Digital Twin for AGV

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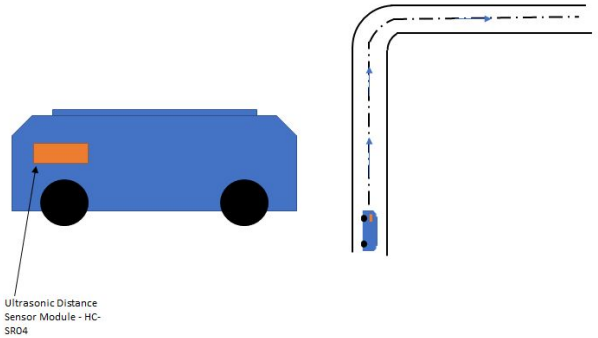
The problem - objectives

- To design and develop a prototype of AGV with the capability of detecting the obstacles in the path and navigate smartly to achieve the destination.
- Collecting the data from the sensors (Ultrasonic Sensors) mounted on the developed AGV prototype
- To develop a Digital Twin of AGV for diagnosis and prognosis



Literature Review

- In the automation of industries, digital twin can be built upon graphs or predictive models based on neural networks

Advantages of graph model

- ❖ It is easy to develop, change and generate the graph-based models

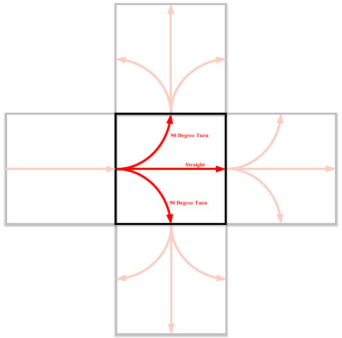
The Authors of the research papers emphasized on the graph modelling for generating an optimal path for the maneuvering of the AGV. But, they didn't stress upon the limitations of the graph model

	Z_{11}	Z_{21}	Z_{31}	...	$Z_{(n-1)1}$	Z_{n1}	Z_{12}	Z_{22}	Z_{32}	...	Z_{cd}	...	$Z_{(n-2)m}$	$Z_{(n-1)m}$	Z_{nm}
Z_{11}	W	1	0	...	0	0	1	0	0	...	...	...	0	0	0
Z_{21}	1	W	1	...	0	0	0	1	0	...	...	...	0	0	0
Z_{31}	0	1	W	...	0	0	0	0	1	...	...	...	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
$Z_{(n-1)1}$	0	0	0	...	W	1	0	0	0	...	...	...	0	0	0
Z_{n1}	0	0	0	...	1	W	0	0	0	...	...	...	0	0	0
Z_{12}	1	0	0	...	0	0	W	1	0	...	...	...	0	0	0
Z_{22}	0	1	0	...	0	0	1	W	1	...	...	...	0	0	0
Z_{32}	0	0	1	...	0	0	0	1	W	...	...	...	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Z_{cd}	...	...	...	...	...	...	...	...	...	...	Hbcd	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
$Z_{(n-2)m}$	0	0	0	...	0	0	0	0	0	...	...	...	W	1	0
$Z_{(n-1)m}$	0	0	0	...	0	0	0	0	0	...	...	...	1	W	1
Z_{nm}	0	0	0	...	0	0	0	0	0	...	...	...	0	1	W

