Shortest Path Detection Using Line Following Robot

[1]N.Venkatesan,   [2]T.Thivya   [3]K.Chinnathambi   [4]M.Valavanthan

Sri Vidya College of Engineering & Technology

Abstract — **Nowadays communication is a part of development of technology. So we determined to work on robotics and reduce the routine of human being and lift up opulence of their life. It deals with the design, creation, process and application of robots as well as computer system for their control. The proposed follower robot is an electronic system that can detect and follow the line. Generally, the line specifies a predefined path that can be either visible like a black line on a white surface with a high contrasted color using IR Array Sensor. This robot is used to decide the shortest path out of other long distance paths at the time of travelling. In this project perfect path is identified for solving the single source shortest path problem like Bellman ford Algorithm. A proximity sensor has been attached to the robot so that it can detect any obstacle in its ways.**

Index Terms — **Shortest Path Calculation, Bellman Ford Algorithm, IR Sensors, DC Motors, PIC Micro Controller, Motor Driver, Serial Communication, USB to UART Converter.**

I. INTRODUCTION

A line follower robot is basically a robot designed to follow a 'line' or path already prearranged by the user. This path may be straightforward as a physical white line on the floor. Obstacle detection and avoidance robots can perform desired tasks in unstructured environments by finding and overcoming obstacles in their way without continuous human guidance. The Bellman–Ford algorithm computes shortest path from a single source vertex to all of the other vertices in a weighted digraph. Two wheels balancing robot with line following capability focuses on the development of a line follower algorithm for Two Wheels Balancing Robot. In this project, ATMEGA32 is chosen as the brain board controller to react towards the data received from Balance Processor Chip on the balance board to monitor the changes in the environment through two infra-red distance sensor to solve the inclination angle problem. Hence, the system will immediately restore to the set point (balance position) through the implementation of internal PID algorithms at the balance board [1]. The path may be visible like a black line on a white surface or may be reverse of that or it can be invisible like a magnetic field [2]. Design and Fabrication of Line Follower Robot can follow a path. It is an integrated design from the knowledge of Mechanical, Electrical and Computer engineering. This paper presents a 700gm

weight of a 9W LDR sensor based line follower robot design an fabrication procedure which always directs along the black mark on the white surface [3]. This paper presents a real time detection of mobile phone in restricted area. Mobile transmission detector can sense the presence of an activated mobile phone from distance of one and- a-half meters. If anyone is using mobile is this range then it will give the alarm and robot will stop at that location. So it can be used to prevent the use of mobile phones for spying and unauthorized video transmission. If an obstacle comes on the way of robot it gives alarm. A non contact proximity sensor is used which can measure the distance and orientation of a surface in a range of four to five centimeters [4]. In this system each back wheel has a dedicated motor while the front wheel is free to rotate. The microcontroller controls two DC motors of robot to navigate through its path. The mechanical constructional design and circuitry interfacing with microcontroller of robot are presented. Several running tests are made on the robot to verify the capability to follow the line by choosing the correct path and achieve the goal position [5]. Design and Implementation of IR based Line Follower Robot for Cooperative Task Sharing demonstrates by relay race of robots. This race is analogous to relay race of human being. Each robot is designed using microcontroller P89V51RD2 which have distinguished addresses. These robots are line follower and also capable to interact with each other

using IR sensor [6]. A straight line would be simple to navigate whereas a T-junction, 90 degree bends and a grid junction would be difficult to navigate. This is due to the physical kinematics constraints which is limited to the motor response, position and the turning radius of the robot. This paper presents a proposed line sensor configuration to improve the navigation reliability of the differential drive line following robot [7]. Light dependent resistor sensor has been attached with the robot whose resistance varies with light intensity. If the LDR receives maximum amount of light then its resistance goes to its minimum value, ideally zero and when no light falling on the LDR then its resistance goes to its maximum value, ideally infinitive. A switch with IR sensor has been fitted near the patient in, which connection has been made by the robot too. If the patient presses the switch then a flag bit is set in the microcontroller, from which line following robot follows the line and reach near the patient to provide the medicine to the patient with the help of dc motor [8]. Routing protocol is responsible to find out the path to be followed by the packets from source to destination. For MANET, different types of protocols are available and as per the requirement, we can use any one. Each protocol has its own criteria to find the path from source to destination. Some of researchers explored the concept of shortest path routing over ad hoc network [9]. The Shortest Path Problem (SPA) is one of the most fundamental and important in combinatorial problem. SPA is an important problem in graph theory and has applications in communications, transportation, and electronics problems [10].

