# Fuzzy Position Control Approach For An Autonomous Robot Controller

## Otonom Bir Robotun Bulanık Kontrollör Yaklaşımı ile Konum Kontrolü

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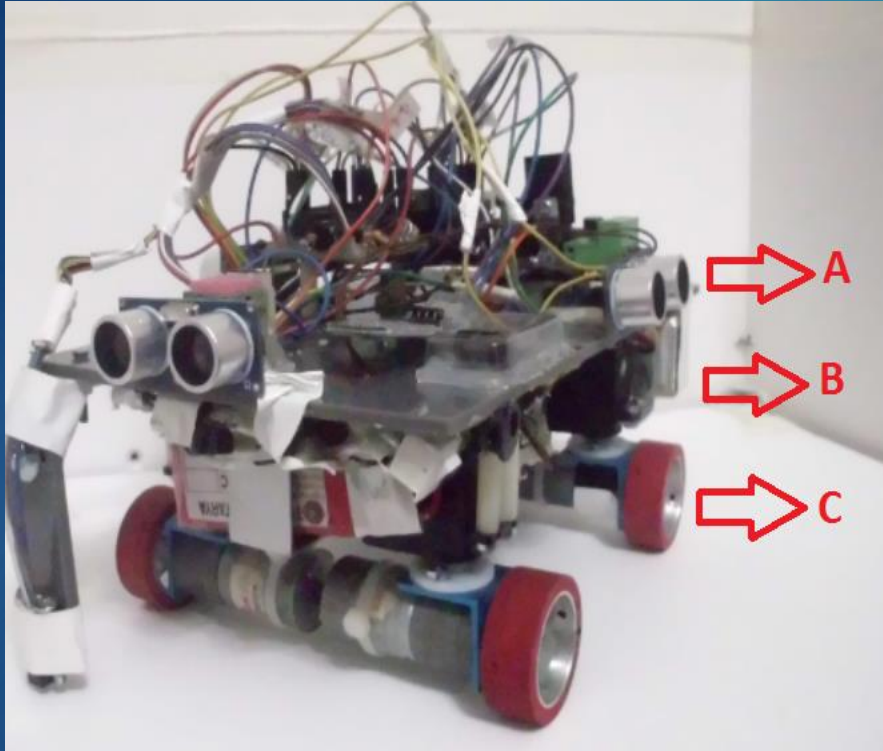# Introduction

➢ In This Study

- fuzzy system is designed for autonomous robot controller

- Arduino MEGA control board and Visual Studio 2015 C Sharp program

- The fuzzy approach is compared with the traditional control method

# Introduction

## ▶ Robot Components



Fig. 1. Altu Robot Hardware

A – Ultrasonic Sensors

B – Servo Motors

C – DC Motors

# Materials and Methods

## ▶ Altu Robot Design

The robot body is made of a Plexiglass with a length of 140mm x 225mm and a thickness of 5mm as illustrated in Fig.1.

On the upper part of the body the following components can be found:

- One wireless point (HC05).

- Four ultrasonic sensors (H04).

- One Schmitt trigger circuit (74HS14 ).

- One microcontroller card (ATMEGA 2560).

- One regulation circuit (LM2576-5V ).

# Materials and Methods

## ▶ Altu Robot Design

On the lower part of the body:

- One Li-Po battery (11.1V 800mA).
- One Li-Po battery (7.4V 1050mA).
- One DC motor driver card.
- Four ON-OFF buttons and the charger section.
- Four servo motors (12 V 500RPM).
- Four silicon wheels;
- One regulated circuit (7805 R 5V).
- Two infrared sensors (QRD1114).

# Materials and Methods

## ▶ Robot Test Environment



Fig. 2. Altu Robot tracks limit

Altu robot, the track is limited to 1m2 , and thus the sensor is suitable for this work. The track is made of strap and the edges of the track are covered by four L-shaped pieces.

