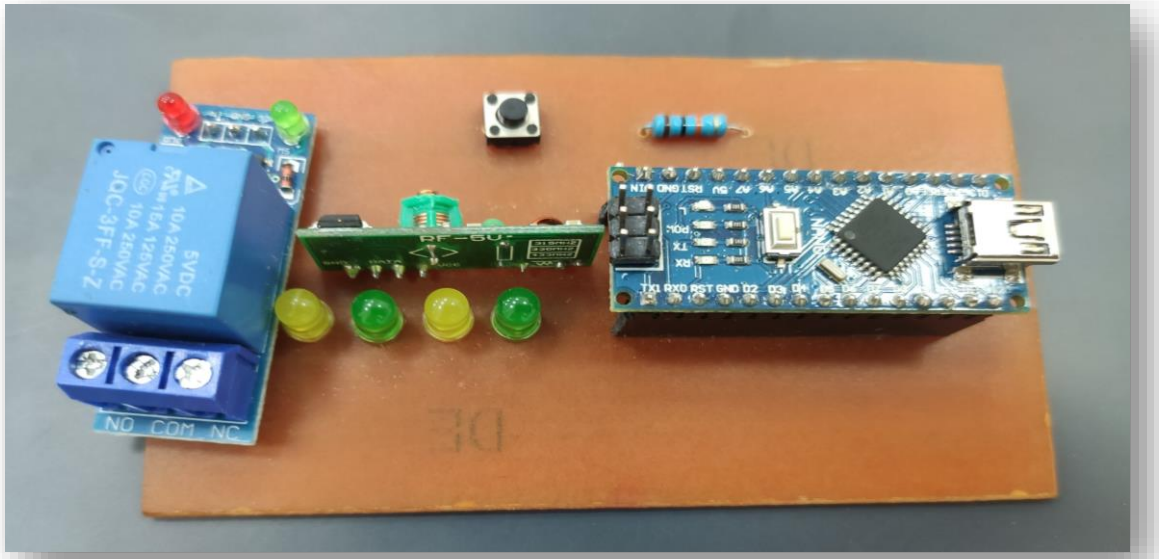


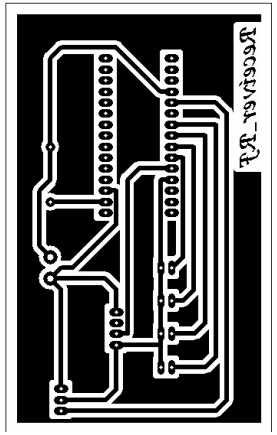
CONNECTION WITH ARDUINO

TRANSMITTER









RECEIVER

PROGRAMMING CODE RECEIVER

3_Receiver_RC §

```
#include <RCSwitch.h>

const int btnSelectLinePin    = 7;

const int ledNormalLineAPin = 3;
const int ledNormalLineBPin = 4;

const int ledFaultLineAPin  = 5;
const int ledFaultLineBPin  = 6;

const int trailRelayPin     = 8;

int lineState     = 0;

bool lineAFlag  = true ;
bool lineBFlag  = false ;

bool statusFaultlineAFlag    = false ;
bool statusFaultlineBFlag    = false ;

RCSwitch mySwitch = RCSwitch();
```

3_Receiver_RC §

```
void setup() {

  Serial.begin(115200);

  mySwitch.enableReceive(0);
  /* Arduino Uno Receiver on
  interrupt 0 =>that is pin #2
*/
  pinMode(ledNormalLineAPin   , OUTPUT );
  pinMode(ledNormalLineBPin   , OUTPUT );

  pinMode(ledFaultLineAPin   , OUTPUT );
  pinMode(ledFaultLineBPin   , OUTPUT );

  pinMode(trailRelayPin      , OUTPUT );

  pinMode(btnSelectLinePin     , INPUT  );

  lineState     = 0;

  Serial.println("Hello Trains Receiver");
```

