

third section draws the reader's attention by presenting an overview and implement to its applying circumstances of our new Smart and Flying Umbrella (SFU). The fourth section is about challenges and hurdles of SFU which may face while carrying out the functions of it. Then, we turn to some researches that are related to our research. And in the sixth section, we discuss possible methods and devices that are applicable for SFU to carry out additional functions. Finally, the last section is devoted to illustrating a summary and our future works.

II. ORDINARY UMBRELLA

The ordinary umbrella which has been utilizing commonly from the date it was invented till now was regarded as an astonishing invention at that time and it is worth to note that, that sort of umbrella is still maintaining its importance stably in our life existence. This item presents a great assistance when we need protection in rainy, snowy and more importantly scorching hot weather. The following figures illustrate some occasions when we utilize ordinary umbrella.

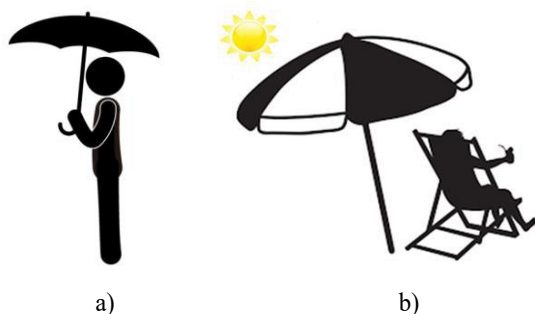


Fig. 1 Implementing of an ordinary umbrella on a particular time.

As it is apparent from the figures that an umbrella is really handy while we are on the way to our work and walking at the park as shown in the Figure 1a or as it is highlighted in Figure 1b in summer days namely in oppressively hot weather when you get a passion towards lying down on the beach umbrellas are so crucial to avoid skin burning. Furthermore, while we are working or doing something under changeable weather conditions and such occasion's umbrellas provide us with great help. However, in such circumstances sometimes we may face perceptible shortcomings of it. For instance, frequently the need of handing a folding umbrella may make the hand always busy and this limits the hand functions in some points. Turning to large and stable sunshades (umbrellas) they put into the ground to form an area which is sheltered from the light of the sun and as the sun changes its light coordination we have to replace the position of the sunshade against the sunlight and apparently it requires further care and matter. Eventually, getting some disadvantages of handing an umbrella or difficulties in moving to another place represents several trouble like requiring an extra support from someone to hold the umbrella while doing unfinished works outside in the changeable weather.

III. OVERVIEW OF THE AVUS

Above mentioned term AVUS is the name of our new startup project as the name comes from the overall features of this new smart device. Aqilli Va Uchuvchi Soyabon (AVUS) can be translated as Smart and Flying Umbrella. From its name, it is evident that this new smart umbrella carries out the older one's functions through flying above the head of the human. The draft prototype of the AVUS is given in the following Figure 3



Fig.3 Smart Flying Umbrella(AVUS)

So, this smart and flying umbrella consists of flying and operating system, frame material and several software and devices in order to follow and detect humans. In an easy way, we can describe AVUS as the composition of drone that is equipped with needed devices and folding frame of the ordinary umbrella. In the following Figure 4 a and b you may see the implement of AVUS in some circumstances.

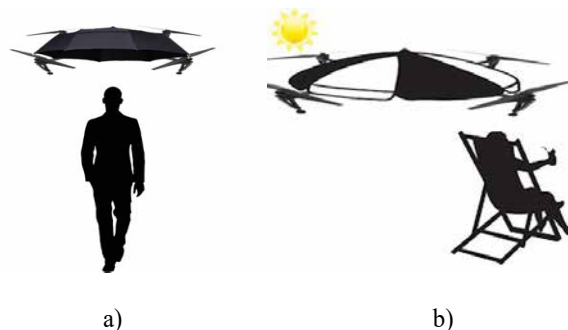


Fig. 4 Implementation of the AVUS on a particular time

IV. CHALLENGES OF THE AVUS

As the AVUS flies above a human's head and takes the same steps as the user we can consider it as a human following robot. Because it takes the function of detecting and continuously following the user. The task of Detecting and Following humans is one of the tasks of AVUS as Human Following Robots (further information on this is given in the next section). Nevertheless, to the point of carrying out these tasks, with a stark contrast to robots, our Smart and Flying Umbrella has to solve several problems and do some additional tasks. As an example, if some peculiar tasks of AVUS such as to define an exact coordination of the user, located position of the sun and to determine the falling directions of rain and snow makes some dissimilarity with Human Following Robots the task of avoiding collision with another object provides general similarities of these two sorts of robots.

V. RELATED RESEARCH

There are several related works on this research. As we mentioned above the working procedure of AVUS bears a striking resemblance with Human Following Robots as both of them have the function of detecting and following humans. In this point, our startup depends on the majority of the researchers about Human Following Robots. Detecting and following humans are considered as an essential task of Human Following Robots. In the intention of achieving the target diverse sorts of methods and devices have been proposed by lots of researchers and this process is still continuing. As a classical pattern, the most successful method among others was proposed by Jae-Geun Lee [10]. The method was invented by the researchers of Kyungpook National University in South Korea and the method proposed the ways of detecting and the following human by determining the location of human through using the wearable device. By means of wearable devices like a smartwatch and smart belt and using the fixed sensor between the device and robot's Radio Frequency (RF) and Low Frequency (LF) communication researchers showed the way of getting the expected results.