# Materials and Methods

▶ Visual Studio 2015 C Sharp program – Getting location

# Materials and Methods

▶ Visual Studio 2015 C Sharp program - Mapping
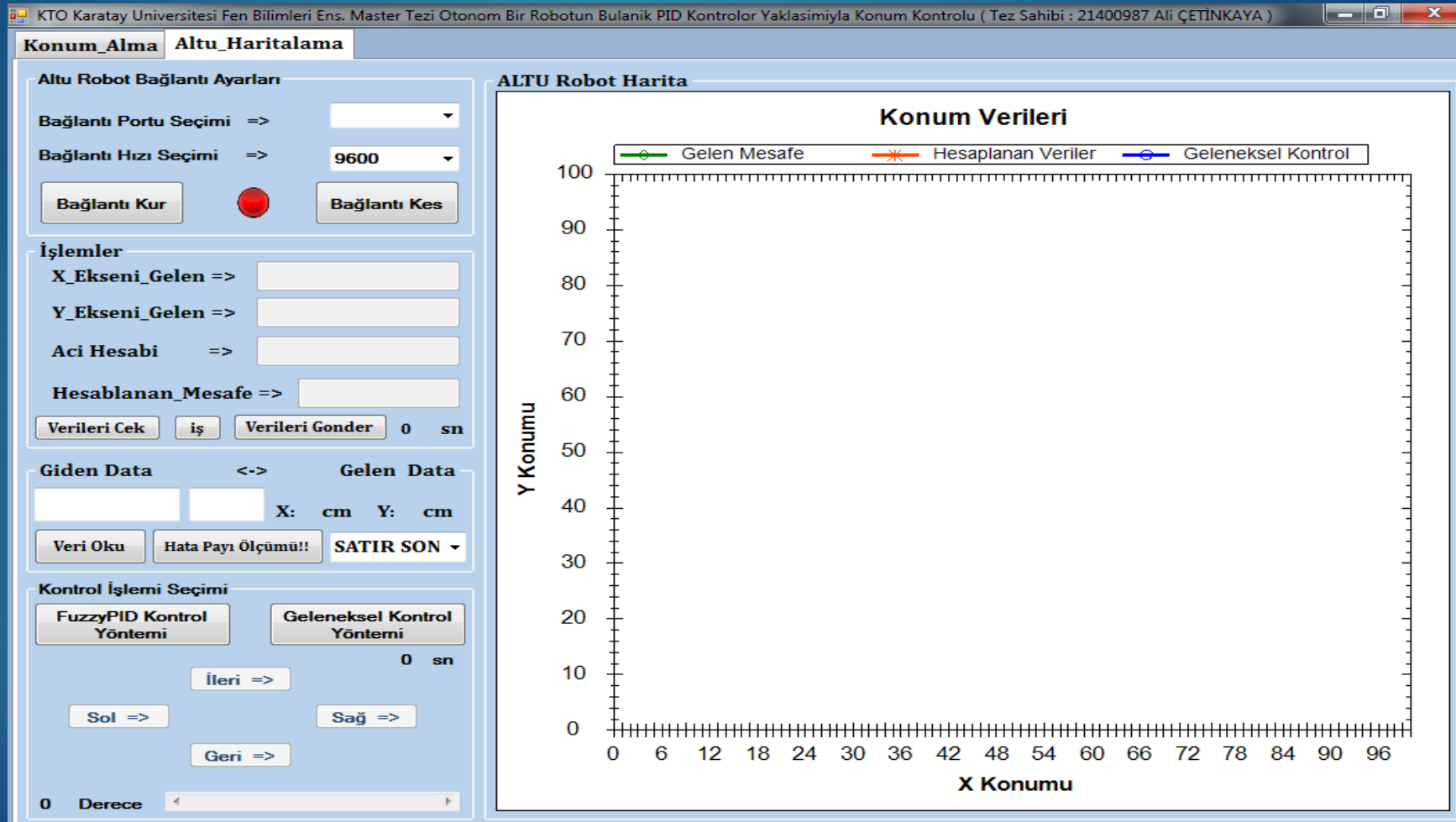
# Materials and Methods
## ▶ Fuzzy Control Approach
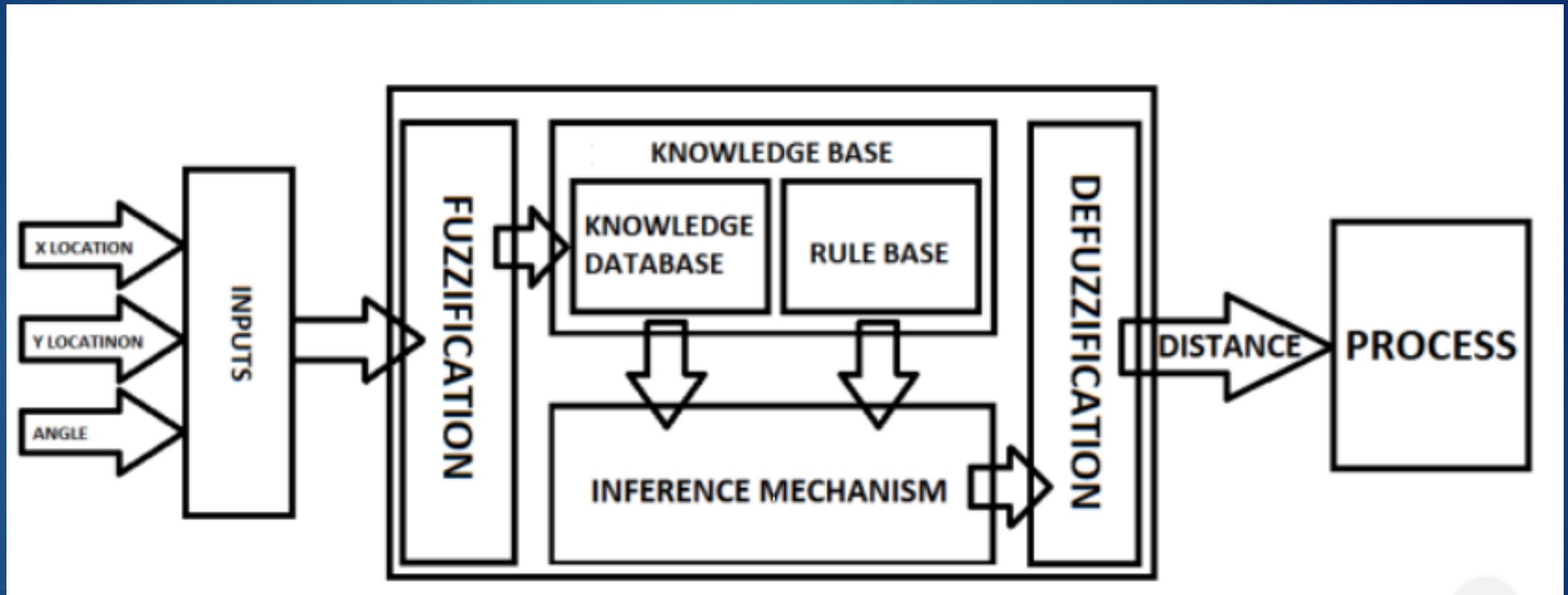


Fig. 3. Blok diagram of the fuzzy system.

# Materials and Methods >Mempersip

- The block diagram od the fuzzy control system designed for this study is shown in Fig. 3.

- The Fuzzy unit of Altu Robot consist of input and output variables, fuzzification, fuzzy inference and defuzzyfication units.

- The input and output variables of the designed controller are:

X position (0 - 100 cm), Y position(0 - 100cm), Angle (0-90°) and Distance (0 – 140 cm).

# Materials and Methods

## ▶ Control System – Calculate Distance
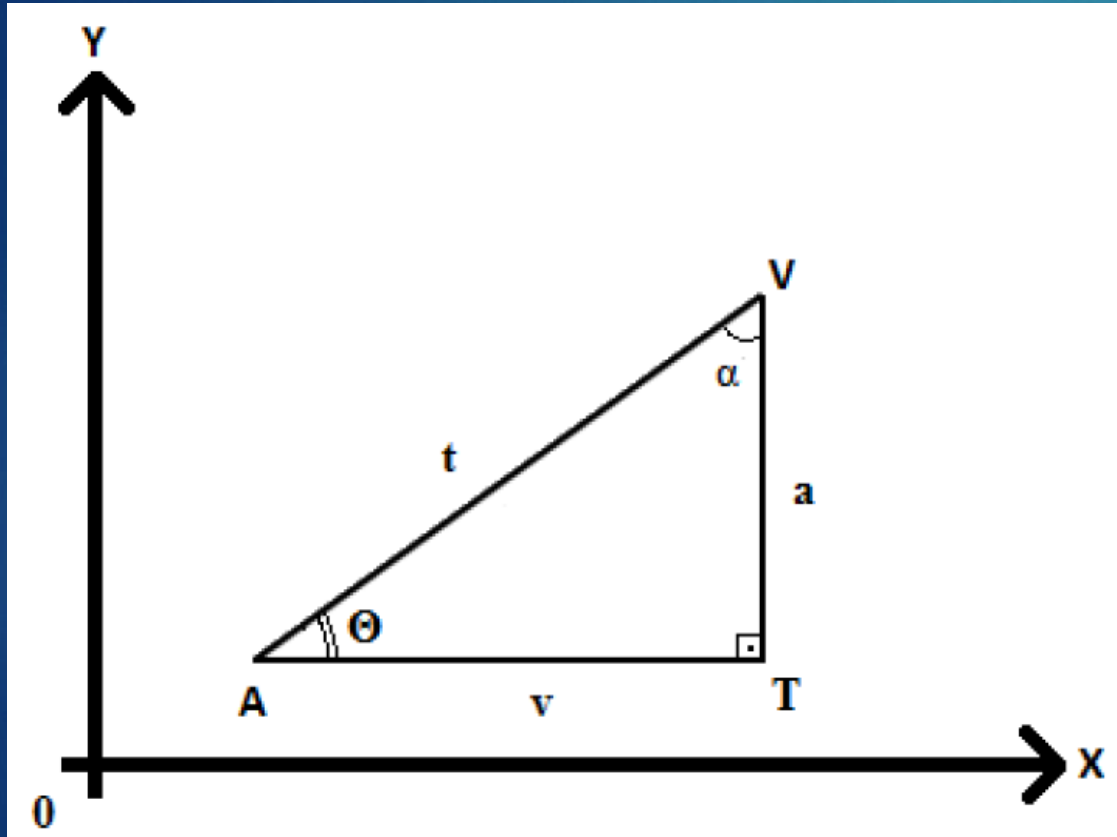


```
teta_acisi = 90 -
(Math.Atan((konum_y_farki) /
(konum_x_farki)) * 180 / Math.PI);
textBox_aci_gelen.Text =
teta_acisi.ToString();
mesafe =
Math.Sqrt(Math.Pow(konum_x_farki, 2)
+ Math.Pow(konum_y_farki, 2));
textBox_mesafe_hesaplanan.Text =
mesafe.ToString();
```