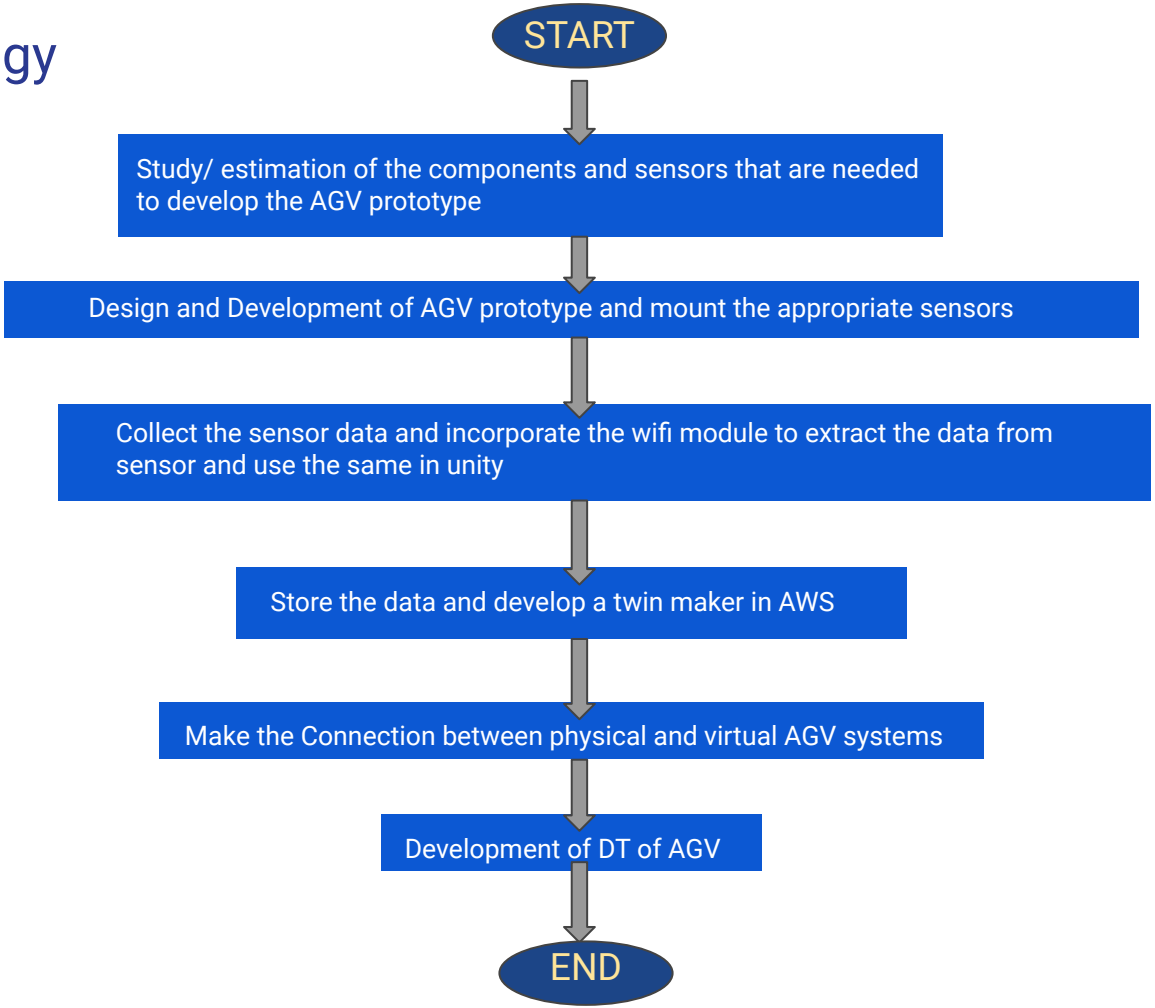
Fig. 3. Adjacency Matrix.

Limitations of the graph model

- ❖ It doesn't act optimally in the crowded environment, the probability of deadlock is high
- ❖ The current implemented maneuvers are limited and can not generate all the required movements in industrial environment



