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By :

Laidi Mohammed
Belalmi Mohammed Ihab

THEME

Algerian Sahara smart tent using Arduino and stand alone PV systems

Publicly supported ahead of a jury composed of:

Mr. Lahdeb Mohamed	*M.C.B*	*President*
Mr. Djekidel Rabeh	*M.C.A*	*Examiner*
Mr. Biran Mouhoub	*M.C.B*	*Examiner*
Mr. Benmouiza Khalil	*M.C.B*	*Supervisor*

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ملخص

في المجتمع الصحراوي يشير مصطلح خيمة (خيمة الصحراء) أيضا إلى مفهوم الأسرة أو المنزل أو حتى القبيلة. الأكثر تقليدية مصنوعة من نسيج الشعر الجمل أو الأغنام. وهي ذات شكل هرمي مع أرضية من حصير ذات واجهة مزينة أحيانا. ومع ذلك فإن هذا البناء التقليدي للخيمة لديه الكثير من المشاكل وخاصة بالنسبة للبدو الرحل. وفقدان الإضاءة الكافية، وعدم وجود مصدر دائم للطاقة، وحرارة الصيف، والعواصف الرملية وغيرها من المشاكل التي تؤثر على حياتهم اليومية بشكل كبير وتجعلها صعبة. وبالتالي فإننا نقترح في هذه الأطروحة مفهوم و دراسة خيمة الذكية التي توفر تجربة جديدة وفريدة من نوعها تماما للبدو الرحل. هذه الخيام يمكن أن تكون ذات طاقة قائمة بذاتها باستخدام الألواح الكهروضوئية والبطاريات. مع القليل من التعديلات على المكان و باستخدام ا الاردوينو وأجهزة الاستشعار الذكية، يمكن لهذه الخيمة الذكية إعطاء المزيد من الوقت للاسترخاء وجعل الحياة سهلة.

الكلمات المفتاحية :

خيمة ذكية، أنظمة الكهروضوئية ، أردوينو، مستشعرات، التحجيم.

Abstract

In Sahrawi society the term khaïma (Sahara tent) also refers to the notion of family, home, or even the tribe. The most traditional ones are made from a weave of camel or sheeps hair. They are of a pyramidal shape with floor mats and sometimes decorated separation. However, this traditional construction of the tent provides lot of problems especially for the Nomads; the missing of sufficient lighting, the absence of permanent source of energy, the heat of the summer, sandstorms and others affect highly their daily life and make it hard. Hence, we propose in this dissertation the conception and the study of a smart tent that offers a completely new and unique experience for Nomads. These tents can be stand-alone powered using PV panels and batteries. With just a few in installations into place using Arduino and smart sensors, this smart tent giving more time to just relax and makes life easy.

Key-words :
Smart tent, PV systems, Arduino, Sensors, Sizing.

Résumé

Dans la société sahraouie, le terme khaïma (tente du Sahara) se réfère également à la notion de famille, de maison ou même de la tribu. Les plus traditionnels sont fabriqués à partir d'un tissage de chameaux ou de moutons. Ils sont de forme pyramidale avec des tapis de sol et parfois des séparations décorés. Cependant, cette construction traditionnelle de la tente offre beaucoup de problèmes, en particulier pour les Nomades; le manque d'éclairage suffisant, l'absence de source permanente d'énergie, la chaleur de l'été, et d'autres tempêtes de sable affectent fortement leur vie quotidienne et la rendre difficile. Par conséquent, nous vous proposons dans cette mémoire la conception et l'étude d'une tente intelligente qui offre une expérience totalement nouvelle et unique pour les Nomades. Ces tentes peuvent être alimentés autonomes en utilisant des panneaux photovoltaïques et des batteries. Avec quelques-uns dans les installations en place en utilisant des capteurs intelligents et Arduino, cette tente intelligente donnant plus de temps pour se détendre et rend la vie facile.

Mots clés :
Tente intelligente, les systèmes photovoltaïques, Arduino, capteurs, dimensionnement.

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Dedication

I dedicate this modest work

To My dearest Mother, who was always at my side

To my father (May God has mercy on him); to my brothers and my grandparents

To all my friends who I shared the best moments of my life,

And to all those who have helped me near or far.

Laidi Mohammed.

Dedication

I dedicate this modest work

To My dearest parents how had always by my side

My grand mother (el moudjahida) and my grand father (el chahid) ,to my sister and my aunte

And the other grand parents (allh yarhmhom) , to my special friend Abdelghani Souffi

And all my best friends who I shared the best moments of my life

To all those who have helped me near or far.

Belalmi Mohamed Ihab.

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List of Abbreviation

PV	: Photovoltaic.
DC	: Direct current.
AC	: Alternative current.
GND	: Ground.
SAPV	: Stand alone photovoltaic.
IDE	: Integrated development environment.
LED	: Light emitting diode.
SMD	: Surface Mount Device.
PCB	: Printed circuit board.
MCU	: Microcontroller unit.
AVR	: Alf and Vegard'sRISC processor.
LDR	: Light Dependent Resistor.
PIR	: Passive infrared.
IR	: Infrared.
DHT	: Digital temperature and humidity.
LCD	: Liquid crystal display.
NB	: Number of Batteries
NP	: Number of panels

General introduction

A desert is a region characterized by a great drought or a very low average temperature resulting in extreme poverty of the vegetation and a very low population. The desert is thus an uninhabited zone, very dry, arid where sudden variations of temperature are present. Therefore, nature and therefore food can't exist in this arid place. Yet there are men capable of living and adopting themselves in this hostile environment

The Sahara is a politically divided desert on both sides of the tropics of cancer spreading over a dozen states: Morocco, Algeria, Tunisia, Libya, Egypt, Sudan, Chad, Niger, Mali and Mauritania. However, this border division is a source of contention by local populations, land claims (Western Sahara), conflicts and movements of refugee populations. The Sahara is the largest desert in the world (in Arabic "Sahara" means desert) and represents the model of hot deserts, characterized by long and torrid summers of contrasts in temperature (annual and daily) Extreme dryness of the air, great irregularity and rarity of rains.