In this Paper, Section II describes the System Overview where Section III deals with the bellman ford algorithm for detecting the shortest path in the robot. This paper concludes with discussion about the electronics of the robot in section IV.

II. SYSTEM OVERVIEW

This smart and intelligent line following robot based shortest path detection system is divided into several parts-sensing, serial link, motor driver and actuators. From the figure 1 shows the Block diagram of proposed system uses IR array and IR proximity sensors for sensing purposes. IR is used in a robot to follow the line drawn on the floor. IR proximity sensor is used to stop the robot when any object comes to its path. Motor driver is used for controlling the motor. The system is connected with the microcontroller to make the system automatic. If

it detects any obstacle then the flag bit of microcontroller is set from which the dc motor can be controlled. Serial link connection is used to establish the wireless connection between laptop and the system
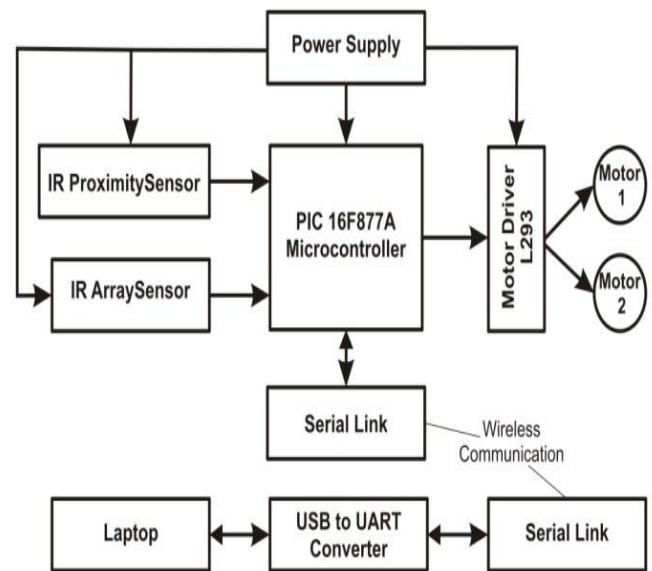

Figure 1. Block diagram of proposed system

A. PIC 16F877A Micro Controller

PIC stands for Peripheral Interface Controller given by Microchip Technology to identify its single-chip microcontrollers. The first 32 bytes of the register space are allocated to special-purpose registers; the remaining 96 bytes are used for general purpose RAM. If RAM is used, the top 16 registers are global, are most important special purpose registers, including the "STATUS" register which holds the RAM bank select bits.

Popularity of the PIC microcontroller is due to the following factors.

1. Speed is 4 clocks per cycle.
2. Instruction sets are easy to understand.
3. Power on reset and brown out reset.
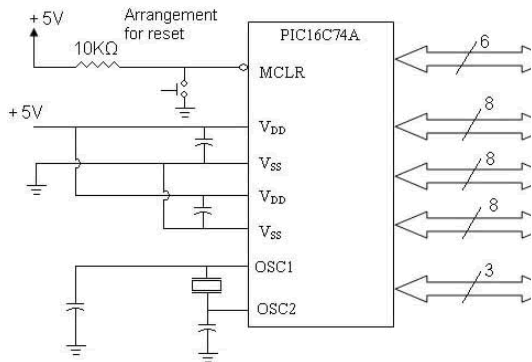4. A watch dog timer resets the processor.

Figure 2. Micro Controller Circuit Diagram

5. Low power crystals, mid range crystal, High range crystal, and RC oscillator are the optional clock sources.
6. Timers and on chip Analog & Digital Converter.
7. Up to 12 no of independent interrupt sources.
8. Powerful output pin control.
9. EPROM/ROM/Flash memory option.
10. I/O port expansion capability.

