# Hive Tracking and Early Warning System By Using Embedded System Technology

**Tugba Saray Cetinkaya *‡, Kadir Cem Tuna**, Ali Okatan****

* Technology Transfer Office, Istanbul Gelisim University, Turkey.

** Department of Computer Engineering, Faculty of Engineering, Istanbul Gelisim University, Turkey.

** Department of Electrical-Electronics Engineering, Faculty of Engineering, Istanbul Esenyurt University, Turkey.

(tsaray@gelisim.edu.tr, kadircemtuna@gmail.com, aliokatan@esenyurt.edu.tr)

‡ Corresponding Author: Tugba Saray Cetinkaya, Technology Transfer Office, Istanbul Gelisim University, Turkey.

**ABSTRACT-** In this study, the high costs and theft of bee swashes and hives, natural disasters, based on losses caused by various environmental factors; A system that performs continuous monitoring of hive, monitoring environmental factors with various sensors, warning and position monitoring against theft status has been developed. The latitude and longitude data provided by the GY-NEO6MV2 GPS module, the data obtained from the DHT 11 humidity and temperature sensors, data from the ultrasonic distance sensor are transmitted through the 800L GSM module. Embedded System (ATMEGA2560 microcontroller) is used in the hardware section of this system. As a result, the data received by the programming of various sensors through this system are designed and sent as SMS to the desired phone number with the help of the GSM module. The software is triggered by the message sent to the SIM card in the system. According to the user's choice of internal temperature and humidity, external temperature and humidity, system location information is taken instantaneously. A separate trigger was created using the distance sensor. With this trigger, notification is automatically sent when motion is detected around the system. In addition to the system, the desired temperature and humidity threshold values have been defined and the other triggering triggered when these threshold values have been established.

**KEYWORDS** Location Tracking in Embedded Systems, GPS and GSM Microcontroller Control, Beekeeping Early Warning System

## 1. INTRODUCTION

GPS (Global Positioning System) tracking systems are the systems that measure the distance between satellites and determine the instant position with a certain margin of error. When the usage of GPS tracking systems is examined, it is seen that it has wide application areas in military and civilian fields. However, the most common use today is the positioning and navigation of marine, air and land vehicles. Primarily designed to follow the beehives, this system is designed in a modular way so that it can be used in different environments.

With the help of GPS and camera, the match and training analysis and performance follow-up of the players were designed as wearable technology with the GPS module and dressed for the players. In terms of GPS technology, it is preferred because it is cheaper than camera cost and provides data in angles that the camera cannot see [1].

In a vehicle tracking system using GPS and GSM modules together, the data obtained with the GPS module was transferred to the desired server via SMS (Short Message Service) technology. These GPS data were passed through an algorithm called Kalman Filter. This algorithm provides more consistent results [2].

In an application running on the Android operating system, it transmits the position data obtained from the internal GPS module in the smart phones to the designed web site over the internet with the help of the internal GSM module in all phones. The data sent to the website are stored in the prepared database.

This software is designed for parents and is intended to track the location of children [3]. Thanks to a mobile application developed, it informs people in case of any natural disaster, disaster, attack in the country and directs emergency teams to the people in need. Thanks to the developed mobile application, the location of the person in distress is determined by using the GSM module built into the mobile devices and directing the necessary units [4]. A study was carried out to reduce occupational accidents and material losses in open pit mining. With this study, embedded systems were installed in all vehicles in the job site. Controls such as the continuous monitoring of the location data received by the GPS modules in the embedded systems and the fact that unauthorized vehicles cannot enter some sections and that the vehicles are left in the right places have been carried out [5]. Using GSM technology, a database management system is designed. Thanks to the designed system, remote connection to databases is established. In the system, commands are sent as coded via SMS. With these commands, reading the data from the database, deleting data on the database, adding data, editing data were performed. In the hardware part of the project, a mobile phone connected to the serial port of the computer was used [6].

In a system designed, market analyzes were conducted based on the users' positions. As a result of this analysis, a location-based marketing and advertising SMS system was created. The shopping habits of the regions were examined and target audiences were identified and these people were reached via SMS advertisements. The GPS data of the users were taken and examined. In addition, thanks to this GPS data, stores close to customers have been proposed [7]. A

study was carried out to solve the problem of finding a parking space in densely populated cities. In this distributed system, GSM system was installed in the parking spaces. Users send an SMS with location information to the system. This information is processed to determine the nearest available parking space. The route is then created between this parking space and the user. The generated route information is sent to the user again via SMS [8]. In this study, which is called Short Mesa and Distribution System, a system has been designed in which students can follow their information about the school via SMS. In addition to communicating the announcements to students, it also enabled students to access information such as absenteeism, grade information, syllabus, exam dates via SMS. Thanks to the commands sent via SMS, the relevant data was read from the database and transferred to the student again via SMS [9].

