

Driver Awareness System Using RFID Technology: A collaboration in Senior Design Projects

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Abstract

Road traffic safety refers to the methods and measures used to prevent road users from being killed or seriously injured. Typical road users include: pedestrians and vehicle passengers. A collaboration work with a Telecommunication industrial partner in senior design graduation projects considers enhancing road safety. In this work, Radio Frequency Identification (RFID) technology is used in order to develop driver awareness systems against pedestrian crossing, foggy weather collisions, construction road site, and bridge crash. This paper will focus on the awareness system developed against pedestrian crossing.

Keywords

Arduino microcontroller; awareness systems; RFID technology; road safety.

1. Introduction

Road traffic safety is an important worldwide topic [1] and road injuries are one of the leading causes of death for children. Two out of every three fatally injured children die due to road traffic crashes. Many studies considered using Radio Frequency Identification (RFID) technology [2-5] in order to achieve more safe roads and hence reducing number of accidents [6-9].

RFID refers to a technology whereby digital data encoded in RFID smart label or tag - that consists of an integrated circuit and an antenna - are captured by a reader via radio waves. RFID is similar to barcoding in that data from a tag are captured by a device that stores the data in a database. RFID, however, has several advantages over barcode systems. The RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner. Also, RFID tags are read/write, i.e. the data on the tag can be rewritten or modified as needed but it is read only in barcodes. Even data on RFID tags can be encrypted. Moreover, RFID tags are more durable and reusable than barcodes.

In senior design graduation projects, different driver awareness techniques were practically implemented and tested in different road hazard conditions. Three awareness systems has been developed. Namely: driver

awareness system against pedestrian crossing, driver awareness system against foggy weather collisions, and driver awareness system for construction road site, and bridge crash. This paper focuses on the pedestrian awareness project.

The safety of pedestrians is a very important issue nowadays. Traffic police have already taken numerous steps to ensure the safety of pedestrians and are still taking vital steps forward. The most important issue in this regard is that Pedestrians, especially children and special needs people may not know about an approaching vehicle. This project has been designed to make sure that the pedestrians present on the streets can cross the road safely. For this purpose, this project proposes installation of a broadcaster for traffic movement and monitoring through RFID. In order to implement such a system, the real challenge would be to measure the speed of a vehicle and the movement of pedestrians accordingly. This would have to be done within seconds before a flash message is displayed to warn both the pedestrian and the driver.

In Section 2, the system description is presented. The block diagrams of the project subsystems are introduced in Section 3. In Section 4, the wiring of different subsystems is shown. Arduino programming flow charts are given in Section 5. In section 6, system testing of different subsystems is shown. Results and discussion are presented in Section 7. Conclusions are given in Section 8.

2. Methodology

2.1 Block Diagrams

The proposed project to detect the vehicle as well as the child using RFID reader includes the following five main Subsystems:

- The main component of Subsystems 1&2 are two RFID readers controlled by Arduino UNO microcontroller board. Each Arduino Uno will trigger a low to high output once a vehicle's RFID tag is read. The outputs of both Arduinos are connected to the Trinket microcontroller board which measures the time difference between the two RFID readers and sends an over speed message to control if the speed is high consequently, flashing LEDs turn on if there is a child.
- The main components of Subsystem 3 are RFID readers each controlled with Arduino Uno. Once Arduino UNO is triggered low-high, and sends the presence of a child as a message to the controller. That shows a message on the display "child nearby" and red LED will turn ON in the display.
- The subsystem 4 consists of the car and DC motor which runs on 12V with a high RPM.
- The subsystem 5 represents a power supply (voltage regulator 12V) feeds each element in the prototype.

The block diagrams of the five subsystems included in this project are shown in Figures 1-5.