The Sahara is today populated by about 7 million inhabitants (especially on the margins) with an average population density of less than one inhabitant per square kilometer. Nomads often feel stifled by the territoriality of modern states; they see it as mutilating and destructive. The populations of the Sahara (traditionally nomadic) are today largely sedentary and urban.

They are concentrated in the oases and especially in the cities that have emerged in recent decades due to population explosion, the modernization of means of transport, commercial activities and the actions of different governments to sedentarized the Saharan populations (Schooling) and better control of their territory. Most nomadic peoples have not changed their way of life and wish to preserve it. Nomads often feel stifled by the territoriality of modern states.

They see it as mutilating and destructive. Nomads (known as Bedouin) life is generally pastoral, herding camels, sheep, goats and cattle. They normally migrate seasonally, depending on grazing conditions. In winter, when there is some rain, they migrate deeper into the desert. In the hot, dry summer time, they camp around secure water sources. Bedouins define themselves as members of tribes and families.

People are divided into social classes, depending on ancestry and profession. Traditionally, the Bedouin's home, the tent, is divided into three sections by curtains: the men's section, the family section and the kitchen. In the men's area, guests are received around the hearth where the host prepares coffee on the fire. This is the center of Bedouin social life. Tea is served as a welcome drink; coffee is usually prepared after the meal and is the last drink before the guest leaves.

The serving of food and drink represents the generous hospitality of the host. The men pass the evening trading news and discussing their animals. Because of the demanding nature of the Bedouin lifestyle, children are expected to assume a considerable amount of responsibility in order to help their families survive. Although modernization has changed the Bedouin lifestyle somewhat, emphasis is placed on teaching children to carry on traditional ways of life, and the advancement of modern technology is not considered important to children's education.

Modern societies have made the traditional Bedouin lifestyle less attractive since as it is demanding and often dangerous. Because of that, many tribes have settled in urban areas. It is not uncommon to see a young Bedouin building a house and living in it. Bedouins who have adapted to the modern world retain their tribal loyalties and code of honor.

Today, water is brought to their camps in trucks; and children go to school. While Bedouins continued to move their herds of camels and goats several times a year to new pastures they no longer depend on their animals for survival. Bedouins in the desert watch television powered by batteries or car batteries.

Affluent ones have car phones and satellite television. However, until today, their life is difficult. The tents are not so comfortable and the Bedouins suffer every day. Hence, by this dissertation we will develop a smart tent that makes their life as simple and comfortable. At first place, the main needs of a Bedouin family are treated. Then, for each need, a full smart system is proposed based on real time.

The concept of smart sensors is studied using Arduino card. Arduino is a freeboard printed circuit board on which a microcontroller is located. It can be programmed to analyze and produce electrical signals, in order to perform a wide variety of tasks, such as home automation (control of domestic appliances - lighting, heating, etc.), control of a robot, etc. At second place, a stand-alone photovoltaic (PV) system is studied in order to power the tent. PV systems are devices that convert solar energy into DC electric power using solar cells. Theirs market is growing year after year because of its low cost and their reliability.

In addition, the motivation of using this kind of systems is , first; Algeria has a considerable amount of sunshine hours over the year (more than 3500hours/year) and second; the support of the Algerian government and the free price of offering these systems for the Bedouins. Finally, a realization of the project of smart tent is reached. Moreover, an economic study of the hall project is reached. This dissertation is structured around three chapters:

- The first chapter will be dedicated to general basic backgrounds of Algerian Sahara and Bedouins.
- The second chapter will be devoted to the presentation of the various stand-alone PV systems components, as well as the basics of Arduino card.
- The last chapter includes the results of the proposition of the smart tent, the used sensors and their characteristics as well their schematics are also viewed. In addition, a sizing method for the PV system is reached. Moreover, an economical study including the prices of the proposed smart tent is studied.

Finally, the real realization of the project is also shown. To end this work, a general conclusion is then given as well as some recommendations for the present work and the future development .

Chapter 1

Conception of the Saharian tent

1.1 Introduction

The desert is a harsh place with vegetation covering less than ten percent of the land. Desert dwellers are lucky to receive more than twenty-five centimeters of rain per year. In order to survive, the Bedouins led a nomadic life style. Their survival depended on being able to move quickly and efficiently given the unpredictable nature of their environment.

This required their tents to be quickly and easily assembled and disassembled, and not cumbersome or heavy to transport. While primitive man used the tent as makeshift shelter, as man evolved so too did the tent. Associated with early Nomads the tent became necessary equipment for tribes that needed shelter that was required to be set up and broken down in a hurry.

The tents not only served as shelter from the harsh desert conditions but also provided a space for engaging and hosting guests. The Bedouins were renowned for their hospitality.

Guests and fellow travelers were always welcomed and the generosity of the Bedouin tribes became one of their best-known characteristics. For travelers in the desert spotting that all too familiar silhouette of a temporary Bedouin village was akin to the sighting of desert oasis. In this chapter, the Algerian Sahara as well as Bedouin tent is presented.

1.2 The Algerian Sahara

The Algerian Desert shown in (Fig.1.1) is located in north-central Africa and is part of the Sahara Desert. The desert occupies more than four-fifths of the Algerian territory. Its expansion starts from the Saharan Atlas, more or less as a stony desert and the farther in land you get the more of a sand dune desert it becomes. In the southwestern parts is the mountain range Tassili n'Ajjer located. This area is a subject of great archaeological interest and was put up on the "World Heritage List" by UNESCO in 1982 [1].