B. Sensors (IR Array and IR Proximity)

An Infrared (IR) sensor is used to detect obstacles in front of the robot or to differentiate between colors depending on the configuration of the sensor. Figure 3 shows IR Emitter, emits IR light and gives a signal when it detects the reflected light. An IR sensor consists of an emitter, detector and associated circuitry.
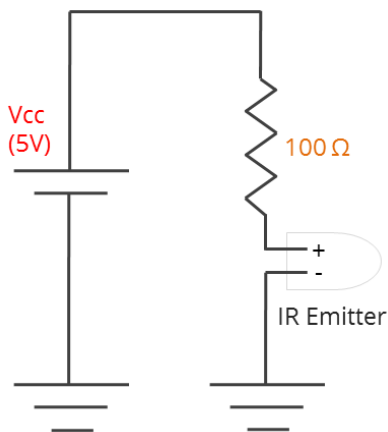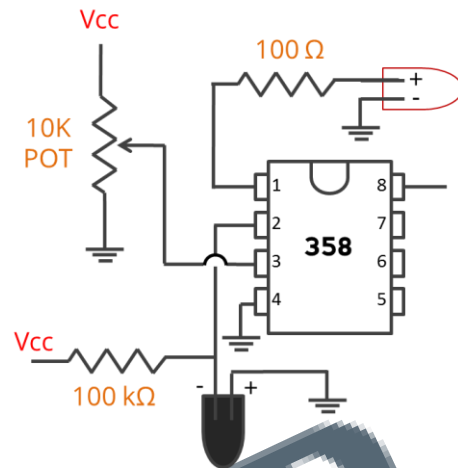

Figure 4. IR Receiver

The circuit required to make an IR sensor consists of two parts; the emitter circuit and the receiver circuit. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly, its output voltage, change in proportion to the magnitude of the IR light received as shown in the figure 5. This is the underlying principle of working of the IR sensor.
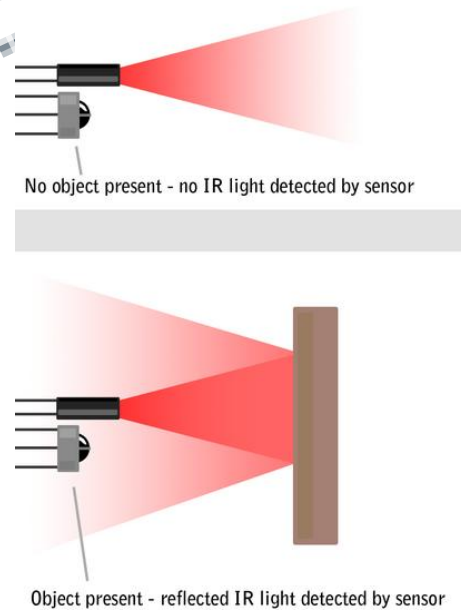

Figure 3. IR Emitter

Figure 5. Working principles of IR Proximity Sensor

IR Line Array Sensor Features
  ➢ On Board Regulator
  ➢ Operating voltage from 6V - 20 V
  ➢ 7 Sensor in a array form
  ➢ Indicator LED's on other side for better view
  ➢ Less sensitive to external ambient light, uses Vishay IR Photodiodes and LEDs
  ➢ Can Detect color difference
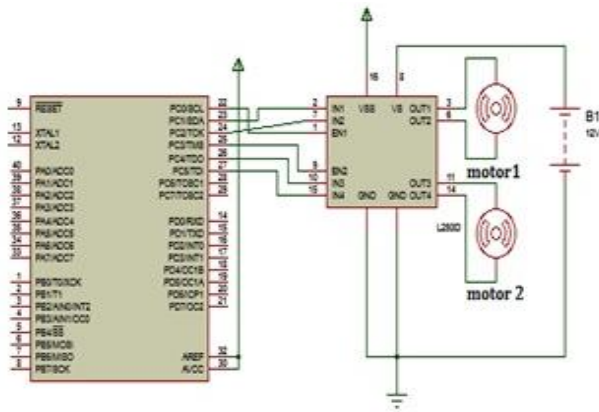 ➢ Reverse Polarity Protection

C. Motor Driver

Figure 6. Motor Driver interfacing with microcontroller

Relays are electromechanical switches that can switch between two circuits. Here when voltage is applied, say to input 'S', it's concerning relay will switch from ground to Vcc which applies voltage to the left DC motor and finds ground through other relays as shown in the figure 6. So the use of the relay based driver circuit gives a very low resistance path to the motors. Relays help provide much greater current to the motors than semiconductor driver circuits. This circuit provides built in dynamic motor breaking ability which is very much necessary for sharp turning for a line follower.