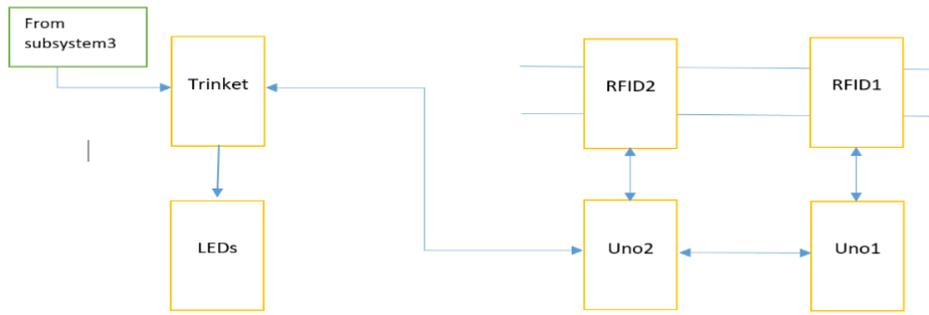


Figure 1. Subsystem 1 for the pedestrian awareness project.

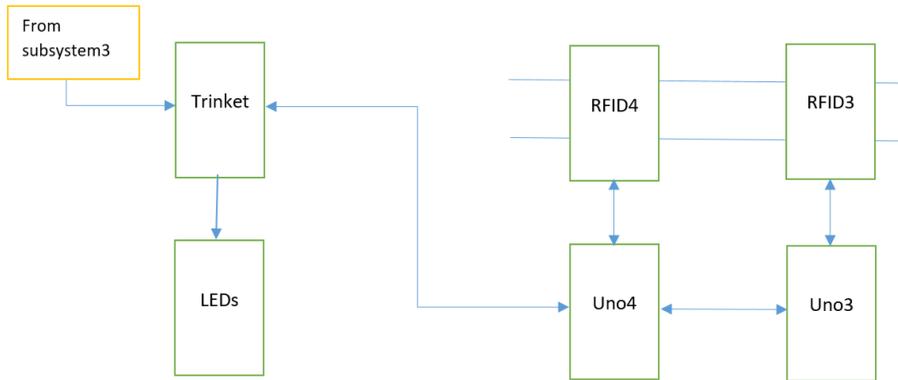


Figure 2. Subsystem 2 for the pedestrian awareness project.

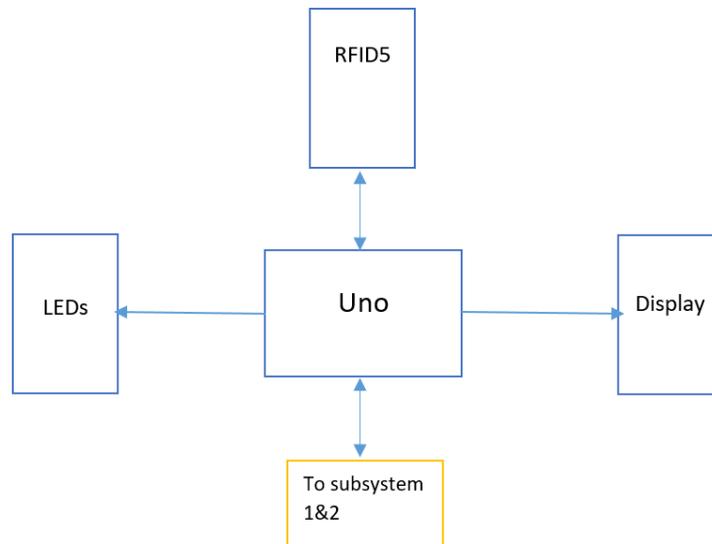


Figure 3. Subsystem 3 for the pedestrian awareness project.

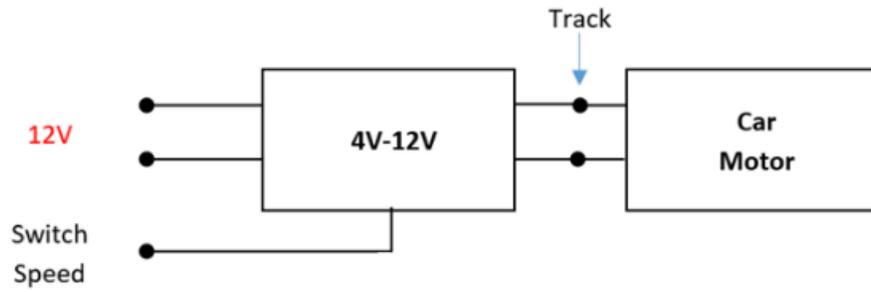


Figure 4. Subsystem 4 for the pedestrian awareness project.