Methodology



Summary of the work done

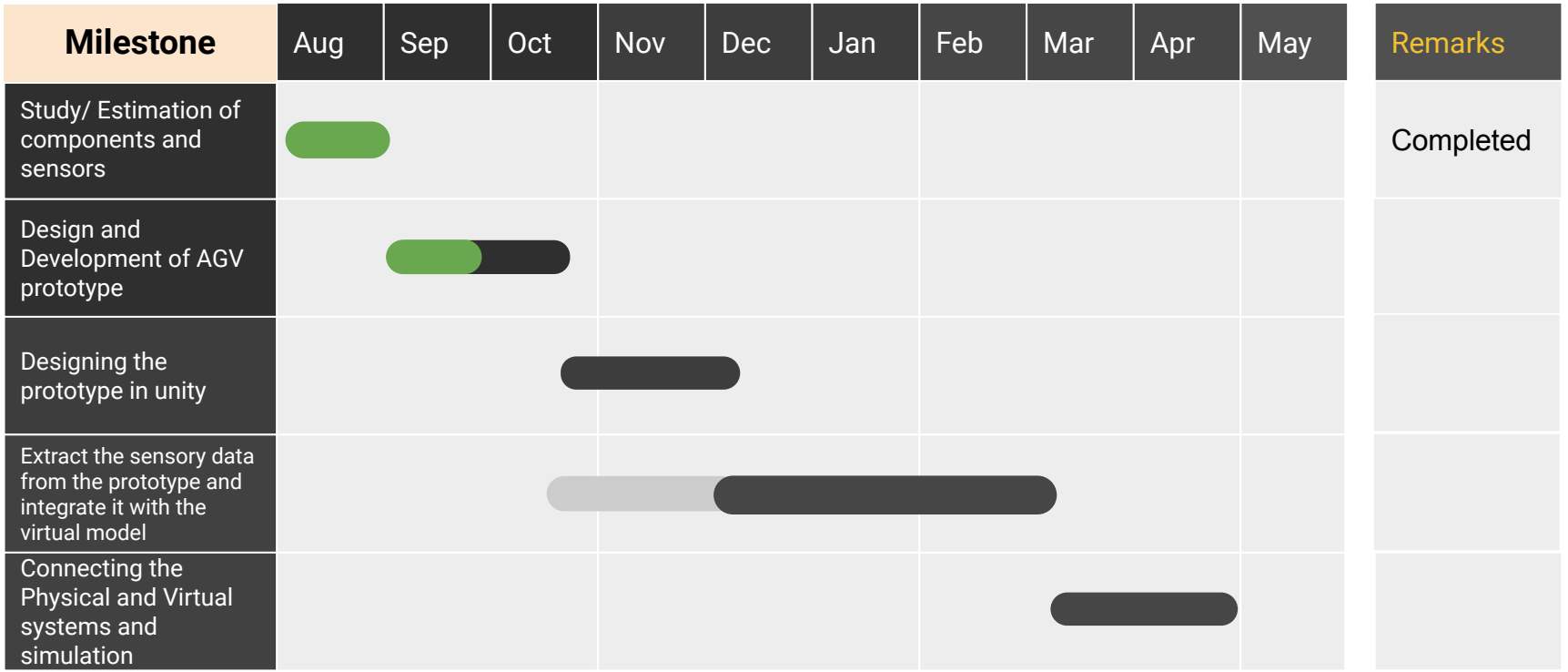
- Worked upon generating a program to maneuver the prototype AGV and the path taken can be traced
- Building a prototype of AGV to collect the approximate data and it is used for making a digital twin (bought most of the components needed for prototype)
    - Components: Arduino UNO, Motor Drivers (L293d), Ultrasonic sensors

```
/
*-------------------------------------------------------------
-------------------------------------------------------------
--void loop ( )-----------------------------------*/

  void loop() {
  Serial.println(" ");
  float distancef, distancel, distancer;
  distancef = firstsensor();
  distancel = secondsensor();
  distancer = thirdsensor();
  delay(1);
  if ((distancef >2* fwd_lim) && (distancel < left_lim )
&& (distancer < right_lim) ) {
    //only possibility is moving forward
    fastfwd();
    l=0;
    r=0;
  }
  if ((distancef <2* fwd_lim && distancef>fwd_lim) &&
(distancel < left_lim ) && (distancer < right_lim) ) {
    //only possibility is moving forward
    fwd();
  }
  else {
    if (distancef < fwd_lim && distancel > left_lim &&
distancer < right_lim) {
      //only possibility is taking left
      left();
      l=l+1;
      r=0;
      fwd();
    }
    if (distancef < fwd_lim && distancel < left_lim &&
distancer > right_lim) {
      //only possibility is moving right
      right();
      r=r+1;
      l=0;
      fwd();
    }
    if (distancef > fwd_lim && distancel < left_lim &&
distancer > right_lim) {
```

Fig: An excerpt of the program

Timeline


Milestone
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Remarks
Study/ Estimation of components and sensors
Completed
Design and Development of AGV prototype
Designing the prototype in unity
Extract the sensory data from the prototype and integrate it with the virtual model
Connecting the Physical and Virtual systems and simulation