Beekeeping is an agricultural activity and a branch of production that has been done in our country from the very old times to today without losing its importance. Although developed since ancient times, its development has been slow against advances in science and technology. One of the most important issues in beekeeping is the queen bee. Worker bees gather around the queen bee and follow the queen bees constantly. The main objectives of beekeeping; to grow large and healthy adult bees and to bring these adult bees with nectar streams. Bees that meet strong nectar produce more honey[12].

These powerful bees are used to collect nectar and thus maximize honey production and pollinate local food plants. It is also carried out for commercial purposes such as raising and selling bee swarms, selling honey, selling pollen and selling propolis [12].

Honeybee is a flying insect that lives socially and as a family in the Apis genus of the bee family. They are generally known for making pentagonal nests of beeswax and filling them with honey. And thanks to their honey, they attract people, bears, honey badgers and many other animals. At the beginning of the 21st century, there are only 7 species and 44 subspecies honeybees known. The best known of these is the “Western Honeybee evcil which can be domesticated and used in honey production and pollination. In addition, honeybees made by these bees are used by modern people in soap making, candle making, lip balm and other fields. Honeybees represent only a small proportion of the more than 20,000 bee species known. Although there are other bee varieties producing honey, only members of the Apis genus are real honeybees [13].

Beehive is a closed, human-made structure where a honeybee species, which is a member of the Apis subspecies of Bee genus, generally lives and has offspring. The beehive was prepared to describe the nests of the bee colony, but the nests differ scientifically and professionally from the hives. The nest is used to describe the habitats of living colonies that contain living things in natural or artificial spaces or hanging and exposed. The hive is defined as an artificial, human-made structure that houses a nest of honeybees. Several Apis species live in colonies but are separated into western honeybees (Apis mellifera) and eastern honeybees (Apis cerana) for honey production [14]. The inner structure of the nest is a group of hexagonal prismatic cells produced from beeswax called honeycomb. Bees use these cells to store nutrients (honey and pollen) and to house offspring (eggs, larvae and pupae). Beehives are used in areas such as honey production, pollination of nearby plants, shelter bees for api therapy treatment and attempt to alleviate the effects of colony collapse disorders. In some areas, hives are transported to different locations during the year, so bees can pollinate crops in other areas. The beehives used in beekeeping are shown in Figure 1.

**Fig. 1.** Beehives

Honeybees use caves, rock caverns and hollow trees as natural nesting places. In hot climates, they can form open openings. The nests consist of multiple honeycombs parallel to each other with a smooth bee space [15].

Hives often have a single inlet. Western honeybees prefer nests by volume of about 45 liters and avoid those less than 10 liters or greater than 100 liters [15].

The main task of the designed tracking system is to provide instant accurate GPS, temperature and humidity data by integrating to beehives, buried systems, civil or military robots, vehicles and products that are at risk of theft for different personal uses. With the inserted sim card, data can be received from anywhere in the world. If it is used in buildings with theft risk, the motion sensor is activated and a notification is sent as soon as motion is detected. In addition to latitude and longitude data, it also provides data such as date, time, speed and altitude. In this respect, it is suitable for use in fixed buried systems as well as mobile buried systems. The main definitions created on the system are latitude, longitude, humidity and temperature. The obtained data is formed and converted into an extension (Link) which will show the exact position on the map when opened.The latitude, longitude data provided by GY-NEO6MV2 GPS Module in the embedded system is captured and controlled instantly and transferred to the “latitude” and “longitude” variables defined in the software developed using the Arduino embedded system development platform. These variables are then converted to a link to the exact location on Google Maps and sent via SMS to the desired phone number. Thanks to the motion sensor in the system, an alert can be sent automatically when motion is detected without an external request. This aspect provides early action for cases such as theft or disaster. With the humidity and temperature sensors, changes in the inside

and outside of the barrel can be monitored. Provides early action by giving warning in abnormal situations.

In this study, the data were obtained with the software developed using Arduino development platform, GY-NEO6MV2 GPS Module connected to the embedded system (Atmega2560 Microcontroller). For this purpose, SIM800L has been transferred via GSM Module via SMS. At the same time, these data were transferred to computer using serial port and transferred to software developed using Microsoft Visual Studio C # development platform. The computer used in this system is the Monster Tulpar T7 V3 model. In practice, solder was used for the necessary connections. All components are assembled on the perforated plate.

## 2. HARDWARE

In the first case of the designed system, it was aimed to use G229 GPS Module and SIM800L GSM module together with Arduino Uno R3 embedded system which has Atmega 328p microcontroller. Afterwards, the Arduino Mega 2560 R3 model was preferred because the GSM and GPS modules need more than one serial port output.