D. Serial Link

A serial interface is a communication interface between two digital systems that transmits data as a series of voltage pulses down a wire. A "1" is represented by a high logical voltage and a "0" is represented by a low logical voltage. Essentially, the serial interface encodes the bits of a binary number by their "temporal" location on a wire rather than their "spatial" location within a set of wires. Encoding data bits by their "spatial" location is referred to as a parallel interface and encoding bits by their "temporal" location is referred to as a serial interface.
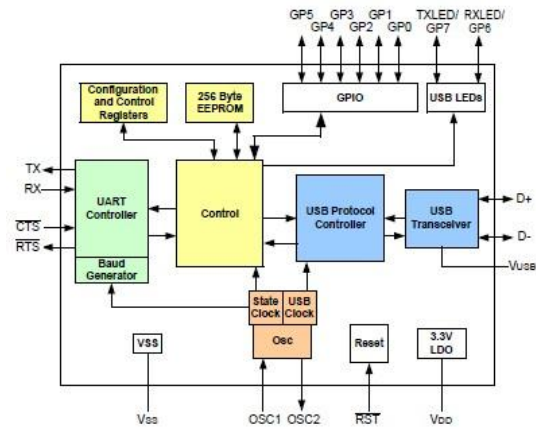
E. USB to UART Converter

Figure 7. USB to UART Converter Block Diagram

The USB to UART Bridge Controller (CY7C64225) is a fully integrated USB to UART controller that provides USB connectivity to devices with a UART interface as shown in the figure 7. The device includes a USB 2.0 Full-Speed Controller, Voltage Regulator and internal EEPROM in a 28-pin SSOP package. These features make the product ideal for upgrading legacy peripherals to USB interface.

F. LCD Display

A Liquid Crystal Display (LCD) is a thin, flat electronic visual Display that uses the light modulating properties of liquid crystals (LCs). LCs does not emit light directly. LCD is easy to interface with microcontroller because often embedded controller. LCDs are more energy efficient and offer safer disposal than CRTs. Its low electrical power consumption enables it to be used in battery powered electronic equipments. It is electronically-modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source or reflector to produce images in color or monochrome. Figure 8 shows the LCD interfacing with microcontroller.
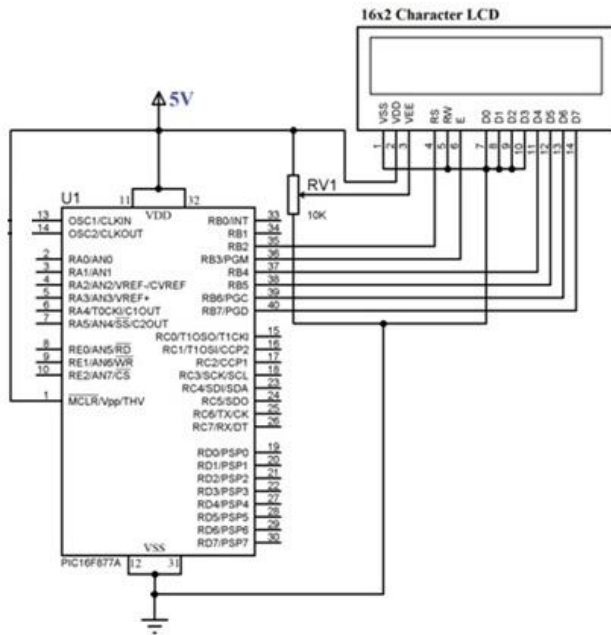
Figure 8. LCD Interfacing with microcontroller

III. BELLMAN FORD ALGORITHM

The Bellman–Ford algorithm is an algorithm that computes shortest paths from a single source vertex to all of the other vertices in a weighted digraph. It is slower than Dijkstra's algorithm for the same problem, but more versatile, as it is capable of handling graphs in which some of the edge weights are negative numbers.

Negative edge weights are found in various applications of graphs. If a graph contains a "negative cycle" that is reachable from the source, then there is no cheapest path; any path can be made cheaper by one more walk around the negative cycle. In such a case, the Bellman–Ford algorithm can detect negative cycles and report their existence.