# Materials and Methods

▶ Fuzzification

X and Y are expressed separately using seven fuzzy subsets
The angle variable is expressed with five fuzzy subsests
The distance variable expressed with thirteen fuzzy subsests

| Alt Küme ismi | Detaylı İsmi | Aralığı |
|---|---|---|
| XCK | X Çok Küçük | [0, 20] |
| XKO | X Küçük Orta | [10, 40] |
| XK | X Küçük | [30, 50] |
| XO | X Orta | [40, 60] |
| XB | X Büyük | [50, 70] |
| XBO | X Büyük Orta | [60, 90] |
| XCB | X Çok Büyük | [80, 100] |

| Alt Küme ismi | Detaylı İsmi | Aralığı |
|---|---|---|
| YCK | Y Çok Küçük | [0, 20] |
| YKO | Y Küçük Orta | [10, 40] |
| YK | Y Küçük | [30, 50] |
| YO | Y Orta | [40, 60] |
| YB | Y Büyük | [50, 70] |
| YBO | Y Büyük Orta | [60, 90] |
| YCB | Y Çok Büyük | [80, 100] |

| Alt Küme ismi | Detaylı İsmi | Aralığı |
|---|---|---|
| AK | Açı Küçük | [0, 30] |
| AKO | Açı Küçük Orta | [20, 40] |
| AO | Açı Küçük | [35, 55] |
| ABO | Açı Büyük Orta | [50, 70] |
| AB | Açı Büyük | [60, 90] |

| Alt Küme ismi | Detaylı İsmi | Aralığı |
|---|---|---|
| MKS | Mesafe Küçük Sınır | [0, 20] |
| MKC | Mesafe Küçük Çok | [10, 30] |
| MKB | Mesafe Küçük Büyük | [20, 40] |
| MKO | Mesafe Küçük Orta | [30, 50] |
| MOK | Mesafe Orta Küçük | [40, 60] |
| MK | Mesafe Küçük | [50, 70] |
| M | Mesafe | [60, 80] |
| MB | Mesafe Büyük | [70, 90] |
| MOB | Mesafe Orta Büyük | [80, 100] |
| MBO | Mesafe Büyük Orta | [90, 110] |
| MBK | Mesafe Büyük Küçük | [100, 120] |
| MBC | Mesafe Büyük Çok | [110, 130] |
| MBS | Mesafe Büyük Sınır | [120, 140] |

# Materials and Methods >Membership Processes
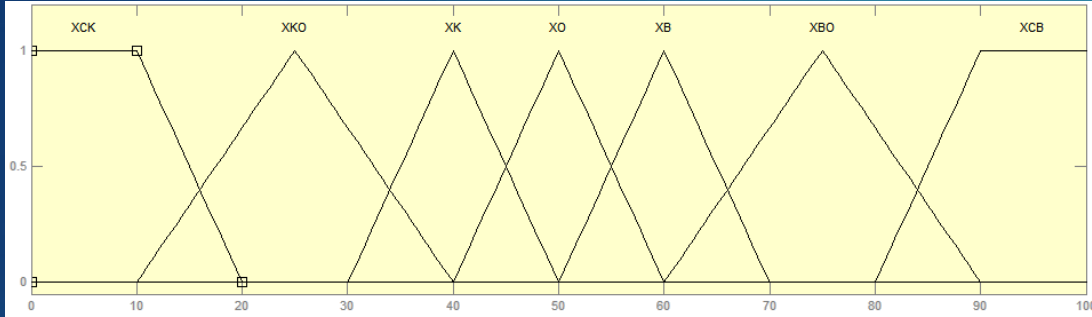


Graph of fuzzy input subsests of X position data
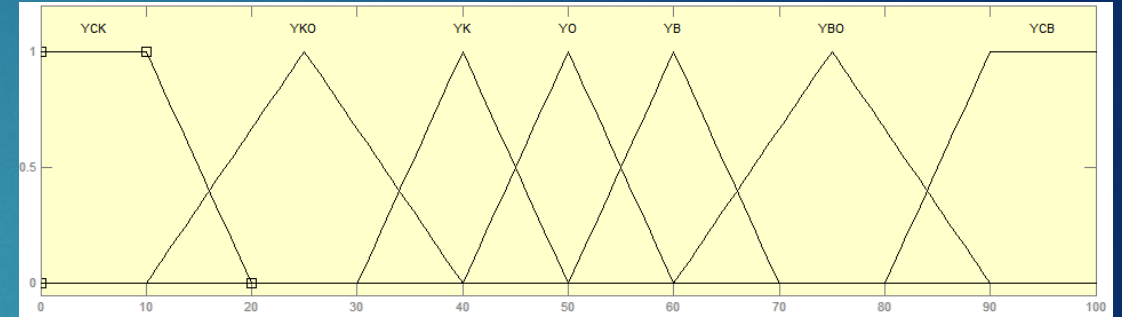