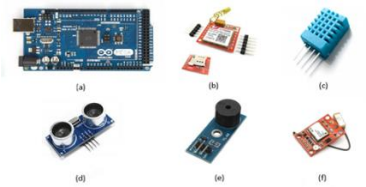

**Fig. 2.** Hardware Parts of the System

The Arduino Mega 2560 R3 model shown in Figure 2-a has the ATmega2560 microcontroller. The operating voltage is 5 Volts. Input Voltage limits are between 6-20 Volts. The recommended supply voltage is 7 - 12 V. While the Arduino Uno R3 has 14 input / output pins, the Arduino Mega 2560 R3 has 54 input / output pins, 15 of which are PWM.

The SIM800L GSM module manufactured by the SIMCOM brand shown in Figure 2-b is used. It can be integrated and run on many development boards. It has a sensitive supply voltage between 3.8V and 4.2V. 4V supply is recommended. It consumes a maximum of 2 mA power in sleep mode, 7 mA in standby mode, 350 mA in GSM transmission and a maximum power consumption of 2000 mA. It is preferred because of its small size. It measures 25 x 23 mm. It has UART interface and supports AT command system. At the bottom, there is a MicroSIM card socket. It can operate at frequencies of 850/950/1800/1900 MHz. IPX antenna connection is available. It has an integrated LED to indicate the operating status. It operates between -40 and +85 ° C [15].

The DHT11 humidity and temperature sensor shown in Figure 2-c is an advanced sensor point that provides filtered digital signal outputs. Stable in systems that provide reliable results and run for long periods of time. It has an 8-bit microprocessor that provides fast and accurate measurement. It measures temperature with an error of 2 ° C between 0 and 50 ° C and humidity with an error of 5% RH between 20-90% RH.

Ultrasonic distance sensors shown in Figure 2-d work by measuring the time of the sound wave that they send and returning and finding the distance from that time. The sensor used in the project is HC-S04. It can measure from 2 centimeters to 400 centimeters with an accuracy of 3 millimeters. It has 5V operating voltage and 15mA operating voltage. The operating frequency is 40 Hz [16]. Viewing angle is 15 degrees. The minimum viewing range is 2 centimeters and the maximum viewing range is 4 meters. It has 10 us TTL trigger leg input and echo leg output signal. The dimensions are 45 mm x 20 mm x 15 mm.

The Buzzer Module shown in Figure 2-e is an integrated circuit that provides audio output in electronic circuits. It can be used in warning systems, Arduino or other microcontroller development environments. When the Input / Output pin is triggered with 5V or 3.3V, the buzzer will start to sound. The card operating voltage is between 3.3 and 5V [17].

The GY-NEO6MV2 GPS Module manufactured by Ublox, shown on Figure 2-f, is an advanced module that uses GPS technology to determine position. It has a sensitivity of 5 meters. GY-NEO6MV2 GPS Module has 160 dBm tracking accuracy and 146 dBm acquisition sensitivity. It has 50 channels. Under a clear sky, it has a Cold Start time of less than 29 seconds and a Hot Start time of less than 1 second. It has a CEP accuracy of 5 meters. SBAS (WAAS, EGNOS, GAGAN, MSAS) support. It has an anti-lock system. 22 mA current is required during operation [18].

## 3. CONTROL AND SOFTWARE ALGORITHM OF SYSTEMS

Figure 3 shows the software flow diagram of the system. On the flow diagram, this code basically consists of two functions, Setup and Loop. After the system is started, GSM and other module connections are started. Check whether the GSM connection is established. If not, it is expected. After the GSM connection is made, the temperature and humidity data are read from the sensors. The position data is then read from the GPS module and the counter that controls the trigger connected to the movement is reset. If motion is detected, the motion counter is incremented by one. If the transaction counter has expired, a notification SMS is sent. If an SMS is received from the system, the SMS is read and according to the code in the Switch-Case structure of the incoming SMS; Humidity and Temperature data is sent, position data is sent, or the alarm sounds. If the incoming SMS is not defined in the system or is incorrect, the menu is sent to the user. This completes the cycle and returns to the beginning of the cycle.