The area is known for extreme aridity and extreme heat, as daytime temperatures are commonly between $46C^{\circ}$ and $51C^{\circ}$ during the hottest period of the year in most of the desert. Cities and towns such as Ouargla, Touggourt, Ilisi, Adrar, and In Salah are among the hottest places on Earth during the height of summer. Annual average rainfall is well below $100mm$ the northernmost part but the center and the southern part receive much less than $50mm$ and are therefore hyper-arid and among the driest places on Earth.

Figure 1.1: Algerian Sahara [2].

1.3 Life of nomads in the Sahara

The Bedouin form a part of, but are not synonymous with, the modern concept of the Arabs. Bedouins have been referred to by various names throughout history, including Qedarites in the Old Testament and Arabaa by the Assyrians (ar-ba-a-abeing a nisba of the noun Arab, a name still used for Bedouins today). They are referred to as the Araab in the Koran.

While many Bedouins have abandoned their nomadic and tribal traditions for modern urban lifestyle, they retain traditional Bedouin culture with concepts of belonging to 'asaiir', traditional music, poetry, dances (like Saas), and many other cultural practices. Urbanized Bedouins also organize cultural festivals, usually held several times a year, in which they gather with other Bedouins to partake in, and learn about, various Bedouin traditions from poetry recitation and traditional sword dances, to classes teaching traditional tent knitting and playing traditional Bedouin musical instruments.

Traditions like camel riding and camping in the deserts are also popular leisure activities for urbanized Bedouins who live within close proximity to deserts or other wilderness areas.

1.3.1 Traditions of nomads

Livestock and herding, principally of goats and dromedary camels comprised the traditional livelihoods of Bedouins. These two animals were used for meat, dairy products and wool. Most of the staple foods that made up the Bedouins' diet were dairy products [3].

Camels, in particular, had numerous cultural and functional uses. Having been regarded as a "gift from God", they were the main food source and method of transportation for many Bedouins [4]. In addition to their extraordinary milking potentials under harsh desert conditions, their meat was occasionally consumed by Bedouins [5].

As a cultural tradition, camel races were organized during celebratory occasions, such as weddings or religious festivals [6].

Oral poetry was the most popular art form among Bedouins. Having a poet in one's tribe was highly regarded in society. In addition to serving as a form of art, poetry was used as a means of conveying information and social control [6].

1.4 Saharan tent (khaima)

1.4.1 The history of the tent

The history of the tent is a long and interesting tale. One of the earliest forms of shelter, the tent is associated with wanders and nomads. From man's most primitive days, the tent was used as a form of shelter. Even the most rudimentary structures have common attributes to today's dwellings – divided sections for different living functions, supporting structures, a roof, a floor and an entrance of some sort.

Tents are a fundamental tool for camping and hiking. They're used across the world for recreation and for survival, and there's no more iconic symbol of man's experience with nature.

Originally, tents served as homes, and used in a variety of environments for keeping dry and safe. With the rise of agriculture, permanent fixtures gained popularity, but tents were still common with moving armies and nomadic peoples. The design of the modern tent is still quite similar to what the original tent probably looked like: a piece of fabric draped over some poles. However, tent materials and features have changed dramatically over the last several decades, with new features and materials greatly improving its basic functions.

The First Tent

We can never really know where the first tent was invented due to the simplicity of the concept. Every person needs to stay warm, dry and safe, and when there weren't any good places to hole up for the night, people had to improvise. A few large leaves strung over some sticks would suffice, and technically, that simple construct would be a basic tent [7].

However, we do have archaeological evidence of some early examples of sophisticated tents. Scientists recently found tent ruins in Russia from about $40,000B.C$, easily the oldest tent ever verified by carbon dating [7].

The tent is Portable homes par excellence; tents can be included amongst some of the most primitive types of lodging known to man. They incorporate all of the principle elements of any small house: partitions, supporting pillars, a roof, flooring and an entrance; however them are much more than just a rudimentary canopy under which a person can eat and sleep: tents are mobile shelters and represent the “portable home” par excellence [6].

1.4.2 Discerption of the architecture of the tent (Khaima)

The Khaima (Fig.1.2) is made from wool and hair provides heat and heating and avoid rain water, as well as protection from the sun and heat .tent a cut cloth sewn together every piece called "Fulaij" varying lengths Fulaij either broad usually 1m weaves directly on the ground, planted pegs pulls the fabric Atoasith two pieces of woods [8].

Extensions of tent:

- "Alteriga", a piece of tissue located at the front entrance along tent;
- "Alehial" a piece of lightweight fabric "curtain point separates women from men hand”;
- Tent rises from the earth, wooden tent poles, call a "Alrkizha" basic mediates the longest column on tent so flies on a hierarchy, On the column header "Alguentas" It is flat and circular piece to keep the tent from the rupture;

Figure 1.2: Algerian tent (Khaima) [8].

- "doors" two columns Allosttiyan front and back;
- "Alswaba" is the columns side pillars;
- "Mattress tent":

Carpeted tent inside with mattress mystical called urban bed, which is dominated by red and black Colors [7]. Construction of the tent by lifting wooden poles, but there are some special remarks which angles own tendency tent in the summer than tilt angle allowing the entry of air currents to be given revivification cooler in two points of the tent (Fig.I.3).