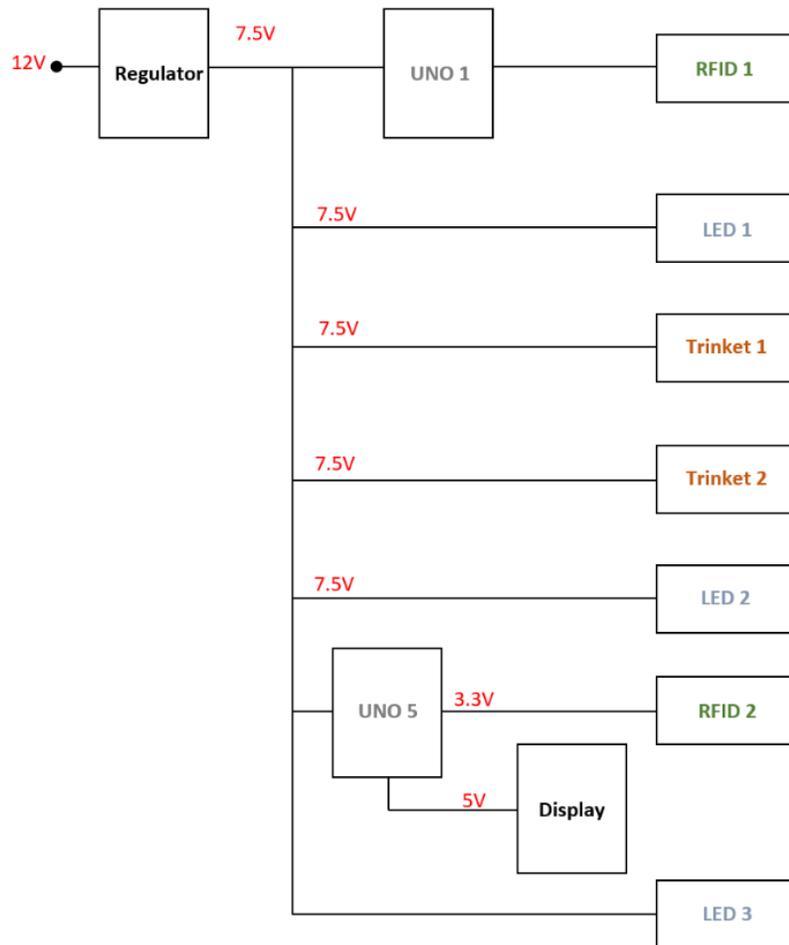


Figure 5. Subsystem 5 for the pedestrian awareness project.

2.2 Programming Flow Charts

The simulation of the prototype is based on the programming flow charts given in Figures 6-7.

