

IoT in Railway Safety System

Rushikesh Manohar Zunjarrao¹ Sarvesh Sujeet Joshi²

^{1,2}Department of Information Technology

^{1,2}B. K. Birla College of Arts, Science & commerce Kalyan (Autonomous), India

Abstract— This paper proposes the use of internet of things in our railway safety system. In our India there is lack of management of safety in railway; for example we see in Monsoon season there is water over flow on the track, lack of safety announcement in the correct time and vehicle crossing gate not work properly. Those are many problems occur daily. So we can use internet of thing device that control the all that safety measures. We use microcontroller, sensors and actuators to build our project. We use microcontroller as Arduino Uno which is cheap, better execution speed, GPIO and memory. We are using sensors like RFID sensor, water level sensor and actuators like LCD display, speaker, servo motor, LED light, water pump. We also use some shields in our project like SD card shield and GSM shield. Basically this paper is proposes a novel approach to designing our project base on Internet of Things.

Keywords: Internet of Things, Smart Railway, Arduino Uno, Water Level Sensor, Breadboard

I. INTRODUCTION

In India railway has been playing a main role of public transportation from 19th century. This provides lots of economy to India. Hundred years passed but we have not improved the condition of the railway safety systems. There is always news in the TV. When there is 24 hours rain the water overflows on our railway tracks and platforms. Many times our trains are late. So many passengers stuck in the stations and they are late for office and collages. We see many times the safety announcements are also late and vehicle gates are not proper working.

For these reasons we build one project which is an IoT project. In this project we make a device which track trains and give the proper location of the trains. The devices also take care of safety announcements, vehicle gates, and excess water on the track. So we use microcontroller, sensors, actuators, shields and physical object that are work as single unit.

We use an arduino as a single board microcontroller. For keeping attention on the trains and water level we use the two sensors one is rfid sensor and other is water level sensor. RFID sensor keeps attention on the trains and water level sensor keeps attention on water level of the tracks. They both get the relative data and give it to the arduino. Arduino act as a microcontroller that process the data and give response by actuators such as LCD screen, water pump, sound, servo, traffic, SD card shield, GSM shield, jumper wires, breadboard, toy train for initial prototyping.

A. Arduino UNO:

It is a simple platform for hardware and software. It is an important component of the tracking system. All sensors and other components are connected to it. Arduino UNO has its own software which can run the specific code for different sensors in C++ language. It is open source software. Arduino UNO has various different pins which can perform different

functions. Arduino Uno is based on Atmega 328p microcontroller.

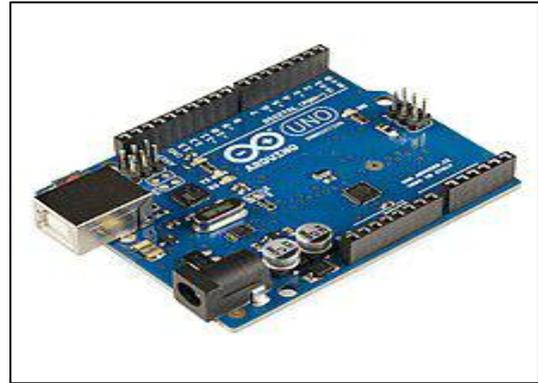


Fig. 1: Arduino Uno[1]

B. RFID Sensor:

Radio frequency identification sensor is used for tracking purposes. It is used for the actual tracking of the train. This sensor has its object with a specific id which it can detect or sense it. So if the object is attached to the car or railway then the sensor can sense it. It can also tell the id of the object which is sensed.



Fig. 2: RFID Sensor[10]

The RFID sensor has two kits; one is rfid transmitter and rfid receiver. In rfid kit we have two transmitters that are card and tag.

C. Breadboard:

Arduino has various pins, but for more sensors, actuators and components to connect to the Arduino, the number of pins with specific purpose are insufficient, so for the connection purpose, breadboard is used. This is how we could connect many sensors to the Arduino and can make an appropriate project.