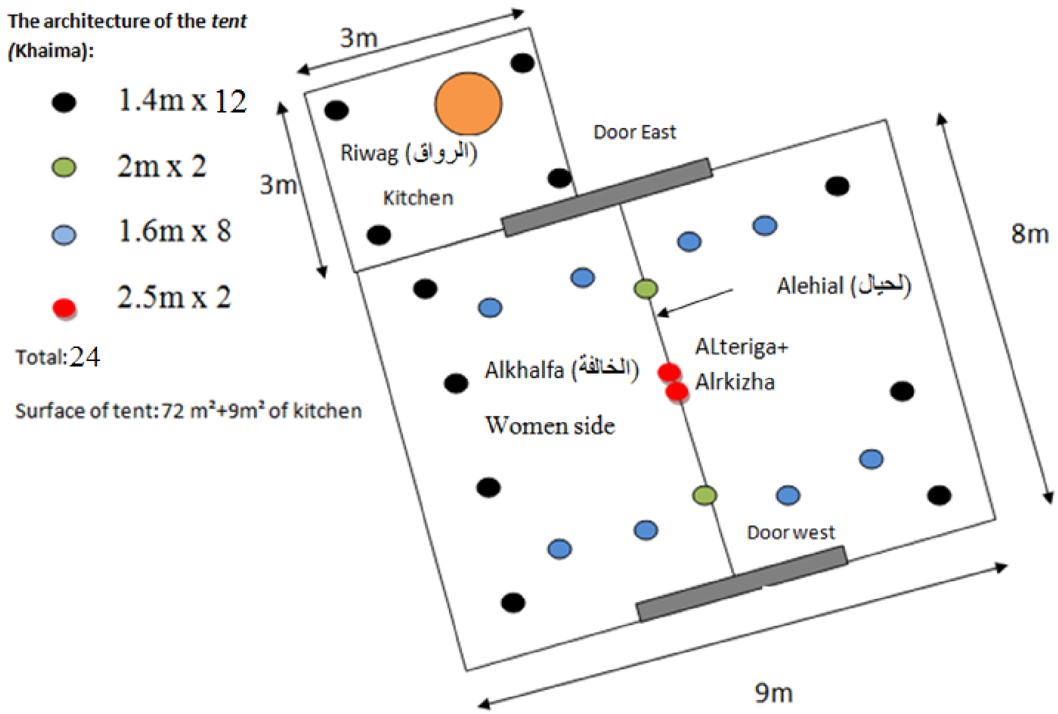

Figure 1.3: Architecture of the tent.

1.4.3 Life in the tent

Incurs nomads across regions of Laghouat Province, Algeria. (A model for areas spread Bedouin) along the infinite, the difficulties and hardships of life coloured differently than was the case across times and eras bygone, in light of the evolution in module form and ways of life, and the lives of Bedouin Here are all a constant challenge to harsh nature of the terrain and rugged, and the weight of living borne by everyone and share the consequences nomadic duplication gathered in the merits of clinging habits ancestral and challenge the harshness of nature, what distinguishes the life of the Bedouins is the dispensing for much of its food needs, which are now they provide for themselves, including meat, milk and milk ghee, and journals are broadly similar (Fig.1.4) [9].

Figure 1.4: Life in Algerian tent (Khaima) [9].

And almost obliterates all signs "Khaimah" known consisting of a full range of tools out they were no longer of interest to many; and the tent is made up of a group known as the "Fulaij", a piece made of goat hair and wool sheep, a considerable length and broad usually 1m, usually shaped tent of 11 pieces of it, are separated by hand, the men from the women, including so-called "Alehial" who is customary place to put purposes such as barley bags, bran, semolina and the needs of the kitchen at the point of women, as well as the "Alkhalfa" that serves as another store for the purposes of the angle of the point men, along what is known as "riwag" a hole at the top of the angle at which women use for cooking.

As well as "door", which is a hole there at the entrance point of the women, and the tent up on poles of wood, through woolness bar known as "Ashabaha", and other ingredients, including "Alteriga" and "Alguntass" and other ingredients [9].

The daily life of nomads is not much different from each other, he comes out in the morning, inspecting his cattle inside what is known as the "Farmyard" and provide them

Figure 1.5: Picture of a Bedouin offered Tea [9].

with fodder which are placed in a special vase known as the "Almgeor" The isolation of the sheep on their mothers, and while that is his role in herding takes him pantry full day , accompanied herd across deserts and over long distances may exceed $10km$, and some of them have a creature accompanied in that it became used for several purposes, including carrying sheep newly generated, for example, at a time when the rest of the brothers is interested in the tent fetches water (Fig.1.5) [9].

Ambassr To nearby cities to spend some special needs days weekly markets and exchange of all life roles over the days of the year. In a renewed spectacle similar to farce with many chapters, and the women they do the kitchen services and care for children, and the girls have, in charge of some of the side quests, including herding sheep or goats and other works primarily associated with the tent, near and its surroundings.

In the night deadline quiet, solitude, and stillness, which is another station, sneaking through young people to meet each other in accordance with the role of the formula as it is in the month of Ramadan. In their sessions fraternal far from any accounts, round, everyone on trays tea, nuts, etc.

What merry food and drink, which share their tales of time bygone and racing in deciphering puzzles and “Mhajiat”, which may take uncover solutions nights and days [9].

1.4.4 Summer and autumn travel

Confirms Bedouin, he would prefer stability in this vast world is inherited from father to son, practicing a craft grazing firm conviction related to what largesse of land from both is the basis of intake for livestock, only their capital and their source of income and livelihood, and indicates his son that summer is a journey that leads them to the west of the country; where pasture along the environment farming and the remnants of the harvest seasonal crops or what is known as “Alhseda” rented sires high prices, but soon everyone back way back after the summer to the first place, all hope at the dawn of the new year heralds the beautiful loom whenever generously rain fall good, and embody the nomadic life of state Laghouat pattern beautiful simplicity and coexistence with all variables, in flagrant defiance of the factors of nature and the environment at the same time, it is patience, Permanent present and the largest in this equation [9].

1.4.5 Bedouin women

Women’s center used Here in knitting and weaving “Albernos” and “Alcashabbiah” or “djellaba” which is the garment most widely used of the Bedouin party, especially in the seasons and cold days, and in that impose “Acetobacter” itself in the wool weaving process, which is relied upon in pass and install wool yarn in traditional “Almensj”, to get the dress “Alcashabbiah" or other for wearing, prevention of natural factors, the different, and women

Bedouin another role is to sew Bedouin tent and work on regular maintenance through patched from time to time, as the centre used in the preparation of “couscous”, the meal most prominent in the life of the Bedouins (Fig.1.6) [9].