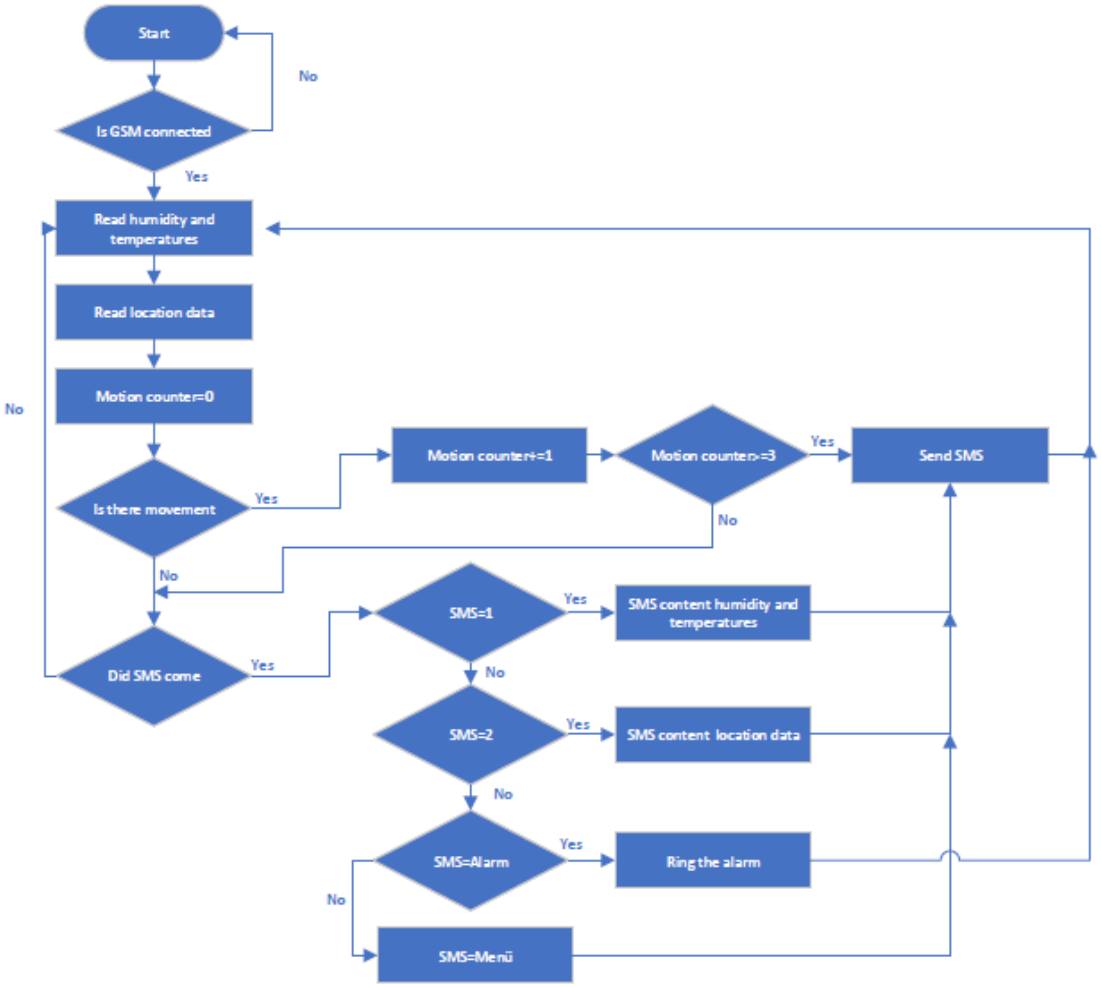


**Fig. 3.** Flow diagram of algorithm step.

Microcontroller programming on the designed system is done with Arduino software. This software is an open source, electronic platform that can be easily developed hardware and software [10]. The main electronic component of the system designed on this platform is the GY-NEO6MV2 GPS module which carries the GPS system on it. GPS is the abbreviation of Position Global Positioning System iyle in Turkish. The Global Positioning system is a satellite-based navigation system. It consists of at least 24 satellites available around the world. The Global Positioning system operates in all weather conditions, around the world, 24 hours a day, with no membership and installation fees [11].

The satellites were initially sent by the United States Department of Defense for military purposes. However, it was opened to the use of civilian people in the 1980s [11].

For this purpose, the protocol established between the microcontroller and the GPS module is read by the third serial port on the microcontroller and the GPS module is read. The following is a block of code that can be read. At one second interval, the GPS data is read and parsed, and the data required for the software is printed.

```
 for (unsigned long start = millis(); millis() - start < 1000;)
 {
   while (Serial3.available()) Is serial port 3 active?
   {
     char c = Serial3.read();   // Data read from Serial 3
if (gps.encode(c))              // Is there valid data?
      newData = true;           // New data received
    }
  }
  if (newData)  // If new data is received
  {
//The latitude and longitude data are requested from the
//GPS.
    unsigned long age;
    gps.f_get_position(&flat, &flon, &age
    Serial.print("LAT=");
    Serial.print(flat ==
TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
// The latitude data is printed.
    Serial.print(" LON=");
    Serial.print(flon ==
TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
// The longitude data is printed.
    Serial.print(" SAT=");
    Serial.print(gps.satellites() ==
TinyGPS::GPS_INVALID_SATELLITES ? 0 :
gps.satellites());
// How many satellites the data is received
    Serial.print(" PREC=");
// It has a sensitivity ratio.
    Serial.print(gps.hdop() ==
TinyGPS::GPS_INVALID_HDOP ? 0 : gps.hdop());
```

```
}
```

When programming the GPS module with Arduino, the Serial Port connection is used. When developing in Visual Studio environment, Serial Port is used again. The information sent by the GPS module to Arduino will be redirected to Visual Studio and used. The serial port operates on the principle that data is sent in series from the port. That is, the information is sent as one bit at a time. This is because the port only works with one data line per direction. Serial ports are also called COM ports. It forms a communication device between the external devices and the computer. The most common devices used with serial ports are serial printing devices such as modems, mice, printers and keyboards.