3_Receiver_RC §

```
  if ( lineAFlag ) {

//      Serial.println("Train on Line A");
     digitalWrite(ledNormalLineAPin    ,HIGH );
     digitalWrite(ledNormalLineBPin    ,LOW );
//      mySwitch.send("A", 24);
//      mySwitch.send(1, 24);

  } else {
//     Serial.println("Train Not Stopped on Line A");
    digitalWrite(ledNormalLineAPin    ,LOW );

  }

  if ( lineBFlag ) {

//      Serial.println("Train on Line B");
     digitalWrite(ledNormalLineBPin    ,HIGH );
     digitalWrite(ledNormalLineAPin    ,LOW );
//      mySwitch.send("A", 24);
//      mySwitch.send(1, 24);
```

PROGRAMMING CODE TRANSMITTER

3_Transmiter_RC §

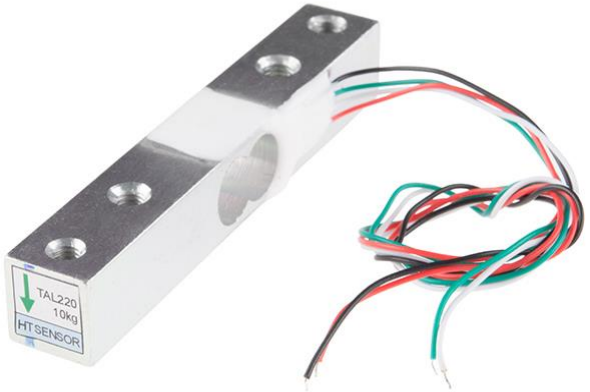
```
#include <RCSwitch.h>

const int btnSelectLinePin    = 6;
const int btnSelectStatusPin = 7;

const int ledNormalLineAPin = 2;
const int ledNormalLineBPin = 3;

const int ledFaultLineAPin   = 4;
const int ledFaultLineBPin   = 5;

int lineState     = 0;
int statusState   = 0;

bool lineAFlag   = true ;
bool lineBFlag   = false ;

bool statusNormalFlag   = true ;
bool statusFaultFlag    = false ;

RCSwitch mySwitch = RCSwitch();
```

3_Transmiter_RC §

```
void setup() {

  Serial.begin(115200);

  pinMode(ledNormalLineAPin   , OUTPUT );
  pinMode(ledNormalLineBPin   , OUTPUT );

  pinMode(ledFaultLineAPin   , OUTPUT );
  pinMode(ledFaultLineBPin   , OUTPUT );

  pinMode(btnSelectLinePin     , INPUT   );
  pinMode(btnSelectStatusPin   , INPUT   );

/* Arduino Uno Transmitter is
connected to Arduino Pin #10
*/
   mySwitch.enableTransmit(10);

  lineState     = 0;
  statusState   = 0;

  Serial.println("Hello Trains Transmitter");
```

3_Transmiter_RC §

```
void loop() {

  lineState    = digitalRead(btnSelectLinePin);
  statusState = digitalRead(btnSelectStatusPin);
  if ( lineState == HIGH ) {
      Serial.println("lineState Pressed");

      if ( lineAFlag  ) {
           lineAFlag   = false ;
           lineBFlag   = true ;
      } else {
           lineAFlag   = true ;
           lineBFlag   = false ;
      }
  }
  if (statusState == HIGH) {
      Serial.println("statusState Pressed");
      if ( statusNormalFlag  ) {
        statusNormalFlag   = false ;
        statusFaultFlag   = true ;
      } else {
        statusNormalFlag   = true ;
```