A. Algorithm:

```
// Step 1: initialize graph
for each vertex v in vertices:
    if v is source then distance[v] := 0
    else distance[v] := inf
    predecessor[v] := null

// Step 2: relax edges repeatedly
for i from 1 to size(vertices)-1:
    for each edge (u, v) with weight w in edges:
        if distance[u] + w < distance[v]:
```

```
            distance[v] := distance[u] + w
            predecessor[v] := u

// Step 3: check for negative-weight cycles
for each edge (u, v) with weight w in edges:
    if distance[u] + w < distance[v]:
        error "Graph contains a negative-weight cycle"
        return distance[], predecessor[]
```

B. Applications

Each node calculates the distances between itself and all other nodes within the AS and stores this information as a table.

Each node sends its table to all neighboring nodes. When a node receives distance tables from its neighbors, it calculates the shortest routes to all other nodes and updates its own table to reflect any changes.

RESULTS AND DISCUSSIONS

The line following robot circuits are constructed and all the components are assembled and we getting the input using serial communication interface, and tests are made to verify the capability of the robot to follow the line, and choose the correct path and achieve the goal. Figure 9 shows the Path – black line over white surface. And figure 10 & 11 shows the robot running over the path.
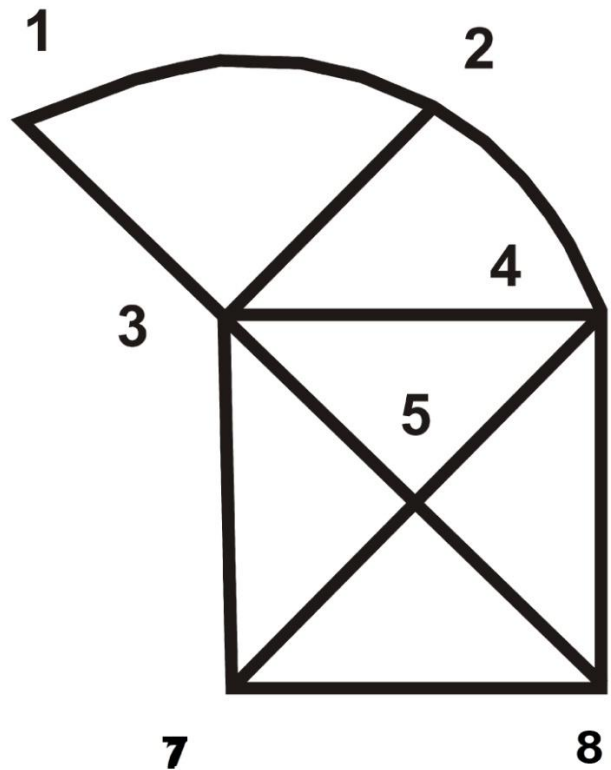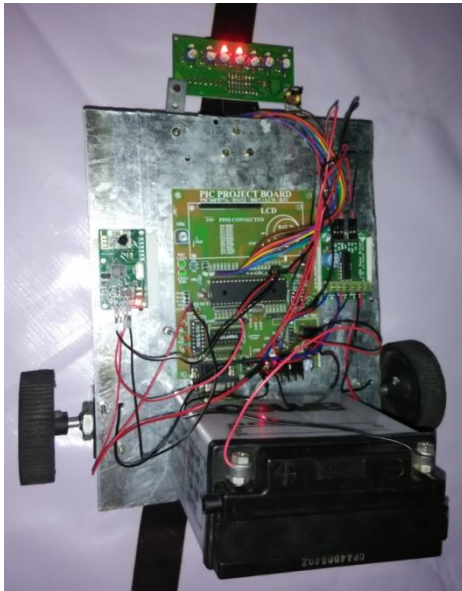
Figure 9. Path – Black line over white surface