Figure 1.6: Bedouin women [8].

At that renewed proverb (food mettle, even if the water), and that, given its close association with the specificities of the region and the lives of simplicity inherent to those social slide, while families also favor, meal "mardud" is known to others as "Albercox", it is mixed herbs and spices give the taste a special flavor.

Bedouin women do with urban environment not exceed occasions character at weddings and grief, unlike the Bedouin man linked to his relationship with the city in so many times to bring the needs and shop for buying and selling cattle at the weekly markets and, if luck male and abundant in the study with some reservation, from the premise that the majority does not exceed their primary level, quickly returning way back to the nomadic life after frequency of knowledge and loved ones school days.

The girl often do not learn as they are governed by customs and traditions, and even the lucky ones to enter the school who are not deported so much for the urban environment, most of whom do not take animals is the means to get to school transport, and the tragedy of those other form of suffering and misery imposed on young nomads [9].

1.5 Bedouins in algeria

1.5.1 Bedouins, Chaamba

The Chaamba, or Chamba, migrated westward through Egypt. Inhabitants of El Golea and El Oued, there are two primary groups, those known as the true Bedouins who are nomadic desert dwellers and those called fellahin who are farmers and are settled along the edge of the desert.

The nomads move deeper into the desert during winter months and the desert edge during hotter summer months. Some may also be found at the Tindouf refugee camp in south western Algeria. Their language is Badawi or Bedouin Arabic. They are 100% Malikite Muslim with little to no known believers.

Malikite is one of the four primary schools of Islam and teaches one to hold more closely to the teachings of the companions rather than to Mohammad himself and are a group known to Algeria.

Daily life is infiltrated with Islamic beliefs. Bedouins are not allowed to marry outside of their own tribe [10].

1.5.2 Bedouin, Dui-Menia

The Bedouin from the Dui-Menia, migrated westward through Egypt during the seventh century. Their language is Saharan Algerian Arabic. Today they are semi-nomadic and both herd animals and farm. Times of migration are determined by water supply.

Livestock are the basis for their economy, and due to desert life and lack of food sources many experience periods of hunger during their life.

They are further divided into tribes. They are Sunni Muslims and have no known believers. Folk Islam, a belief in the spirit world, is mixed with traditional Islamic teachings. Some also follow a mystical type of Islam known as Sufism. Daily life is infiltrated with Islamic beliefs. Bedouins are not allowed to marry outside of their own tribe [11].

1.5.3 Bedouin, Hamyan

The population of this people group varies in statistics from $1,770,000$ to$2,297,000$, with the above being potentially most accurate.

The Hamyan Bedouin is the second largest people group in Algeria after the Algerian Arabs comprising 6.9% of the population, and they are listed eighth among the world's largest people groups without a mission's agency targeting them [12].

1.5.4 Bedouin, Nail

The Ouled Naïl are a tribe and a tribal confederation living in the Ouled Naïl Range, Algeria. They are found mainly in Bou Saâda, M'Sila and Djelfa, but there is also a significant number of them in Ghardaïa Province, beyond their ancestral region.

A Bedouin dialect of Algerian Arabic, Bedou, is their heart language. They are a mixture of Berber and Arab Bedouin people, who live in large black tents [13].

1.5.5 Berber, Mozabite

Berber peoples inhabited the Maghreb of North Africa, the area where Morocco, Algeria, and Tunisia, are located, before the seventh century Arab invasion.

Despite Arabization, which has taken place over centuries, most Berbers have maintained their own language and aspects of culture. They call themselves Imazighen or noble men. Other names for this group include Mzab Berber and Wargla. Tumzabt is their heart language. Algerian Arabic is their second language and French is their third.

The Mozabites are Kharijite Muslims the Mzab is an oasis area comprised of five towns: Ghardaia, Beni Isugene, Bou Nouara, Melika and Al-Ateuf, and is located southwest of Constantine in the Northern Sahara. Over $300,000$ date palms grow there, and are watered by an exceptionally efficient system of irrigation. Towns are walled and are entered gates.

The area was founded during the 11century as the Kharijite Muslims fled persecution. The Oasis was allegedly built around a cave believed to have been inhabited by Daia, a female saint, who is venerated by women in the area still today.

Mzab men are noted throughout Algeria for their business skills and often travel out to other cities in the country to practice their trade.

Young boys are taken with their fathers to learn the business until around age 14 when they return home to be married Women are heavily covered, in a long white fabric called a haik, only being able to bear their left eye. Not even the palms of their hands are to be shown in public and their husbands may be the only one to see their faces.

Mzab society is very tightly knit and is not overly welcoming to outsiders, not even other Algerians. Non-Mozabites are rarely invited into an Mzab home. Travelers are not permitted to spend the night in Ghardia and the city of Beni Isguene does not allow entrance to non Mozabite peoples. A group called Azzaba is the governing body of the community [14].

1.5.6 Berber, Tougourt

The Tougourt live near the city of Temacine and speak Tamazight. Scripture portions are available in this language.

Twenty five percent of men are literate while only five percent of women are literate. Sunni Islam is the practiced religion. Folk Islam, a belief in the spirit world, is mixed with traditional Islamic teachings, and is common among Berbers. Holy men known as Marabouts operate as village witchdoctors. There are no known believers among this people group.

Farming and cattle breeding are the basis for Berber economy. Dairy products, wool and hides are benefits provided by domestic animals.

Berbers are known for their pottery, rugs, and other crafts. Monogamous marriages are most commonly practiced, though polygamy exists in rare cases. Areas of need among this people include community development assessment and projects [15].