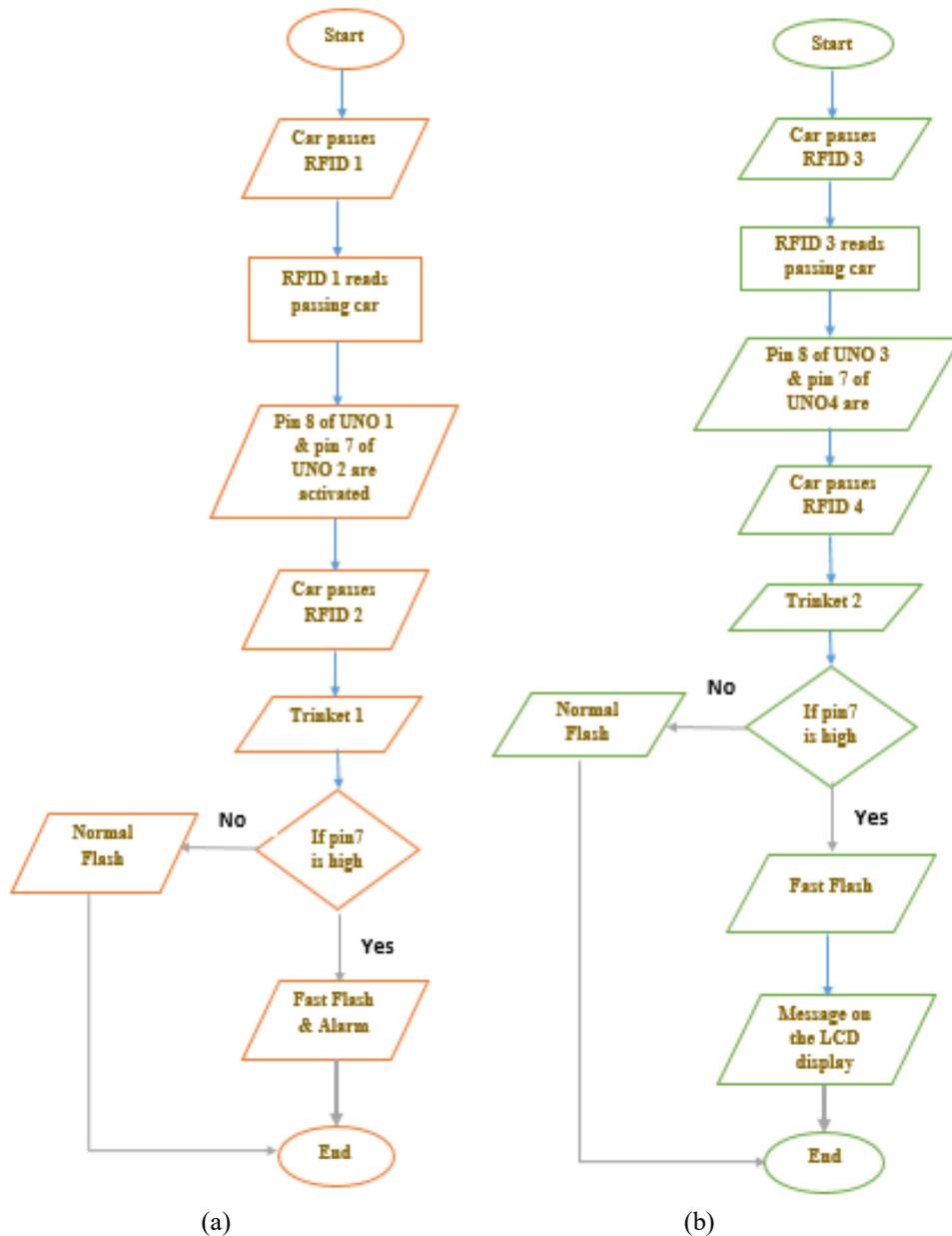


Figure 6. Programming flow chart for (a) Subsystems 1 (b) Subsystem 2.

For Subsystems 1 & 2: when a car passes over RFID reader 1 or 3, pin 8 in Arduino Uno1 will be activated, and pin 8 in Arduino Uno 1& 2 is connected to pin 7 of Arduino Uno 2 & 4, so pin 7 is activated too. As a result when the car passes over RFID reader 2 or 4 we will have either one of the following two cases:

No: if RFID2 senses a car while pin 7 is high, this refers that the car is (fast).

Yes: if RFID2 senses a car after pin 7 goes off, this refers that the car is (slow or normal).