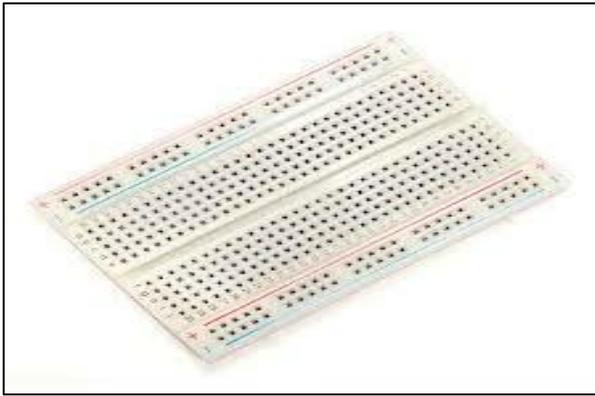


Fig. 3: Breadboard[11]

D. Water Level Sensor:

The water level sensor keeps attention on the level of the water from the particular surface. Water level sensor identifies the point at which a water level is below minimum level or is above maximum level.



Fig. 4: water level sensor[6]

E. GSM Shield:

The GSM shield is used for sending message. GSM stands for Global System for Mobile Communications. The GSM shield work just like a mobile phone. GSM shield also provide GPRS technology. It provides data communication to access the internet. In this project we use GSM shield for sending the message to the passengers with a reason, why the train is being delayed or is arrived early.



Fig. 5: GSM shield [1]

F. Traffic Signal:

Traffic signal is used for the controlling the pedestrian from crossing the path. It is actually linked to the RFID sensor. If the sensor detects the object, then the traffic signal is activated and it will turn red for stopping the pedestrians from crossing the train route. The traffic signal will be green when the sensors didn't find any object.



Fig. 6: Traffic Signal [12]

G. Water Pump:

Water pump moves the water from the train route. The water from the route is moved to the different water storage area or could be sending to the sea. It is very useful as it can prevent train lags. Water pump is activated if the water level on the route raises to the certain limit. Water pump controls the water level to a limit where the train can run.

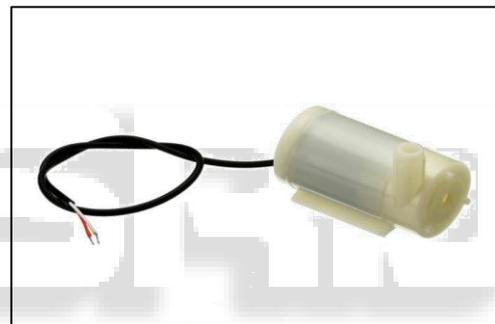


Fig. 7: water pump[13]

H. Relay:

Relay is an important component for the water pump. It actually gives power supply to the water pump. It detects the water level and energizes or de energizes the water pump. Due to water pump and relay, the water level on the route is controlled automatically.

I. LCD screen:

LCD screen is used for showing the output. LCD screen will display a message for people to stop crossing the train route. We can connect the LCD screen to the arduino and code it using the Arduino software. It can display as we want using the modification in the code



Fig. 8: LCD Screen[14]

J. SD-Card Shield:

It is a shield which is connected to the Arduino board. SD card has to be inserted in the shield. Using this shield, we can expand the storage. It is connected to the SPI port of the Arduino board.

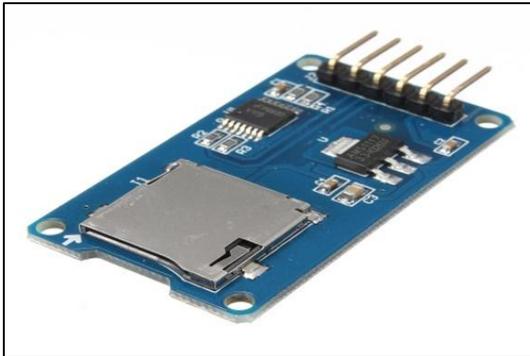


Fig. 9: SD card Shield[15]

K. Servo Motor:

A servo motor is an electric device used for control of angular rotation. We use this motor for the vehicle gate of the railway crossing roads. We connect motor with the arduino through breadboard with the help of jumper wires. The rotation angle of the servo motor is controlled by giving a PWM signal. A change in the rotation angle and direction of the motor is depending on the width of the PMW signal.



Fig. 10: Servo motor[16]

II. METHODOLOGY

We are designing here a project which consists of components that we are discussed in introduction part.