Graph of fuzzy input subsests of Y position data
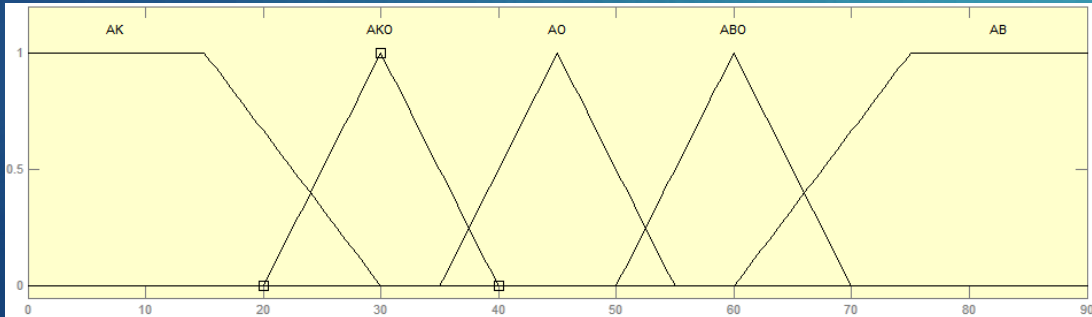


Graph of fuzzy input subsests of Angle Ө
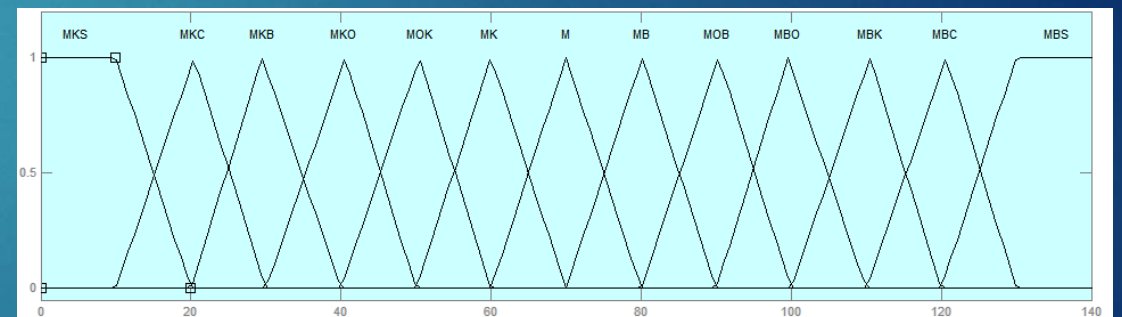


Graph of fuzzy output subsests of Distance data

# Materials and Methods

▶ Fuzzy Inference

Fuzzy rules are the most important part of fuzzy control. In this part, the Altu robot fuzzy knowledge base and decision making mechanism are created. There ara many techniques available for creating fuzzy inference.

In this study max-min (Mamdani) method is adopted.

# Materyal ve Metot

▶ Determination of Fuzzy Rules

Rule 1. If XCK,YCK ,and AK, then the distance value is MKS

….

Rule 71. If XO, YCK, and AB, then the distance value is MOK

….