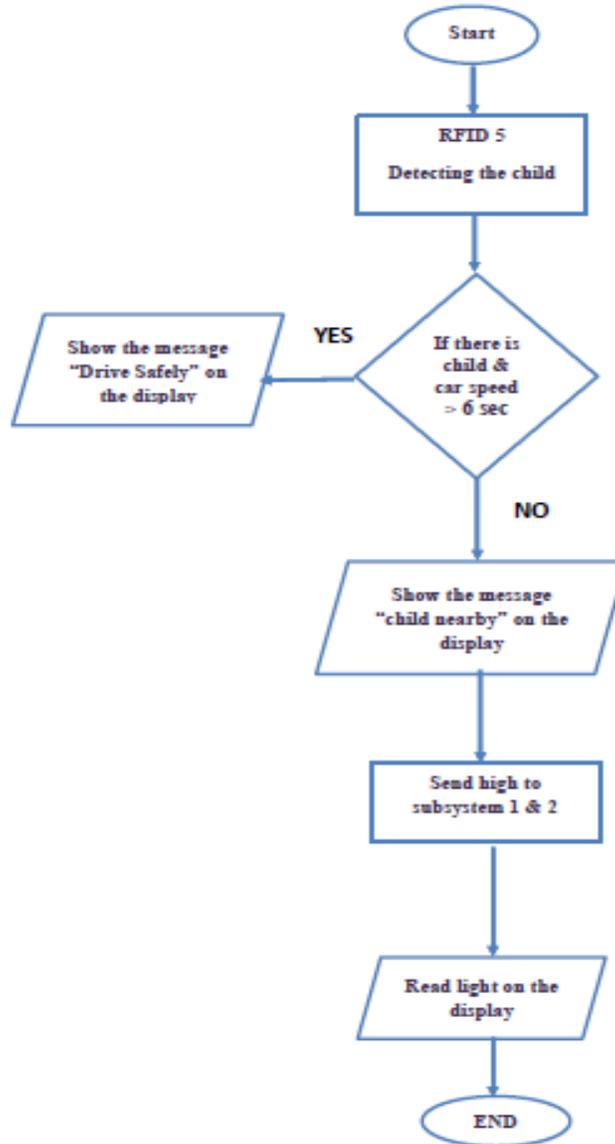


Figure 7. Programming flow chart for Subsystem 3.

For Subsystem 3: when RFID5 detects the presence of a nearby child, we will have one of the following two cases:

No: If the child is present, and the speed of the car is slow or normal the display will show “Drive safely”

Yes: If the child is present and the speed of the car is too fast the display will show “child nearby” and Uno will send a high to subsystems 1 and 2, as well as RED LEDs will turn ON in the display.

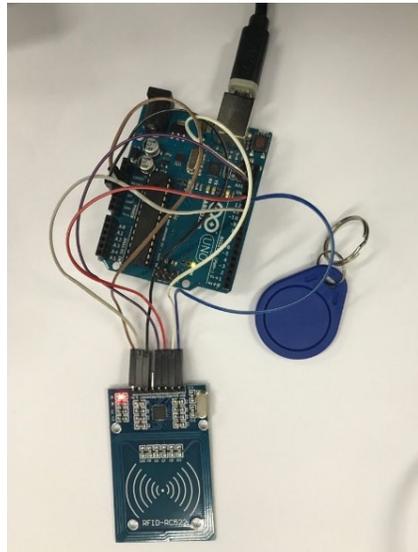
2.3 System Testing

The work of the project is based on the RFID reader which detects the presence of any nearby vehicle as well as pedestrians (child). One tag would be present on the car, and another tag would be present with the pedestrian which also measures the speeds of cars between the RFIDs. To calculate the car speed we consider 3 RFID readers to read the speed of the car by measuring the time between them. Testing process is divided to three steps. Namely: Components testing, Subsystems testing, and assembled system testing.

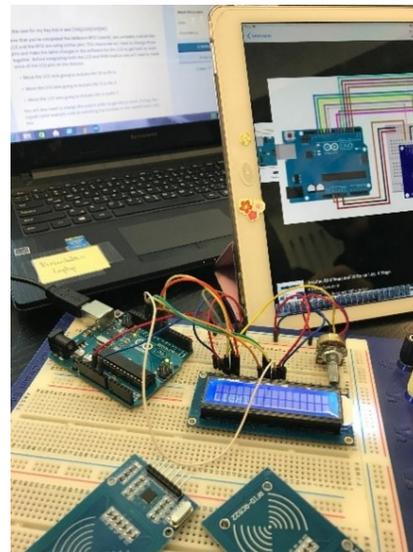
a) Component Testing

The initial test done for each component is to check their activation and operation. Then building and testing the whole circuits. The following components were tested (see Figure 8):

- Arduino UNO was tested by connecting it to the computer and then running the link program.
- RC522 RFID Reader & RFID Tag was tested by connecting them to Arduino UNO and then running the program.
- Display (LCD) was tested by connecting to Arduino UNO and then running the program.
- Flashing LEDs were tested by connecting to Trinket and then running the program.