Here we use Arduino Uno; it is the single-board microcontroller based on the ATmega328P. It has fourteen digital input/output pins of which six can be used as PWM outputs, six analog inputs, a sixteen MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support as the microcontroller in our project. We connect arduino board to power by cable and battery. We connect many sensor, actuators, through breadboard for working of our project as follows

We connect the arduino board to our first sensor which is RFID sensor. The RFID sensor gets the details of the train and tells to the arduino that there is train passing through this location. We connect RFID sensor to arduino as follow.

Connect SDA pin of rfid sensor to Digital pin 10 of arduino, connect SCK to Digital pin13, connect MOSI of rfid sensor to Digital pin 11, connect MISO to Digital pin 12, let IRQ pin remains unconnected, connect GND of RFID sensor to GND of arduino, connect RST pin to Digital pin 9 of arduino, connect power pin to 3.3V power of arduino

Then we connect the second sensor to our arduino this sensor is known as water level sensor. Water level sensor get the details of the environment whether there is water overflow on the track or not and gives this information to the arduino; arduino fetch the information and take the decision of pumping from area of excess water. The connection of water level sensor to arduino as follow:

+ (power)	+5 volt
-(GND)	GND
S (signal)	Analog pin A0

Now we will connect some actuators to the arduino board with the interface of breadboard. Arduino pins with specific purpose are insufficient, so for the connection purpose, breadboard is used. There is no need for soldering while creating connection with arduino and sensor, actuators. We are connecting some registers, relays, crystals, Potentiometer to the breadboard for the sufficient voltage to actuators.

Let's connect first LCD screen to arduino. For this purpose we required Solder less Breadboard, Potentiometer (10k ohm), LCD Screen (16x2), Jumper wires. Connect the top and bottom pins on your potentiometer to GND and 5v rails. As you twist this potentiometer you will control contrast. We connect Pin 4 of the LCD to pin 12 on our Arduino board. This will be the register select pin. Connect Pin 5 of the LCD to ground. Connect Pin 6 of the LCD to pin 10 on our Arduino. This is the data enable pin this pin we will use later. We are using data pin 4, pin 5, pins6 and 7 for our LCD screen. This represents 4 bits of data, known as a nibble. The LCD screen has the capability for 8-bit parallel communication but 4 bit will be adequate for our project. Connect those pins to 4 pins on your Arduino, we use 5,4,3,2 respectively. Then the code which we have uploaded in the arduino will display on the LCD screen.

Now we connect servo motor to the arduino. A servo motor is an electric device used for control of angular rotation. We use this motor for the vehicle gate of the railway crossing roads. We connect motor with the arduino through breadboard with the help of jumper wires. We connect the positive terminal of the servo motor to the +5 voltage of the arduino board, GND pin to GND pin of arduino and the signal pin to the PWM signal pin of arduino which is digital pin 11. The rotation angle of the servo motor is controlled by giving a PWM signal. In this project Servo motor turn up and down in 45 degree of angle. If the train is passing the vehicle gate then the servo motor turns off the gate. Then no vehicle can cross the track. When the train has passed the gate then servo motor automatically ON the gate and then vehicles can cross the track. These all operations are handled by the arduino with the help of RFID sensor.

We connect the traffic signal which monitors vehicle driver to stop or leave. This connection of the traffic signals as: we connect the red, yellow and green led to make the traffic signal. They all have two pins (+, GND). Those all led

we combined in one and connect to arduino with help of breadboard; also we get the help of registers for voltage. Connect digital pin 2 to the positive terminal of the green LED, digital pin 3 to the positive terminal of the yellow LED, digital pin 4 to the positive terminal of the red LED. Add a 100-ohm resistor to each of the negative terminal of LED and it connects to GND of arduino.