The most important difference between a serial port and a parallel port is that the transmission of information through the serial port is more reliable. Because the data is transmitted individually. In this case, the problem of being slow occurs. Therefore, parallel ports transmit information faster than serial port. Parallel port transmits information in octal packets. System.IO.Ports uses the class structure to control the serial ports to which it is connected. The most important class used is SerialPort, which provides synchronous, event-oriented input / output, PIN and interrupt status for access, and a framework for accessing serial drive features. Allows the serial port to be accessed by classes that use stream streams that can be used to scroll.

To make a serial port connection in the Visual Studio development environment, first add the “System.IO.Ports ütüph library to the project. The SerialPort tool is added to the created form screen from the Toolbox. The SerialPort tool is an invisible tool but runs in the background. The SerialPort tool is added to the form screen as shown in the image. Some special functions need to be created in order to establish a connection between the form display and the serial port. The currently active and available ports are added to the ComboBox tool that is added to the form screen with the following code snippet. The important part is that this piece of code is executed in the form's load () load function. With this flow created, when the form screen is loaded, the available ports that are active will be displayed.

```
String[] Ports = SerialPort.GetPortNames();

        comboBox1.Items.AddRange(Ports);
```

The SerialPort.GetPortNames () function returns an array of serial port names that are active on the computer. Then, the desired port is selected from the ComboBox tool and connection is made with the help of a button. The following code snippet is used to make this connection.

```
try
        {
           serialPort1.PortName = comboBox1.Text;
           serialPort1.Open();
        }
catch (Exception)
        {
           throw;
        }
```

The important part here is the serialPort.Open () function. The serialPort.Open () function opens a new serial port connection. Using the Try-Catch link, it is possible to capture possible errors. Another important part is that in the form's closing function (Form1_FormClosing), the serial connection must be terminated. This prevents potential errors and releases the selected serial port for other uses.

```
if (serialPort1.IsOpen)

            serialPort1.Close();
```

The serialPort1.Close () function terminates the open serial port connection. After the serial port connection is established, data can be read in several different ways. Since there is a continuous data flow from the GPS sensor, the event of the serial port is triggered when data is received.

```
 String Datain;
// String variable that holds incoming data
 private void serialPort1_DataReceived(object sender, SerialDataReceivedEventArgs e)
      {
         Datain = serialPort1.ReadExisting();
         this.Invoke(new EventHandler(ShowData));
      }
      private void ShowData(object sender, EventArgs e)
      {
         textBox1.Text += Datain+"\n";
}
```

Here the incoming data is transferred to the textbox using EventHandler. EventHandler allows us to define how to react to an event. Here, a function named ShowData is created, the received data is displayed in the desired textbox tool.

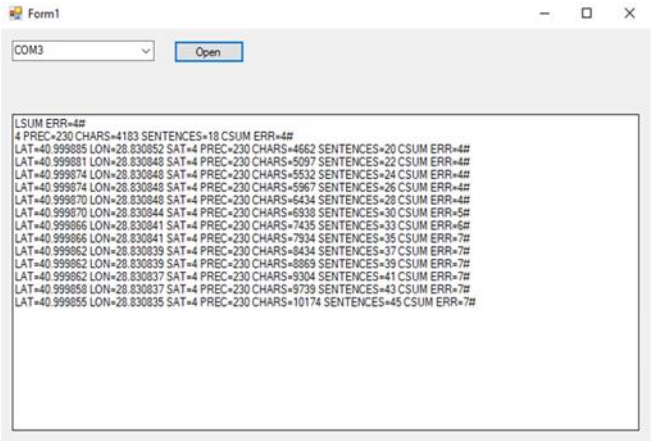


**Fig. 4.** Data from Serial Port Connection

Figure 4 shows the data from the interface screen designed on Visual Studio c # Form. The SIM800L module, which provides communication with the user of the designed GSM system, works continuously within the loop function and checks whether an SMS message is sent to the inserted SIM card or not and reads it. The following is the code block that is executed via the SIM800L GSM module.

```
if (started) { // If the GSM module is ready
   if (gsm.readSMS(smsbuffer, 160, n, 20))
/*
If an SMS is received, it assigns the incoming message and
SMS sender number to the corresponding variables.
*/
    {  Serial.println(n);
// Prints the SMS sending number on the screen.
    Serial.println(smsbuffer);
// Prints the SMS message on the screen.
    Serial.println("------------------")
    digitalWrite(buzzer, LOW);      // The buzzer is run.
    delay(200);
// The system is delayed by 200 milliseconds.
    digitalWrite(buzzer, HIGH);     // Buzzer stops.
    delay(100);
// The system is delayed by 100 milliseconds.
    SmsYolla(smsbuffer);
// The incoming message is forwarded to the Send SMS
//function.}
 }
```