(a)



(b)

Figure 8. Components testing for (a) the LCD display (b) RFID reader.

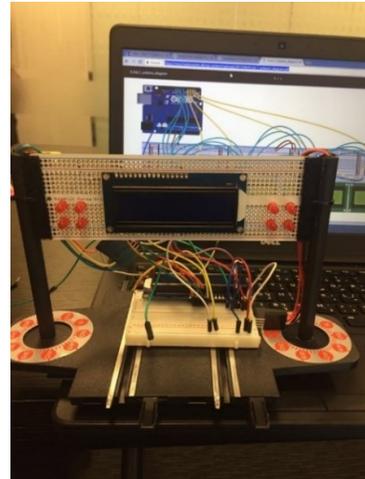
b) Subsystem Testing

For both Subsystem 1 & 2, the RC522 RFID reader (1 & 2) (3 & 4) each of them were wired to their respective Arduino UNOs. The Arduino UNO was wired and programmed. An RFID tag on the vehicle was passed over the RC522 RFID reader 1 then over the RFID 2 in subsystem 1 as well as the RC522 RFID reader 3 & 4 in subsystem 2, The UNO Arduinos were connected to a Trinket to measure the time difference between both readings of the UNOs. The LEDs flashed fast or normal depending on the speed of the vehicle.

For subsystem 3 once RFID Tag of a child is detected by the fifth RC522 RFID Reader, the Arduino UNO activated, the display showed “child nearby” and Arduino sent a high to subsystems 1 and 2, RED LEDs will turn ON in the display. The subsystems testing is shown in Figure 9.



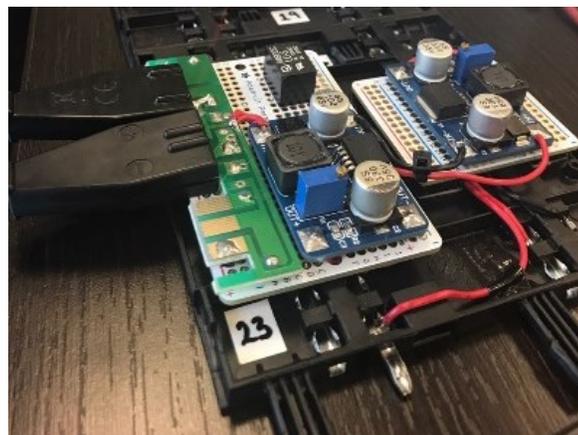
(a)



(b)



(c)



(d)

Figure 9. Testing for (a) Subsystems 1 & 2 (b) Subsystem 3 (c) Subsystem 4 (d) Subsystem 5.

c) Assembled System Testing

The system assembly was started after the subsystems were tested to ensure it operates in a stable way. The project members were able to compile the parts of the prototype and the program was working successfully. However, some errors appeared during the first final test and were corrected by the team. The errors will be explained in the results. The project members worked on the approach to have both Arduinos and the Trinket works in sequence with the RFID readers.

3. Results and Discussion

Once all the components were tested, the team was able to identify any required enhancements or modifications to the components and plans. The first challenge was with the flashing LEDs on the side of the track, they must flash faster when there is a pedestrian and a car moving at high speed. However, it was flashing faster before the car reached the RFID reader 2, so the project team identified that the coded time was a little bit high. As a result, the coded time was modified and changed from 6sec to 4 sec.

In order to calculate the car speed we consider 3 RFID reader to read the speed of the car by measuring the time between them. For instance, we considered the time 5 sec, if the car is moving and reaching to the next RFID reader in less than 5 sec, it means that the car is moving very fast. However, if it is reaching to the next RFID reader in more than 5sec, it means the car is moving slowly.