1.6 Difficult of living in algerian sahara

Extreme heat

Unbearable hot is the main hazard faced by a traveler at Sahara desert.

Scarcity of water

Water is precious in all deserts .Water is available only at oasis situated here and there in the deserts at great distance.

Scarcity of food materials

One who travels desert should carry the food materials by themselves. Otherwise, it will be available only at oasis located at great distances.

Scarcity of living homes

Tents are used as living homes there that is unbearable to Europeans.

Non availability of Motor Transport facilities

In Sahara Camels were utilized for passenger and goods transportation.

Sand Winds

Sand winds are another hazard faced by a traveler at desert

Communication problem is another hazard

Desert people are nomadic tribes and they usually lives near every oasis. They are illiterate and they spoke either Arabic or regional languages.

1.7 Conclusion

In this chapter, we have presented the Bedouin life, their tents, black tents, or houses of hair have been a symbol of hospitality in the harsh terrain of the Arabic deserts for centuries. The Bedouin people believed that every traveler should be given shelter and protection from the relentless elements for at least three days. Fast forward several centuries to today.

The tent is still very much alive, and has been modernized and updated to fit suit today is needs. Still very much in touch with its origins in hospitality and good times Bedouin tents today are used for entertaining, for protection against the elements and to create a welcoming oasis for any event or function.

However, their life's is very difficult and it should be improved. Hence, in the next chapter we will focus on the used technics for making their life as simple and conformable as possible in the tent. Using the photovoltaic systems to ensure the free electricity of them and presenting the smart tool used in this work based on Arduino card is also viewed.

Chapter 2

Photovoltaic systems / Arduino fundamentals

2.1 Introduction

Energy is the main problem for any country in the world. Each state has an energy management strategy that insures the best compromise between efficiency and cost. Renewable energies are becoming attractive solutions. They collected from renewable sources, which are naturally replenished, on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy often provides energy in four important areas: electricity, air and water heating/cooling, transportation, and rural (off-grid) energy services.

In this chapter, the solar energy is applied for the smart tent. First, each part from the stand-alone PV systems is discussed. Then, and based on Arduino microcontroller, the conception of smart is illustrated. A full discretion of Arduino, its main function and how its work is demonstrated.

2.2 Stand alone pv systems

2.2.1 Discerption of PV systems

Every day, the sun provides energy to the Earth. The energy can be used as free energy thanks to a technology called photovoltaic, which transforms solar energy into electricity. PV systems are classified according to three types: Autonomous (stand-alone), hybrid and grid-connected. The chosen type will depend on needs, Location and budget.

Autonomous systems are completely independent of other sources of energy. They serve usually to feed homes, cottages camps in remote areas, as well as applications such as remote monitoring and the pumping of water. Hybrid systems receive a portion of their energy of one or more additional sources. In practice, PV system modules are often allied to a wind turbine or a fuel generator. Such systems usually have accumulators of energy storage.

Grid-connected systems reduce the power consumption from the utility and in some cases, return it excess energy. In some cases, the utility may credit you with the energy returned to the system. Since the energy is normally stored in the network itself, the accumulators are not necessary unless you want an autonomous form of energy during the breakdowns of electricity. These systems are used in buildings, homes or chalets already connected to the electricity grid [16].

2.2.2 Stand-alone PV systems

A photovoltaic (PV) system is said to be stand-alone - or isolated - when it is not connected to a distribution network. The stand-alone PV system (SAPV) provides power to areas where there is no network. It turns out particularly suited for applications such as a garden pump, insulated lighting, power supply for telephone terminals along the motorway, etc. For these applications, it is not always possible to set up a conventional power supply network, either because of technical constraints or for economic reasons.

These systems consist of the following parts: Solar panels, Batteries to store the produced DC energy, Charge controller, DC/DC converters and DC/AC inverters. (Fig.2.1) shows SAPV system powering AC loads with battery bank. DC loads can also be connected directly to the battery bank. It is also possible to power the AC load without battery, but in that case, it would be confined only to daytime when solar radiation is sufficient to generate required electricity [17].

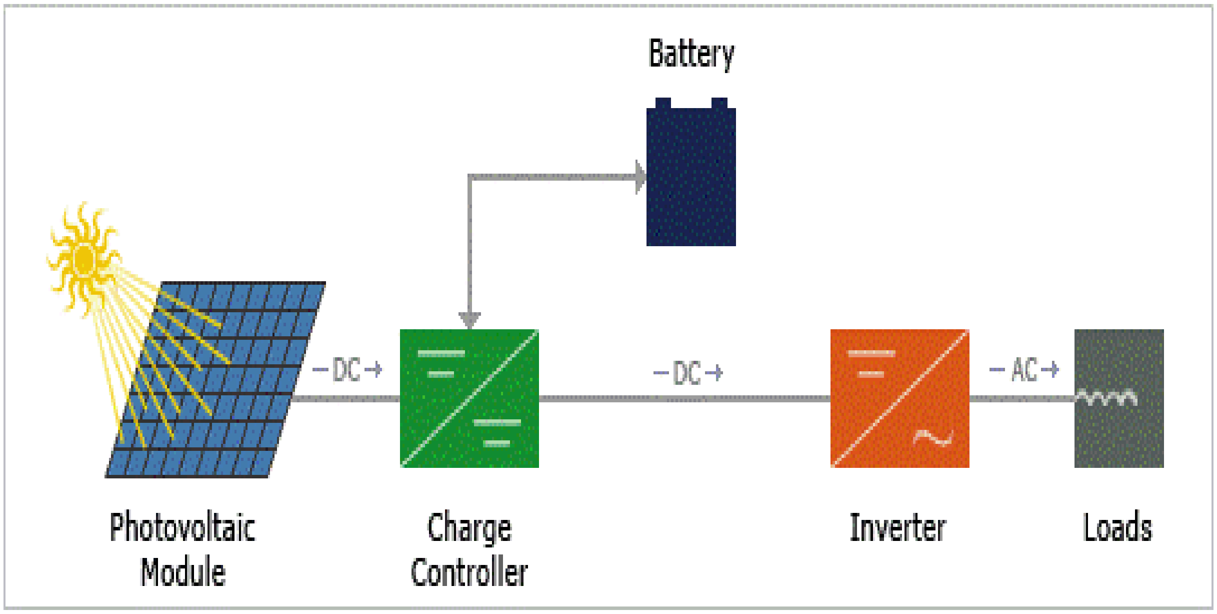

Figure 2.1: PV system parts [18]