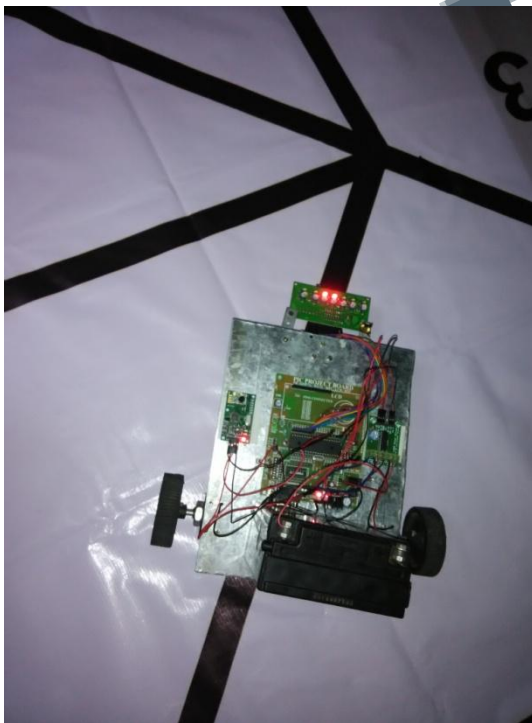Figure 10. Robot running over the track

Figure 11. Robot running over the track

CONCLUSION

The line following robot works successfully to track the black line above a white surface. The robot uses sensors and on board logic circuit for its movements it controls efficiently in an automatic straight forward manner. It uses Bellman Ford Algorithm to choose the shortest path and produces accurate results. IR proximity sensors are used to detect the obstacles in particular region. It will be refined by increasing the region of path in future.

REFERENCES

[1] Two Wheels Balancing Robot with Line Following Capability by Nor Maniha Abdul Ghani, Faradila Naim, Tan Piow Yon Published in World Academy of Science, Engineering and Technology Vol:5 2011-07-27

[2] Implementation Of Autonomous Line Follower Robot by Kazi Mahmud Hasan, Abdullah-Al-Nahid, Abdullah Al Mamun published in Informatics, Electronics & Vision (ICIEV), 2012 International Conference on 18-19 May 2012

[3] Design and Fabrication of Line Follower Robot by M. S. Islam & M. A. Rahman published in Asian Journal of Applied Science and Engineering, Volume 2, No 2 (2013) ISSN 2305-915X

[4] Design and Implementation of Cell-Phone Detection based Line follower Robot by Kanwaljeet Singh 1 , Mandeep Singh 2, Dr. Neena Gupta 3 published in International Journal of Electronics and Computer Science Engineering ISSN 2277-1956/V1N3-1362-1368

[5] Design And Implementation Of Double Line Follower Robot By V Hymavathi, G Vijay Kumar published in V Hymavathi et al. International Journal of Engineering Science and Technology (IJEST) ISSN : 0975-5462. Vol. 3 No. 6 June 2011

[6] Design and Implementation of IR based Line Follower Robot for Cooperative Task Sharing by Pintu and Alka Dubey* published in e-Journal of Science & Technology (e-JST) (http://e-jst.teiath.gr)

[7] Analysis of Line Sensor configuration for the advanced Line Follower Robot by M. Zafri Baharuddin, Izham Z. Abidin, S. Sulaiman Kaja Mohideen, Yap Keem Siah, Jeffrey Tan Too Chuan Published in International Science Index Vol: 5/2011

[8] Development and Applications of Line Following Robot Based Health Care Management System By Deepak Punetha,

Neeraj Kumar, Vartika Mehta Published in International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 8, August 2013

[9] Shortest Path Routing Over Scalable Mobile Ad Hoc Networks by Kanika Pasrija , Ashok, Seema Rani Published in International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 9, September 2013

[10] Shortest Path Algorithm by Shivani Sanan, Leena jain, Bharti Kappor Published in International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 2, Issue 7, July 2013

AUTHOR'S PROFILE

N.Venkatesan
He is currently working as an Assistant Professor in Department of Information Technology at Sri Vidya College of Engineering & Technology, Virudhunagar, Tamil Nadu, India and he has experience of 6.5 years. His area of Interest is Image Processing, Data Structures and Signal Processing.

T.Thivya
She is currently working as Assistant Professor in Department of Information Technology at Sri Vidya College of Engineering & Technology, Virudhunagar, Tamil Nadu, India and she has experience of 2.8 years. Her area of Interest is Image Processing, Embedded Systems and Signal Processing.

K.Chinnathambi
He is currently Pursuing his Bachelor of Technology in the Department of Information Technology at Sri Vidya College of Engineering & Technology, Virudhunagar, Tamil Nadu, India. His area of Interest is Embedded Systems and E-Commerce Security.

M.Valavanthan
He is currently Pursuing his Bachelor of Technology in the Department of Information Technology at Sri Vidya College of Engineering & Technology, Virudhunagar, Tamil Nadu, India. His area of Interest is Embedded Systems and Data Structures.