The car speed was controlled by varying the voltage applied to the car track from 9V to 12V to simulate high speed. Another challenge was that the motor of the used car had a low torque and high speed with 15000 rpm. In order to control the speed of the car and guarantee that the car is moving in a stable way, the solution was modifying the hardware to have high torque and lower speed with 12000rpm at 12 V.

In some cases, the car was moving out of the track, so the project team increased the weight of the car in order to improve the contact of the car with the track, and we added a magnet under the car to hold the car on the track. Moreover, the distance between two RFIDs are very short as a result difficult to calculate the time also distinguishing between high speed and low speed was not possible in order to reduce the time to milliseconds. Also, the relay on the LED and LCD output display was very sensitive which caused the messages shown on the display to be unstable and/or missing so it was replaced with a transistor buffer. One of the Trinkets wasn't reliable and unstable so it was replaced with Arduino YUN.

Considering the RFID reader of the pedestrian as a first input, and the RFID reader of an existing car on the road as a second input:

- If a child is present and the car passes between Subsystems 1& 2 in a normal or slow speed the LEDs will flash slowly and the red LEDs in Subsystem 5 will turn ON as well as the display will show a message "Drive Safely".
- If a child is present and the car passes between Subsystems 1& 2 in a high speed (over speed) the LEDs will flash faster and the red LEDs in Subsystem 5 will turn ON as well as the display will show a message "A Child is Nearby".
- If a car passes between Subsystems 1& 2 in a high speed and if there is no child the LEDs will not be flashing and the green LEDs in Subsystem 5 will be turned ON.
- If there is no child (0) and there is a car (1) it will not show anything.

Figure 10 shows the flash light, LEDs and the LCD screen in operation. The complete prototype of the project is shown in Figure 11.

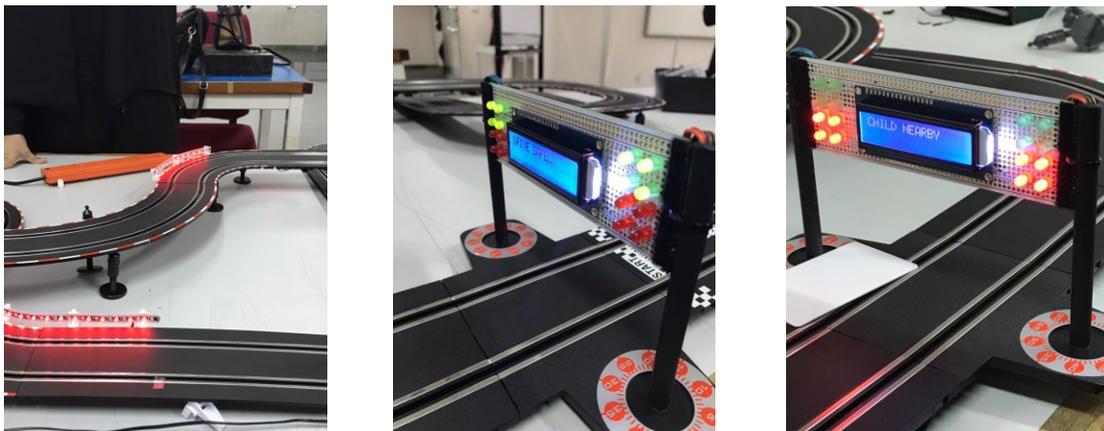


Figure 10. Flash light, LEDs and LCD screen in operation.



Figure 11. Final prototype.

4. Conclusions

In this paper, a senior graduation project has been introduced. The project builds up awareness system against pedestrian crossing that helps to reduce number of car accidents. The concept of the project is to RFID tag vehicles and crossing road children. The RFID reader placed on the road will detect the vehicle speed by measuring the difference time between two subsystems. Another RFID reader will detect the presence of the child near road crossing point. According to these conditions the vehicle driver can be warned about child presence and even the vehicle speed can be deaccelerated. This would help to reduce pedestrian accidents. To implement such a project, the project team did a research on RFID systems and their applications using Arduino. This provided the team members with an excellent theoretical and practical experience dealing with such systems. This type of project can be used also for stray animals in farm areas or for workers in hazardous industrial areas to avoid accidents.

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