Rule 141. If XCB, YCB, and AB, then the distance value is MBS

# Materials and Methods

## ▶ Defuzzification

In this work, 141 fuzzy rules are defined that relate the verbal expression and the fuzzy expressions of each input and output variables.
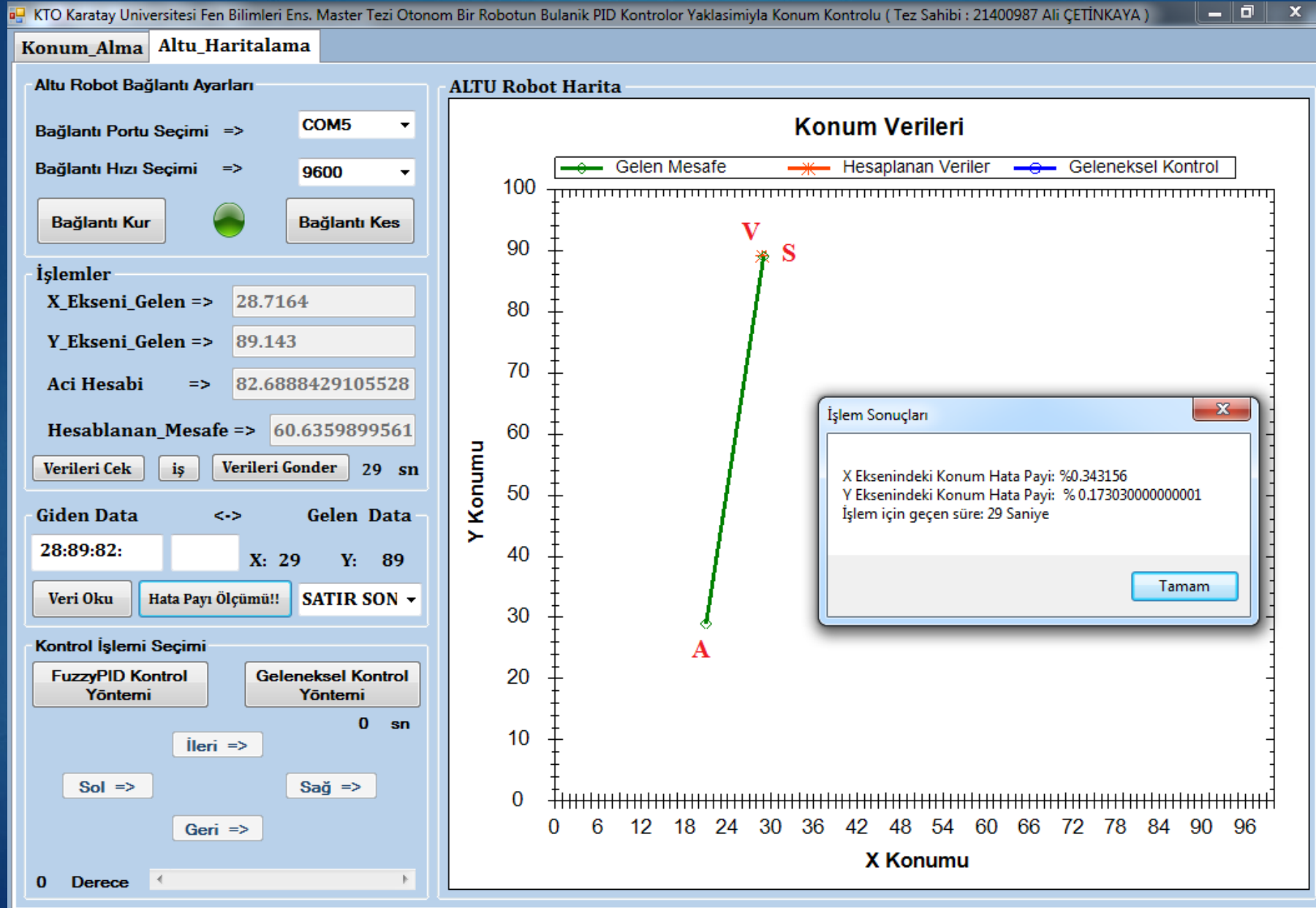
There are several methods to do that transformation. In this work, the weight average method is used to identify the single and exact values
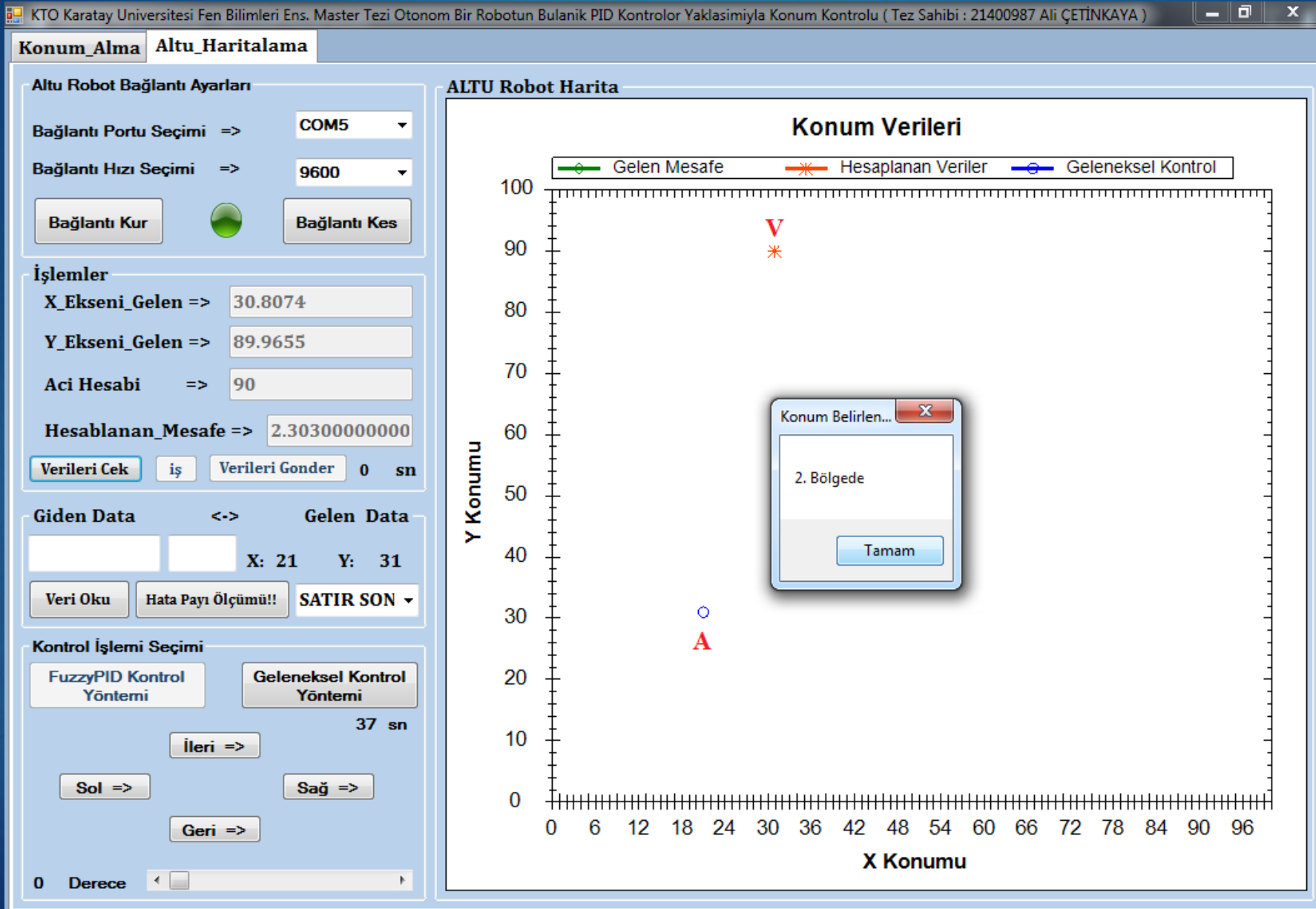