DHT11 sensor module is used to measure the humidity and temperature values defined for the designed system. The DTH11 provides a high-precision digital IO pin for measuring calibrated temperature and humidity data connected to the Arduino. The sensor provides temperature in Celsius format and converts the measured temperature into Fahrenheit, Kelvin and Rankine by the Arduino program. Temperature measured on the system is sent to GSM Module via serial port. DHT11 can read temperatures between 0 ° C and + 50 ° C and humidity between 0% and 100%. The Arduino microcontroller card measures temperature and humidity reads at two-second intervals within the limits specified in the software and sends it to the GSM module on the serial port.

Equations (1), (2) and (3) and other temperature units of information measured in centigrade (Fahrenheit, Kelvin and Rankine) conversion formulas are given below.

$$\text{Fahrenheit=- T (° F)} = \text{T (° C)} \times 9/5 + 32 \quad (1)$$

$$\text{Kelvin=- T (K)} = \text{T (° C)} + 273.15 \quad (2)$$

$$\text{Rankine=- T (° R)} = (\text{T (° C)} + 273.15) \times 9/5 \quad (3)$$

The code blocks that measure the temperature and humidity with DTH11 on the system are given below.

```
nem1 = dhtsensor.readH
umidity();
// First humidity data is read.
sck1 = dhtsensor.readTemperature();
// The first temperature data is read.
nem2 = dhtsensor2.readHumidity();
 // Second humidity data is read.
sck2 = dhtsensor2.readTemperature();

// The second temperature data is read.

 if ((nem1 < 20 || nem1 > 70) || (sicaklik1 < 5 || sicaklik1 >
35))
{
// If the data is above the threshold values, the system
// notifies you.

          SmsYolla("44458");
         delay(2000);
```

## 4. EXPERIMENTS

In this study, the developed system works in accordance with the sent SMS. The different streams are shown below on the applications.

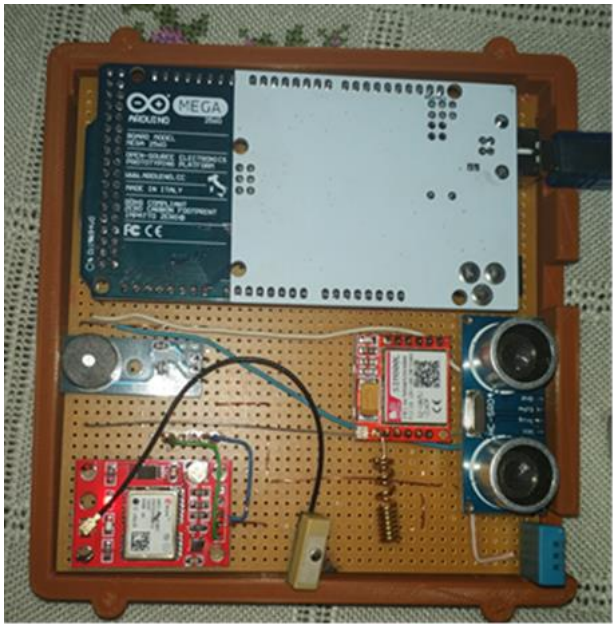

**Fig. 5.** Completed Version of the Circuit

Figure 5 shows the design of the electronic card, which is designed by drawing on Solidworks software, and placed in the box.

### 4.1. System Start and Menu

The system starts to operate from the moment it is connected to electricity. Wait until you receive an SMS. Sends the menu to the user after a discarded message.

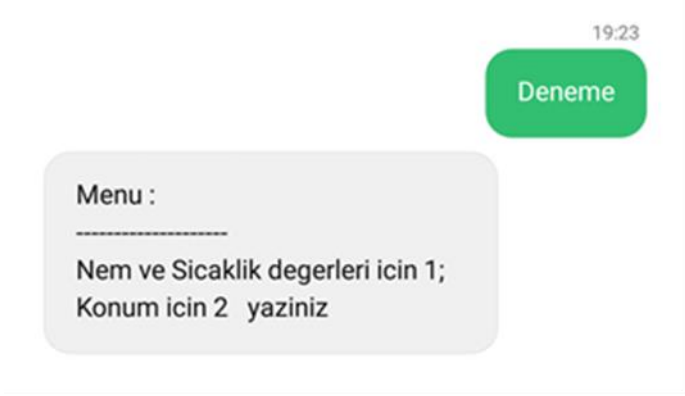


**Fig. 6.** SMS Showing Menu

The menu shown to the user as a result of any incorrect SMS is as shown in Figure 6. The response of the "Trial (Deneme)" letter sent to the system on Figure 6 is received as a binary option. The first is to write and send 1 for humidity and temperature values, the second is to write and send 2 for position.