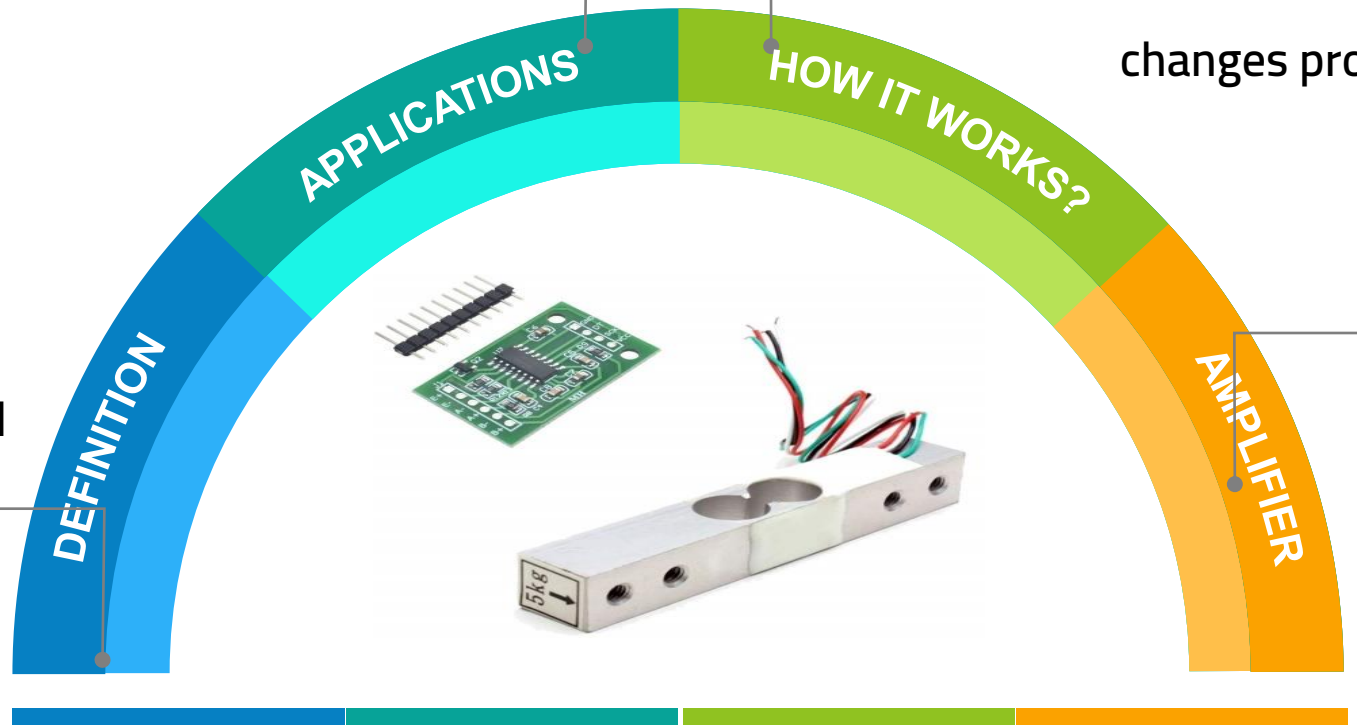
LOAD CELL PROTECT
TRAINS & SLIPWAY

LOAD CELL SENSOR

- On-board weighing
- Platform weighing
- Belt scales
- Hopper scales
- Weighing agricultural produce