2.2.2.1 Photovoltaic panels

PV cells are the main part in PV systems. They are devices that convert the absorbed sunlight to DC electricity using the photovoltaic effect. Photovoltaic modules or panels are composed of semiconductors as shown in (Fig.2.2) and (Fig.2.3).

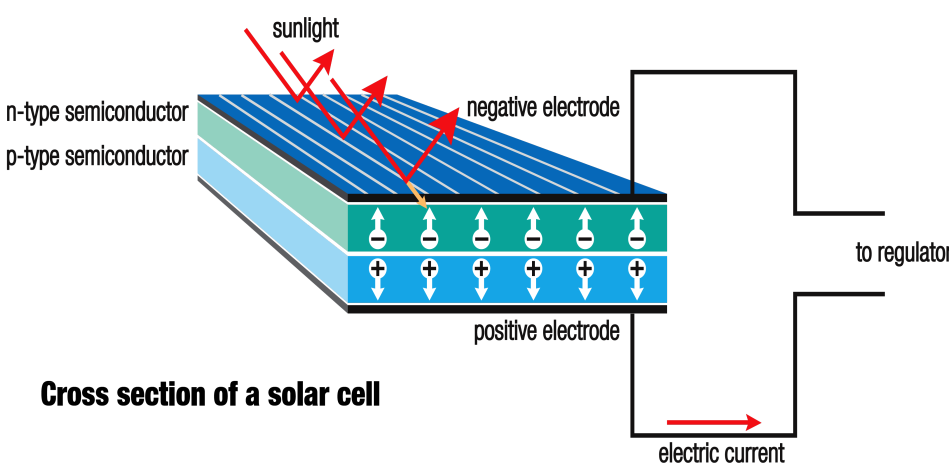

Figure 2.2: Solar cell [20]

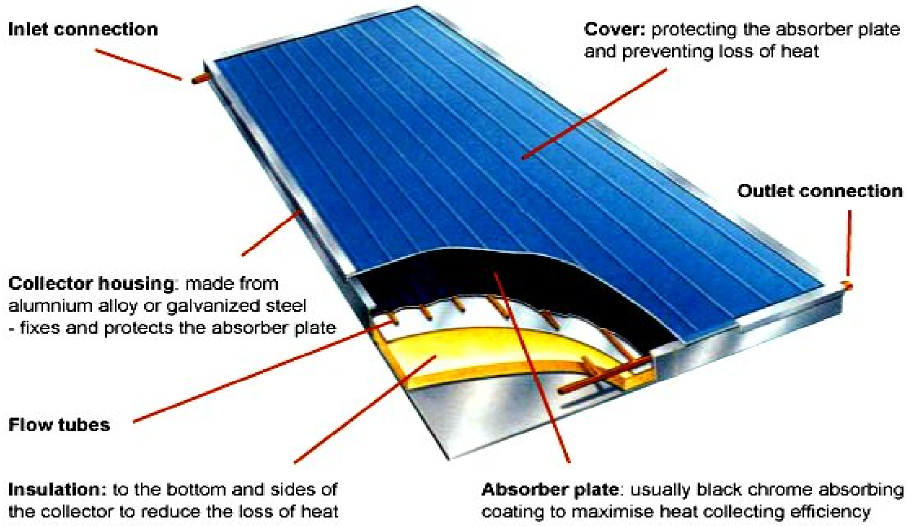

Figure 2.3: Solar panel [21]

These modules can be a source energy that is safe, reliable, maintenance-free and polluting for a very long time. The majority of modules on the market today are equipped with Guarantees of more than 20$years$, and they will well beyond that period. Each module is rated by its DC output power under standard test conditions, and typically ranges from 100 to365$watts$. The efficiency of a module determines the area of a module given the same rated output – an 8% efficient $230 - watt$ module will have twice the area of a 16 efficient 230$watt$ module [19].

2.2.2.2 Battery

Batteries are an important element in any stand-alone PV system but can be optional depending upon the design. They are used to store the produced energy from PV panels for night or emergency uses. The can be of 12V, 24V or 48V and many hundreds of amperes in total depending on the solar array configuration. Each battery is made using chemicals to make combination the differs from low cost (low power) to the high ones as shown in (Fig.2.4)The most common used battery for SAPV systems are lead-acid batteries [22].