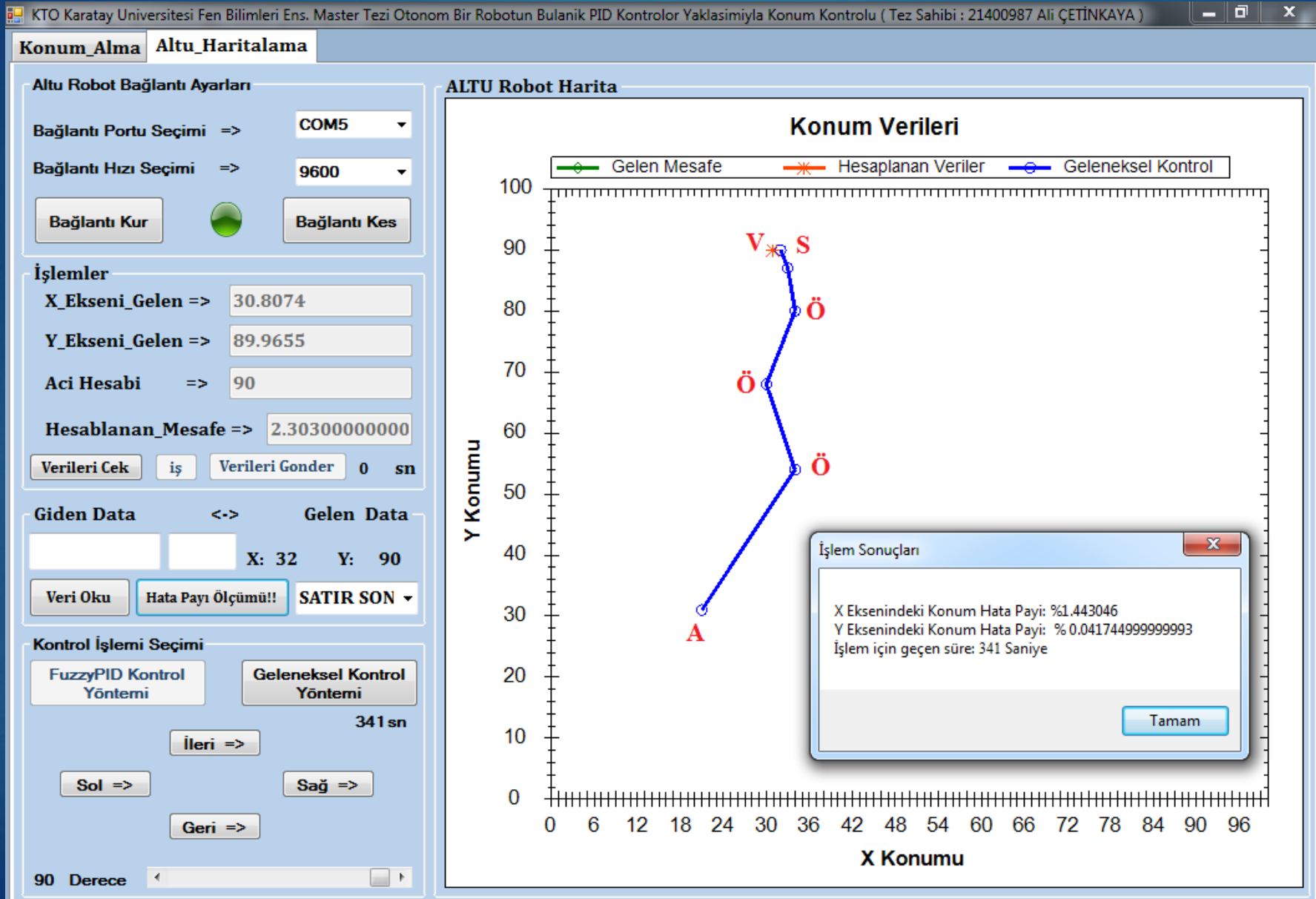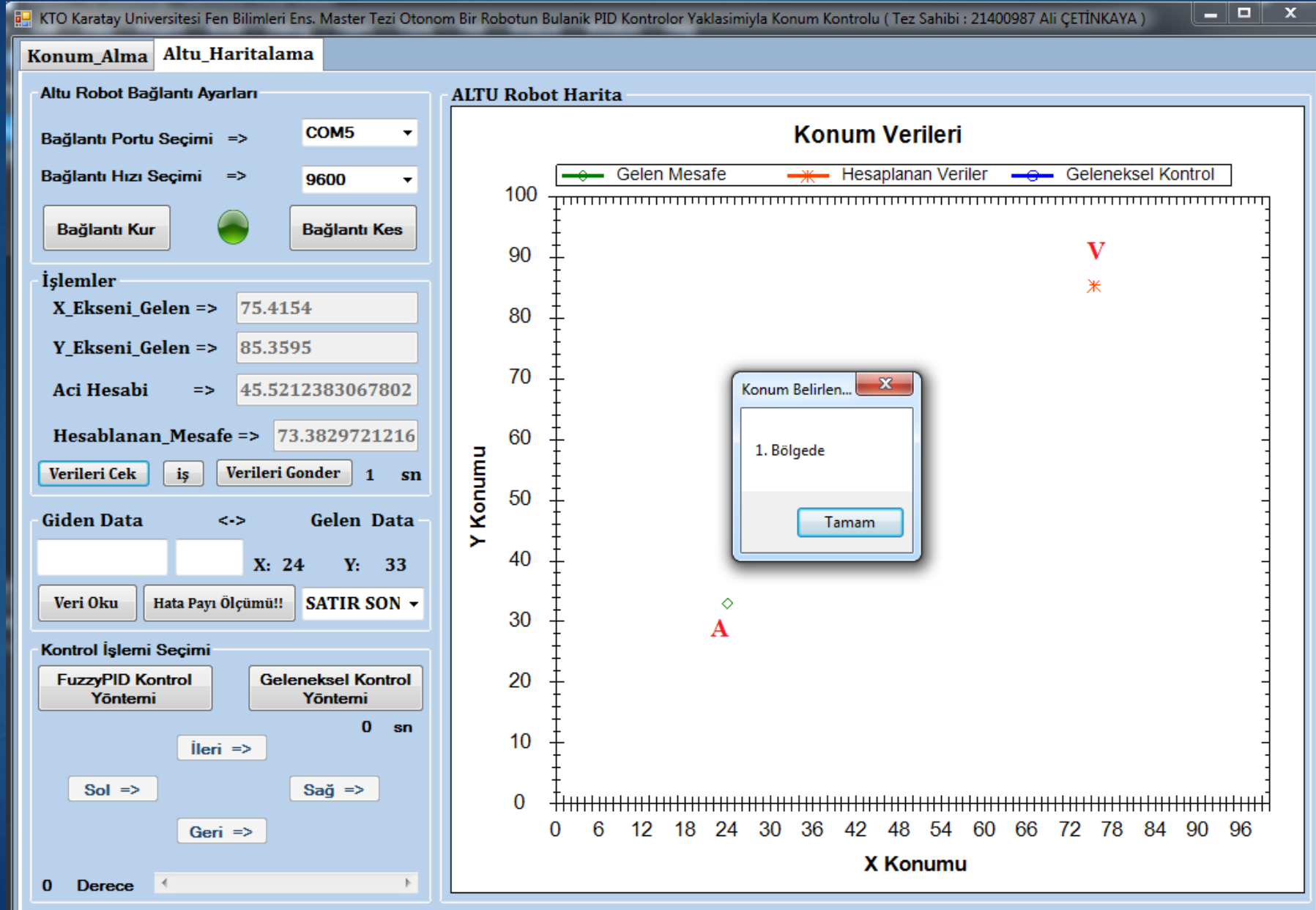
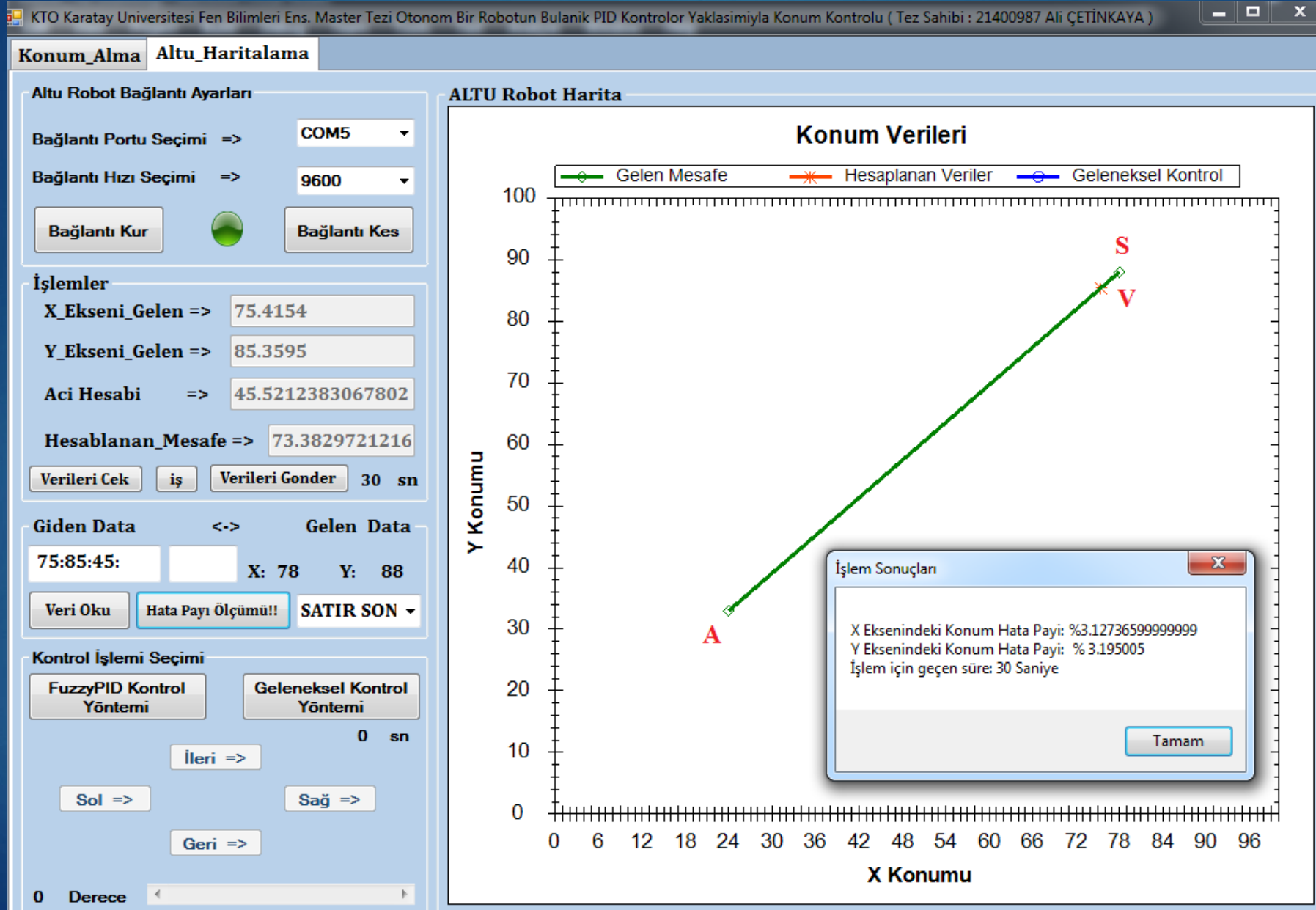# Experimentals
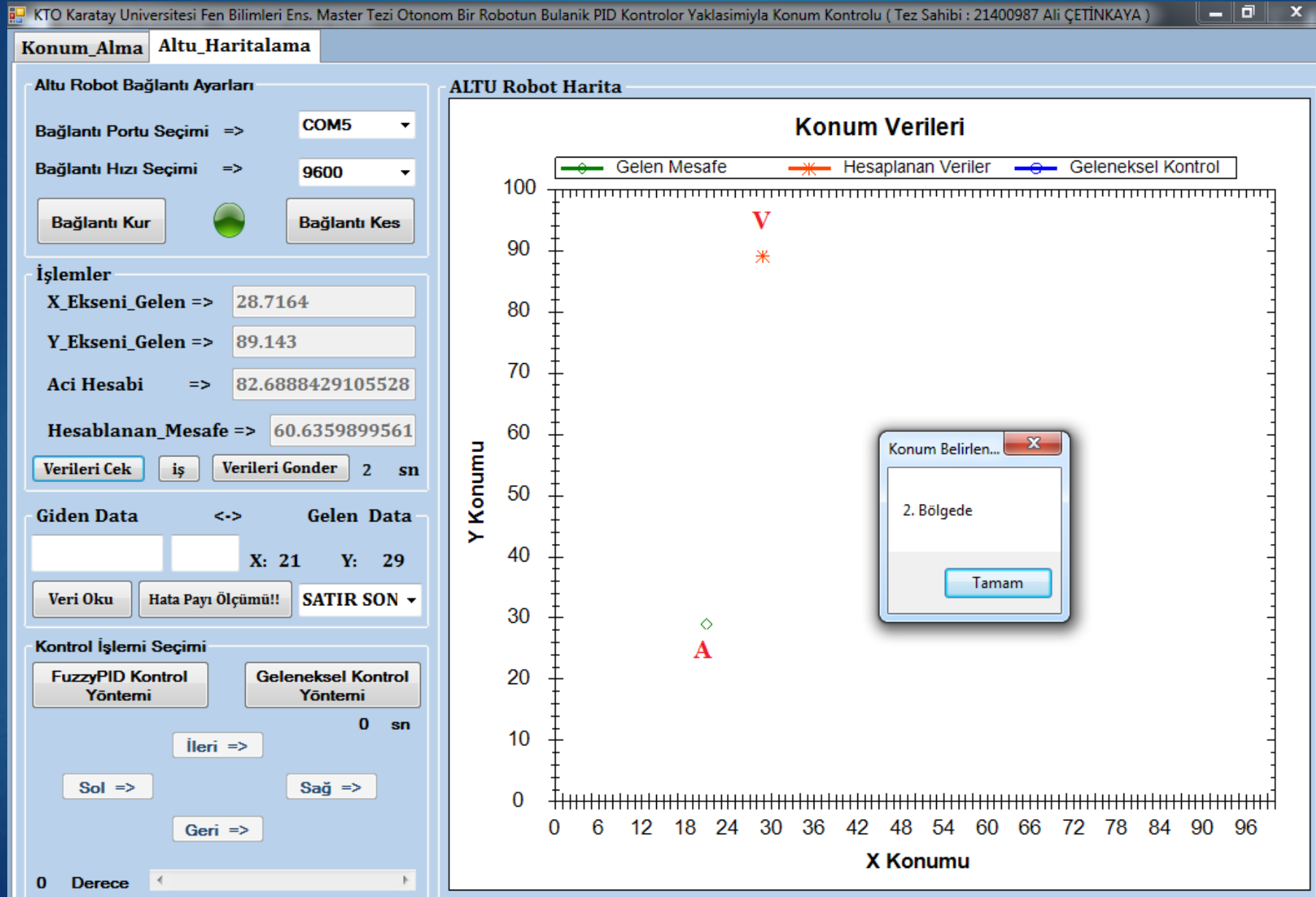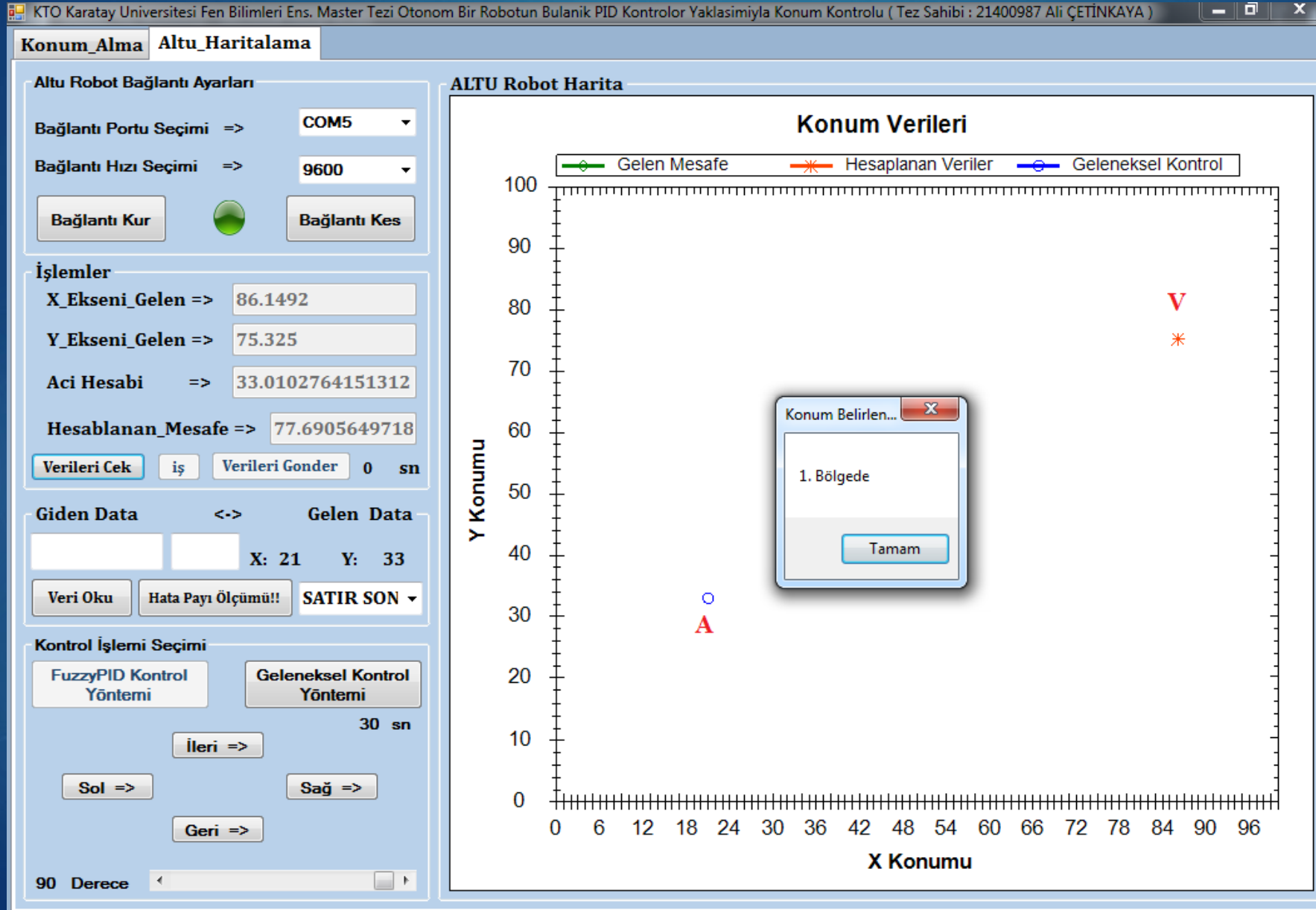
# Experimentals