Another exciting and widespread method is following and detecting human by utilizing the sensor of Kinect High Speed. The Kinect sensor consists of a color sensor, IR depth sensor, and IR emitter and these sensors can give deep information about the object's color, size, structure (skeleton) which stands in front of it [11] [12] [13]. That is the reason of giving adequate interest towards human tracking robots by using these sensors. In these, all researchers Kinect sensor carries out nearly identical function. It means they detect human with the help of sensor by differentiating human skeleton's coordination and by means of an additional sensor and their methods they got the target of following human.

By working on several proposed human following types of research Malaysian researchers mentioned that [14] one of the most inexpensive ways was highlighted in the research of S. Shaker and J.J. Saade [15]. The reason of being such economical is by means of utilizing only Laser Range Finders (LRF) they invented to detect human pace and follow through Fuzzy Inference system.

In the way of offering methods towards detecting and following human one of the well-received approach is using diverse sort of cameras to recognize the parts of human body like a foot, face, shoulder or to identify external details such as the color of the garments and texture. For instance, [16] binocular camera was utilized in order to identify the color of human's garment and its texture, 2 stereo cameras [17] were applied to take a photo of the objects in front of the robot and identify the diversity of the objects. By using the diversity of the pictures through algorithms researchers have presented their methods about human following robots [18]. The authors describe a robot with the following and returning function using a monocular camera. Apart from this, in order to detect human, there have been used diverse sorts of cameras such as monochromatic [19] and omnidirectional [20] [21]. Nearly in all the mentioned works in order to track humans besides

cameras, additional devices, as well as algorithms, have been also utilized.

VI. POSSIBLE SOLUTIONS

By means of tracking human AVUS protects him from rainfall, snowfall, and sunlight. On this matter, it is required not only following but also it has to make an action towards an exact coordination. In such points, as we have mentioned in section IV making a stark contrast with human following robots AVUS have to make additional functions. Following units illustrate such functions as well as their feasible solutions.

A. Determining a precise coordination of AVUS

The coordination of AVUS (X_1, Y_1, Z_1) can be determined by fixing GPS or by communicating with the human coordination (X, Y, Z), the distance length $-L$ between AVUS and human and the height $-H$ between the ground and AVUS can be identified through Ultrasonic, IR or another simple sensor and by means of these all three measures it can be calculated in a mathematical way.

B. Identifying an exact coordination of human

The coordination of human (X, Y, Z) can be indicated by making a connection with portable devices (such as smartphone) or via GPS facility clarifying its coordination (X_1, Y_1, Z_1) and the distance between the user $-L$ like the problem of $-A$ can be acknowledged by sensors like Ultrasonic, IR.

C. Identifying the coordination of the sun

An accurate coordination of the sun (X_0, Y_0, Z_0) can be determined by acknowledging its geometrical located coordination (X_1, Y_1, Z_1) and the current time of particular area (DD, MM, YYYY) and (HH: MM: SS). As we know that the sun gets the same coordination according to a particular coordination in an exact time.

D. Determining falling angle of rain and snow

This matter is not concerned with the main issue as the position of falling snow or rain to the ground commonly happens at an angle of 60 and 90 degrees. Yet it is essential to be acquainted with the degree of falling angle toward the direction of the user's movement. In this term, inventing a kind of software that is specialized to get some data about the weather forecast and checking it on websites might be an appropriate solution to the matter.

E. Avoiding a collision with objects

Refraining from crushes can be solved by using some devices like Ultrasonic.

F. When the user is indoor areas

It is common that on a daily basis we have to spend some time inside a building and at that time we need the diverse amount of time. For instance, to be in public places like supermarkets or restrooms requires 5 to 10 minutes whereas at educational institutions or working places we spend more time. Taking into account such occasions it is profitable for AVUS to work in several modes. It means that if the user wants to spend a little amount of time inside a building AVUS works in a waiting mode. If it is required, changing the mode can be done by application or voice recognition.

G. Battery life problem

In all technological devices which require electricity to work battery life is concerned as the main problem, in the line of these items our device is also likely to face such problem. In some circumstances when the smart and flying umbrella run out the battery, naturally, it gets the function of ordinary umbrellas that means we can use it by handling. Furthermore, the solar energy can be utilized in order to solve the problem.

The TABLE I highlights, the devices which are likely to be used for challenges

TABLE 1. THE DEVICES THAT ARE LIKELY TO BE UTILIZED FOR CHALLENGES IN AVUS

Functions	Sensors which can use for solving particular problem						
	Ultrasonic sensor	GPS	IR sensor	Voice recognition Sensor	Camera	Range sensor	Clock
Determining a precise coordination of AVUS (A)	○	○	○			○	
Identifying an exact coordination of human (B)	○	○	○		○	○	
Identifying the coordination of the sun (C)	○	○	○				○
Determining falling angle of rain and snow (D)							○
Avoiding a collision with objects (E)	○		○			○	
When the user is indoor areas (F)				○			○

VII. CONCLUSION

In this paper, we have proposed Smart Flying Umbrella. The presented project of smart device focuses on doing all the functions of ordinary umbrella without getting any assistance from humans. It works above a human's head and protects him from the sunshine, rain, and snow. As it gives by chasing the user its working system looks like human following robots and its flying system is really close to the drones'. So this reason we can call it drone umbrella. A draft possible design, all the possible devices which are essential to do the functions and the software challenges and their possible solutions have been given in this article.

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