### 4.2. Location Data Request

If 2 is selected in the incoming menu, position data is transferred. When we call the response 2 to the system as shown in Figure 7, the hardware sends us latitude and longitude information running on Google maps.


**Fig. 7.** SMS Showing Menu

As shown in Figure 7, the location data comes as a link that will automatically open in Google Maps.

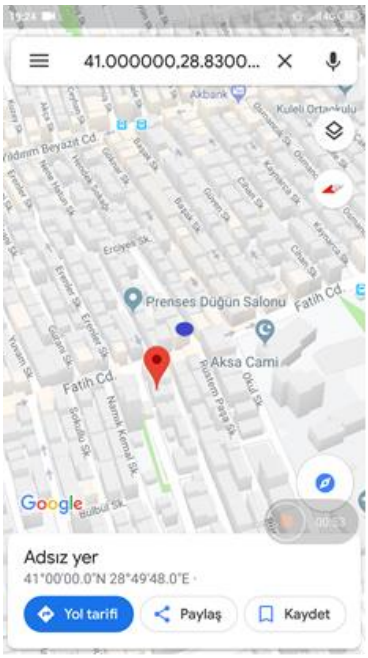


**Fig. 8**. Displaying Location Data from the System on Google Maps

When the link showing the GPS information is opened, it appears as in Figure 8. There are approximately 5 meters of error with the actual location data.

### 4.3. Humidity and Temperature Data Requested

1 When the option is selected, the system's temperature and humidity values are displayed. It is shown in Figure 9.


**Fig. 9.** Temperature and Humidity values of the system

When the response 1 is sent from the system to the equipment as shown in Figure 9, it sends the humidity and temperature information of the equipment's environment. In Figure 9, outdoor temperature (Dis Sicaklik) information is 26.9oC, humidity (Dis Nem) is 41.00%, indoor temperature (Ic Sıcaklık) is 28oC, humidity (Ic nem) is 41.00%

### 4.4. Motion Detection

If a continuous movement is detected around the system, an automatic notification is sent to the user. This notification is as shown in Figure 10.


**Fig. 10.** Motion Detected Message

When the hardware detects any motion at the moment of instant operation, the system sends the warning message (Motion detected) shown in Figure 10 to the system.

### 4.5. Alarm Play

If the user wants to sound an alarm, the buzzer on the system will sound for 5 seconds. This message is as shown in Figure 11.

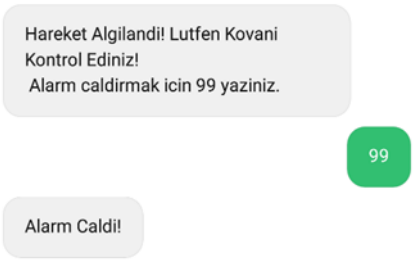


**Fig. 11.** Motion Detected Message

### 4.6. Incorrect Sms

In case of an incorrect SMS, menu is sent to the user automatically. This is shown in Figure 12. If the sent messages contain invalid characters or if a missing message is sent to the hardware, the menu information is sent to the user.

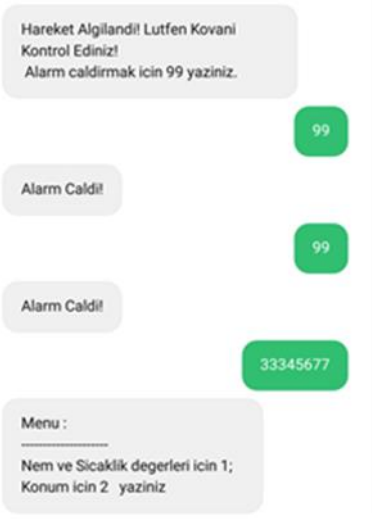


**Fig. 12.** Incorrect Condition SMS

## 5. Conclusions and Discussion

As a result of the studies, it has been shown on the literature that GPS and GSM technologies facilitate use in many areas. Starting from the high costs of bee swarms and hives and damage caused by theft, natural disaster and various environmental factors; A system was developed to monitor the hives continuously, monitor the environmental factors with various sensors, and make warning and position tracking against theft. This system has been developed to provide remote control and monitoring of beehives through the joint use of different technologies.