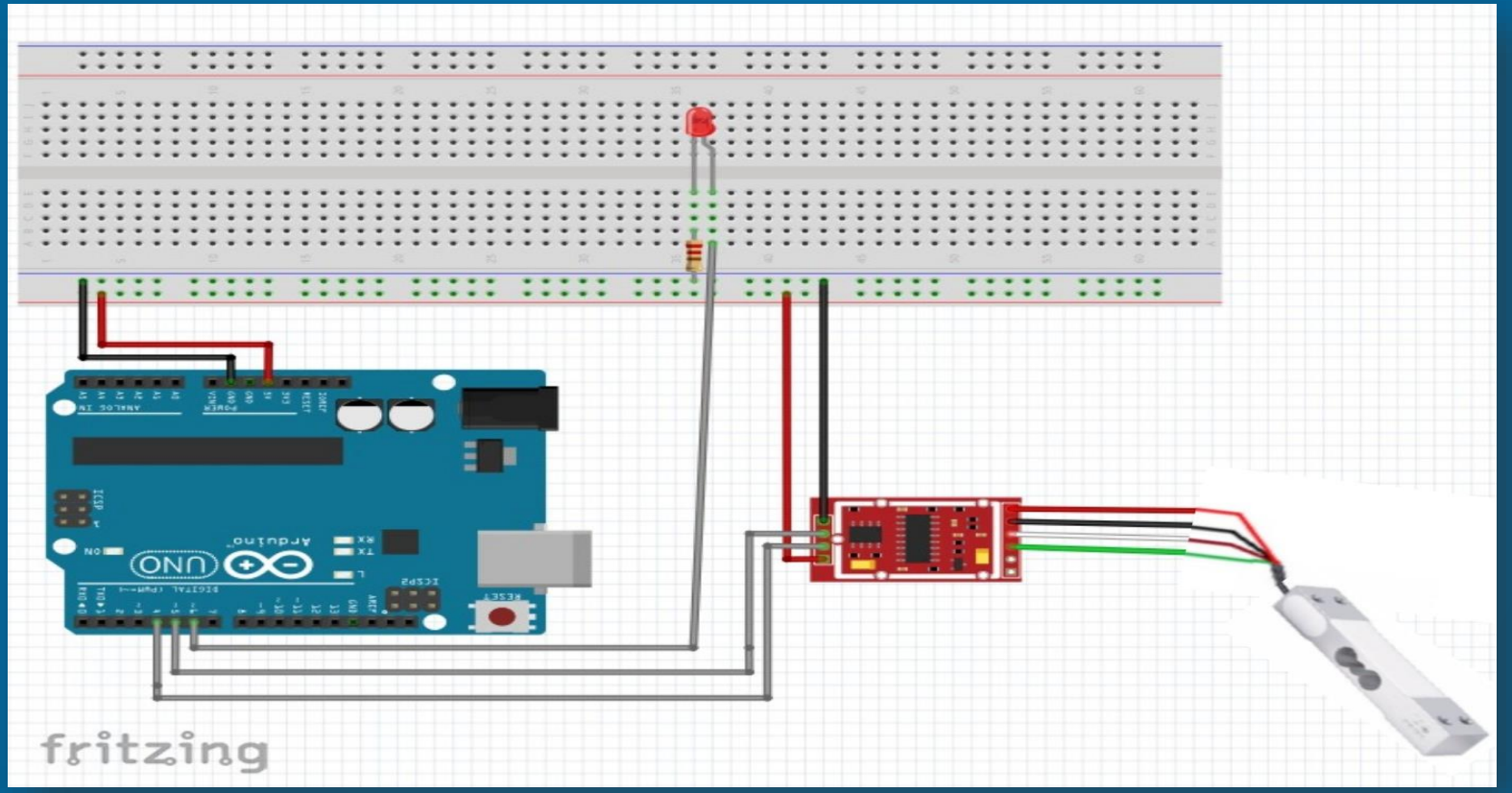
It converts a force such as tension, compression, pressure, or torque into an electrical signal that can be measured and standardized. As the force applied to the load cell increases, the electrical signal changes proportionally.

A load cell is a force transducer. It converts a force such as tension, compression, pressure, or torque into an electrical signal that can be measured and standardized



Output signal is very small for strain gauge load cells, output signal must go through load cell amplifier to improve signal quality before use by displays or control systems

CONNECTION WITH ARDUINO



PROGRAMMING CODE

weight3

```
//HX711 constructor:
HX711_ADC LoadCell(HX711_dout, HX711_sck);

const int calVal_eepromAdress = 0;
long t;

int max_weight = 200 ;

void setup() {
  Serial.begin(115200);
  delay(10);
  Serial.println();
  Serial.println("Starting...");

  pinMode( ledPin , OUTPUT );

  LoadCell.begin();
  long stabilizingtime = 2000; // preciscion right after power-up can be im
  boolean _tare = false; //set this to false if you don't want tare to be p
  LoadCell.start(stabilizingtime, _tare);
  if (LoadCell.getTareTimeoutFlag() || LoadCell.getSignalTimeoutFlag()) {
    Serial.println("Timeout, check MCU>HX711 wiring and pin designations");
```