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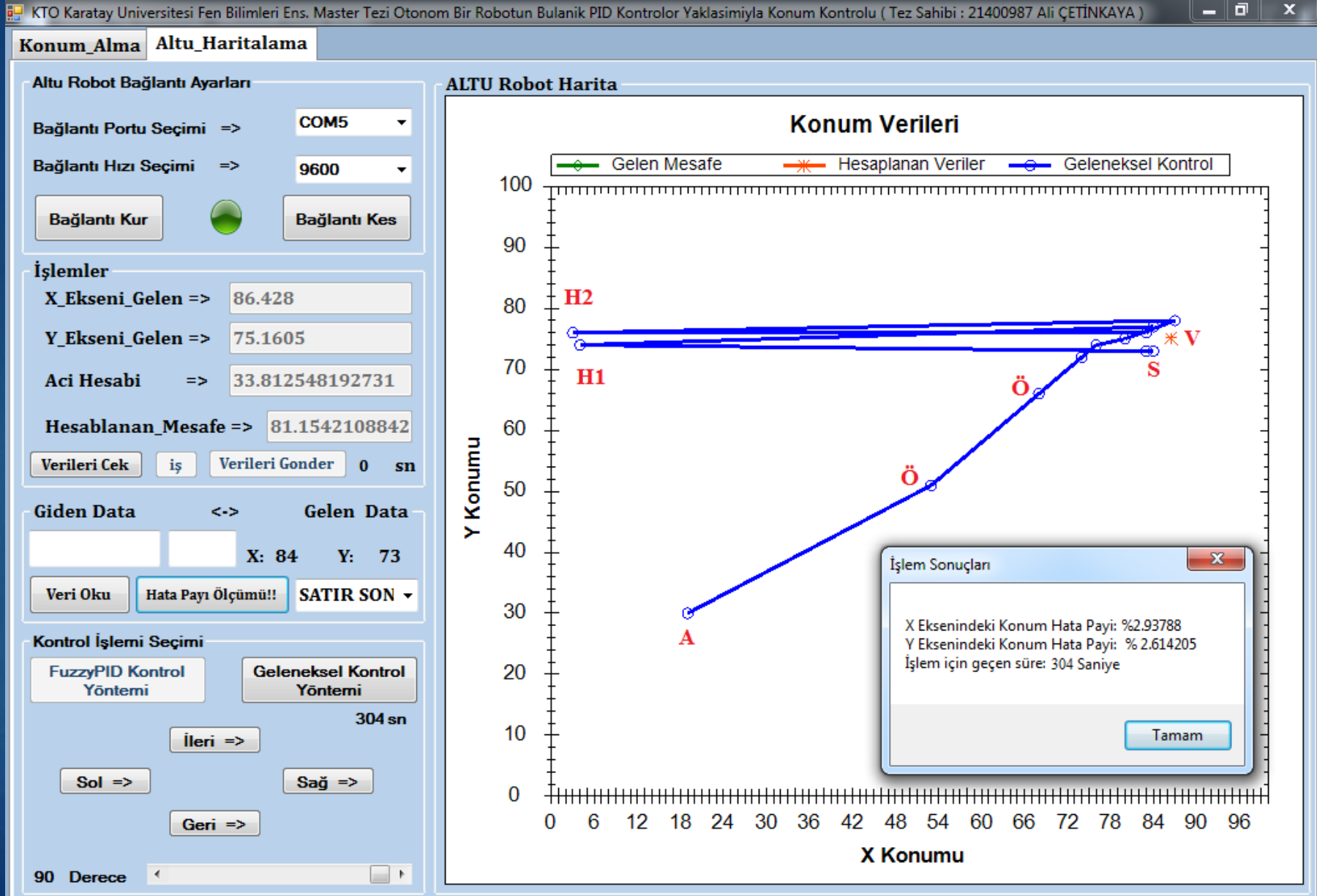# Experimentals

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# Conclusions

▶ In this study, the "Fuzzy Approach" and the "Traditional" methods for controlling the Altu robot autonomously have been designed and applied practically. Both methods have been tested and the results have been compared in the experiment section....

## Acknowledgment

# Thank you…

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