Thanks to this developed system, producers can easily follow their hives via satellite even if they are in other cities. In addition, early warning system against environmental factors has been developed with the help of sensors on the system. Thanks to this system, beekeepers can react early to events occurring in and around the hive. The developed system allows continuous monitoring of indoor and outdoor humidity and temperature information for 24 hours to examine the status of bees and environment. The two main tasks of this developed system are tracking the sensor data and GPS position tracking.

Thanks to the constantly evolving phone operating systems such as Android and IOS, application convenience is also improving. In this context, instead of SMS technology, mobile software can be developed and thus the monitoring of the system can be transferred to the internet environment. More than one module can be used and different users can be added on the mobile software targeted to be developed. Thus, the monitoring of more than one sleeve or zone can be performed via the same interface. At the same time, retrospective graphs can be generated by storing the data.

Energy requirements of the system can be reduced by using more advanced hardware integrations. The system can be reduced in size and increased accuracy. In line with these improvements and improvements, the project can work much more efficiently.

**Acknowledgements**

Many thanks to Istanbul Gelisim University and Technology Transfer Office for their support.

**References**

[1] G. Ünlü, B. Polat, A. H. Güler, A. Işık, Futbolda Oyuncu Performans Takiplerinde Kullanılan Küresel Konum Belirleme (GPS) ve Çoklu Kamera Sistemlerinin İncelenmesi, Sportif Bakış: Spor ve Eğitim Bilimleri Dergisi, 5 (SI1), 38-45, 2018.

[2] M. Al-Khedher, Hybrid GPS-GSM Localization of Automobile Tracking System, International Journal of Computer Science & Information Technology (IJCSIT) Vol 3, No 6, Dec 2011, DOI: 10.5121/ijcsit.2011.3606.

[3] H. Bayıroğlu, K. Ayan, Android Üzerinde Web Tabanlı Çocuk Takip Sistemi, SAÜ. Fen Bil. Der. 18. Cilt, 2. Sayı, s. 87-91, 2014.

[4] J. Juaneza, Hinigaran Community Emergency Assistance System Application, Journal of Education and Technology Management, Volume 1, No. 1, October 2018.

[6] F. Kasa, Açık İşletmelerde Ocak İçi Güvenliğinin Arttırılmasında GPS'in Kullanımı, Yüksek Lisans Tezi, Çukurova Üniversitesi Fen Bilimleri Enstitüsü, 2008.

[7] U. Karakoç, GSM Üzerindeki SMS ile Veritabanı Kullanımı, Yüksek Lisans Tezi, Marmara Üniversitesi, Fen Bilimleri Enstitüsü, 2004.

[8] G. Çınar, Mikro Lokasyon Bazlı Teknolojilerin Mobil Pazarlama Alanında Kullanımı: Kitlesel, Kesimlenmiş ve Lokasyon Datası Bilinen Müşterilere SMS Gönderimi, Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, 2015.

[9] Ç. Cura, Parking Spot Finder: An Automated Software Service with SMS And Map Interface, Yüksek Lisans Tezi, Bahçeşehir Üniversitesi, Fen Bilimleri Enstitüsü, 2009.

[10] H. Yüzücü, SMS Distribution and Information System, Yüksek Lisans Tezi, Işık Üniversitesi, Bilgisayar Mühendisliği Anabilim Dalı, 2003.

[11] Arduino, 2019, What is Arduino, https://www.arduino.cc/en/guide/introduction, Erişim Tarihi, 13.02.2019

[12] Garmin, 2017, What is GPS, https://www8.garmin.com/aboutGPS/, Erişim Tarihi, 15.02.2019

[13] Tarım ve Orman Bakanlığı, 2013, Arıcılık, https://www.tarimorman.gov.tr/Konular/Hayvancilik/Aricilik, Son Erişim Tarihi: 14.05.2019

[14] Honeybee Centre, 2015, What is Beekeping, http://www.honeybeecentre.com/learn-about-beekeeping#.XNnjqbtR1hE, Son Erişim Tarihi: 14.05.2019

[15] SIMCOM, SIM800, https://simcom.ee/modules/gsm-gprs/sim800/, Erişim Tarihi, Erişim Tarihi, 15.05.2019

[16] A. Çalış, 2013, Ultrasonic Mesafe Sensörü, https://www.direnc.net/arduino-ultrasonic-sensor-hc-sr04, Erişim Tarihi, 15.05.2019

[17] Robotistan, Ses Kartı, https://www.robotistan.com/ses-karti-buzzer-karti, Erişim Tarihi, 15.05.2019

[18] NEO-6 u-blox 6 GPS Modules Data Sheet, https://www.ublox.com/sites/default/files/products/documents/NEO-6_DataSheet_%28GPS.G6-HW-09005%29.pdf, Son Erişim Tarihi: 16.05.2019