weight3 §

```
  _resume = false;
  Serial.print("Save this value to EEPROM adress ");
  Serial.print(calVal_eepromAdress);
  Serial.println("? y/n");
  while (_resume == false) {
    if (Serial.available() > 0) {
      char inByte = Serial.read();
      if (inByte == 'y') {
#if defined(ESP8266)|| defined(ESP32)
        EEPROM.begin(512);
#endif
        EEPROM.put(calVal_eepromAdress, newCalibrationValue);
#if defined(ESP8266)|| defined(ESP32)
        EEPROM.commit();
#endif
        EEPROM.get(calVal_eepromAdress, newCalibrationValue);
        Serial.print("Value ");
        Serial.print(newCalibrationValue);
        Serial.print(" saved to EEPROM address: ");
        Serial.println(calVal_eepromAdress);
        _resume = true;
      }
```

weight3 §

```
void loop() {
  static boolean newDataReady = 0;
  const int serialPrintInterval = 0; //increase

  // check for new data/start next conversion:
  if (LoadCell.update()) newDataReady = true;

  // get smoothed value from the dataset:
  if (newDataReady) {
    if (millis() > t + serialPrintInterval) {
      float i = LoadCell.getData();
      Serial.print("Load_cell output val: ");
      Serial.println(i);
      if ( i > max_weight ) {
         Serial.print("Exceeded");
         digitalWrite ( ledPin , HIGH );
      } else {
         digitalWrite ( ledPin , LOW );
      }

      newDataReady = 0;
      t = millis();
```

NOTIFY THE DRIVER OF THE SEPARATION OF RAIL CARS

CIRCUIT IDEA

- Knowing the communication between the cars and if a car was separated from the train.
- We can control whether the cars on the train are on or off
- By placing a LED in each car, and when the car is separated, the LED is Turned off .

CONNECTION FOR THE LED

We control the LED by connecting it to a battery with the train car

COMPONENTS FOR 3 CARS

✓ 6 LED -- 1 battery -- Display for 6 LED

CONNECTION

- Connecting LED positive to battery positive and LED negative to battery negative from the car .
- Each LED of a car and with the battery.
- Then we connect LED from car to LED that the driver can see it in the driving car, Each LED from the cars is connected to the LED in the display in the driving car via positive with positive and negative with negative .

RECOMMENDATIONS

Positive Train Control (PTC) is a processor-based/communication-based train control system designed to prevent train accidents. .

PTC technology is capable of automatically controlling train speeds and movements should a train operator fail to take appropriate action for the conditions at hand. For example, PTC can enforce a train to a stop before it passes a signal displaying a stop indication, or before diverging on a switch improperly lined, thereby averting a potential collision. PTC systems required to comply with the requirements of Subpart I must reliably and functionally prevent:

- Train-to-train collisions
- Overspeed derailments
- Incursion into an established work zone

A TYPICAL PTC SYSTEM INVOLVES TWO BASIC COMPONENTS:

- Speed display and control unit on the locomotive
- A method to dynamically inform the speed control unit of changing track or signal conditions

INTELLIGENT DATABASES

- Railroad owners and railroad cars take advantage of the information provided by big data to improve railroad safety.
- Derailment Detection and Rail Fracture Devices
- India has some of the busiest and most widely used railways in the world. It also had some of the worst train accidents. This year alone has seen several major incidents, including a terrorist attack in March where a bomb went off.

- ✓ Currently, the Indian Institute of Technology Kanpur (IIT Kanpur) is developing skew detectors, which will be in the form of on-board equipment. The device will integrate with existing brake mechanisms to reduce losses from towing a derailed vehicle, according to IIT Kapur. There are currently no devices on the Indian Railways to detect deviation potentials.

- ✓ The Indian Institute of Technology, Madras (IIT Madras) is developing a crack detection system on railway tracks; So far there is no automatic system for this. Currently, rail operators rely on ultrasound tests conducted by engineers every two months to check track conditions, as well as reports from train drivers. IIT Madras hopes to develop a system that digitizes the ultrasound testing process.