We have connect the speaker to the platform which announce some safety instructions like some fast train going to cross the platform, then RFID sensor indicate the particular fast train and it will give proper instructions to the passengers on the platform. For this application we required SD card shield. Arduino don't have enough storage to store particular audio files, we are using SD card shield. Connect VCC with 5V in the Arduino, then, connect the GND of SD card to the ground of Arduino, connect CS to digital pin 14, connect SCK to digital pin 13, MOSI connect to the digital pin 11 and lastly connect MISO to digital pin 12. First we have to upload the WAV audio file which announce should be given to passenger. Now we can connect the speaker to the arduino board. For the connection we connect one pin of the speaker to the GND of arduino board and other pin to the digital pin 9 of the arduino. Speaker announces the safety instruction and at the perfect time that we code and wav file is uploaded into arduino and SD card shield.

We already connect water level sensor to the Arduino. A water level sensor detects the water level and gives details to arduino. If water level is higher than water pump remove the water from track or platform. Connection of water pump to arduino includes relay. We use 12v relay. Relay is a switch used to turn on and off circuit by low level signal. So we connect water pump to arduino with the help of relay. Wire of the relay is connected as below. Connect 12v pin to the digital pin 13 of arduino, and VCC to +5v, and ground to ground connection. Then connect relay to the water pump.

In this paper we are also explaining about the main application of our project which is; if train will be late then our device automatically send the message to passengers. For this purpose we use GSM shield for sending the message through arduino. GSM shield contain SIM card slot which is use to send the message. While connecting GSM shield to arduino, the shield is directly put on the top of arduino. Digital pins 2, 3 and 7 are reserved for communication between the Arduino and shield and these pins cannot be used by other devices.

III. CONCLUSION

If we apply this project into the real life then it will definitely reduce problems which are face by citizens regarding the train's issues. There is a need of such kind of plans in railways. It will be a help for everyone.

ACKNOWLEDGEMENT

I wish to express my wholehearted appreciation and deep sense of heartfelt gratitude to my guide Prof. Swapna Nikale, Department Of Information Technology, B.K. Birla College of Arts, Science & Commerce for her generous help, excellent guidance, lucid suggestions and encouragement throughout the course of this work. Her concrete directions

and critical views have greatly helped me in success full completion of this work.

REFERENCES

- [1] <https://www.arduino.cc>
- [2] <https://pimylifeup.com/arduino-traffic-light-project/>
- [3] www.electronicwings.com
- [4] <https://core-electronics.com.au/tutorials/use-lcd-arduino-uno.html>
- [5] <https://microcontrollerslab.com/water-level-sensor-interfacing-arduino/>
- [6] <https://randomnerdtutorials.com/security-access-using-mfrc522-rfid-reader-with-arduino/>
- [7] J. Kim, S.W. Choi, Y.-S. Song, Y.-K. Yoon, and Y. K. Kim, "Automatic train control over LTE: Design and performance evaluation", *IEEE Communications Magazine*, vol. 53, no. 10, pp. 102–109, Oct. 2015.
- [8] S.-G. Park, S.-T. Song and C.-M. Jung, "Analysis of the Status of the Railway Facility Maintenance and Its Implications", 2013 Autumn Conference and Annual Meeting of the Korean Society for Railway, vol.2013, no.11, pp.383-389, Nov. 2013.
- [9] <https://www.robomart.com/buy-rc522-rfid-reader-writer-arduino-compatible-online-india>
- [10] <https://www.wiltronics.com.au/wp-content/uploads/images/components/400-hole-breadboard-300-2-50.jpg>
- [11] <https://cdn1.mecum.com/auctions/ch1018/ch1018-346040/images/img7085-1537305441471@2x.jpg?1537449205000>
- [12] <https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcTkCnvn5OaSjNcYrQ8GYcjeFMhO9HsnLMk2VP8j2uixfCDsXYnw>
- [13] <https://www.robotistan.com/2x16-lcd-screen-black-over-green-tc1602a>
- [14] <https://imgaz3.staticbg.com/thumb/large/oaupload/banggood/images/F6/90/ba2b1ea8-eef8-473c-abe3-8b945609730b.JPG>
- [15] https://www.google.com/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwjgmzcz-ObkAhWE_XMBHZ0QDJEQMwi0ASgPMA8&url=https%3A%2F%2Fwww.konga.com%2Fproduct%2Fservo-motor-sg-90-2451749&psig=AOvVaw1Sae2pEmHBBUaW9KJJvm57&ust=1569328106481533&ictx=3&uact=3