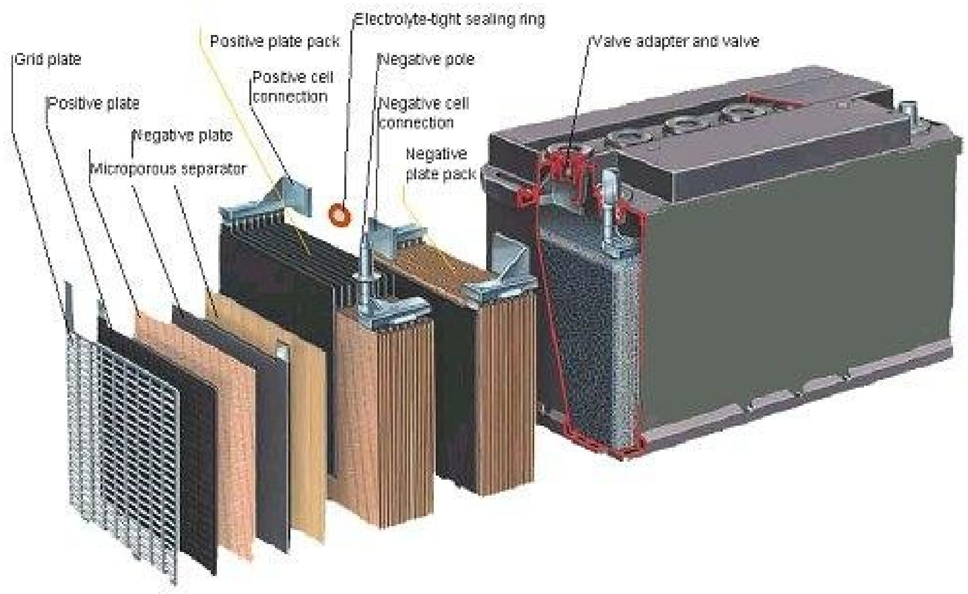

Figure 2.4: Battery [23]

2.2.2.3 Solar charge controller (dc/dc controller)

DC/DC converters are used generally to regulate the output power from solar array to prevent the batteries from being over charged (or over discharged) and to maintain the safety of the system. They are available in a variety of types and have several different applications. Generally maximum peak power tracker methods are used to control the duty cycle of these converters and guarantee the efficiency of the conversion between panels, batteries loads as shown in (Fig.2.5) [24].

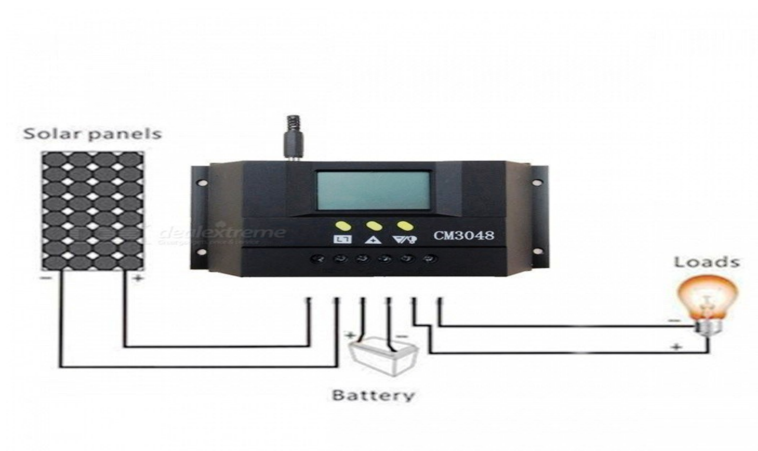

Figure 2.5: Charge Controller diagramme [24]

2.2.2.4 DC /AC inverter

Inverters (Fig. 2.6) are used to take the low-voltage, high-current signals from the PV panels and convert them into $120VAC$ or $240VAC$, which is directly compatible with grid power (AC load) .

Figure 2.6: DC/AC Solar inverter [25]

2.2.2.5 Loads

Any device or appliance in an electrical circuit that uses power, in standalone systems they are two types of loads: DC loads: Are the loads connected with the inverter directly like: lights...; AC loads: Are the loads connected with converter like TV, mini fridge ...

2.3 Arduino

Arduino is an open-source electronics platform based on combination between hardware and software. Arduino boards are able to read inputs (analog or digital) using sensors, and to provide outputs (analog or digital). By sending a set of instructions to the microcontroller, using Arduino programming language by downloadable software called Arduino IDE all inputs and output can be controlled easily. Today, Arduino is used in thousands of projects, from everyday objects to complex scientific instruments. And shared on a worldwide community of makers - students, hobbyists, artists, programmers, and professionals. The most advantages of Arduino are its simple and accessible user experience.

Using its software that runs on Mac, Windows, and Linux. And its multidisciplinary, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire. In addition, its low cost at the market and the worldwide availability of the Arduino card [26].

2.3.1 History of Arduino

It was in the year 2005 that the first ever Arduino board was born in the classrooms of the Interactive Design Institute in “Ivrea, Italy” [27]. The name Arduino originated in the name of the bar in which the team used to meet. Arduino is also the name of an Italian king, a historical figure of the town "Arduind ’Ivrea", or a masculine Italian first name meaning "strong friend". The core Arduino developer team are “Massimo Banzi”, “David Cuartielles”, “Tom Igoe”, “Gianluca Martino”, and “David Mellis” as shown in (Fig.2.7)

Figure 2.7: Arduino developer team - David Cuartielles, Gianluca Martino, Tom Igoe, David Mellis, and Massimo Banzi.[27]

In 2002, “Banzi” had to rely on the BASIC Stamp, a microcontroller developed by Parallax that coded using the BASIC programming language using a circuit board packed with essentials of a power supply, memory, a microcontroller, and input/output ports to which hardware can be attached. However, the BASIC Stamp had two issues; it have not sufficient computing power for some of the projects and it was expensive (more than 100$US by board) [27]. The new Arduino microcontroller that best suited their needs had signs of its roots at this point of time.

One of “Banzi’s” students, “Hernando Barragan”, took the first baby step in the direction towards creating software tools similar to Processing. He developed a new prototyping platform known as Wiring; it included both a user-friendly IDE as well as a ready-to-use circuit board. It turned out to be a promising project the success of which continues till date [27]. “Banzi” succeeded in creating the first prototype board in the year 2005; it was a simple design and at that time and he makes it open source with a price of 30$. Today, Arduino has a famous market and it used widely in different project thanks to its reliability and its price [27]. The chronology of Arduino board is shown in (Fig. 2.8)

2.3.2 Arduino hardware

The PCB design of the Arduino UNO uses SMD (Surface Mount Device) components as shown in (Fig.2.9). It consists of capacitors, SMD, regulators, LED’s and a microcontroller.

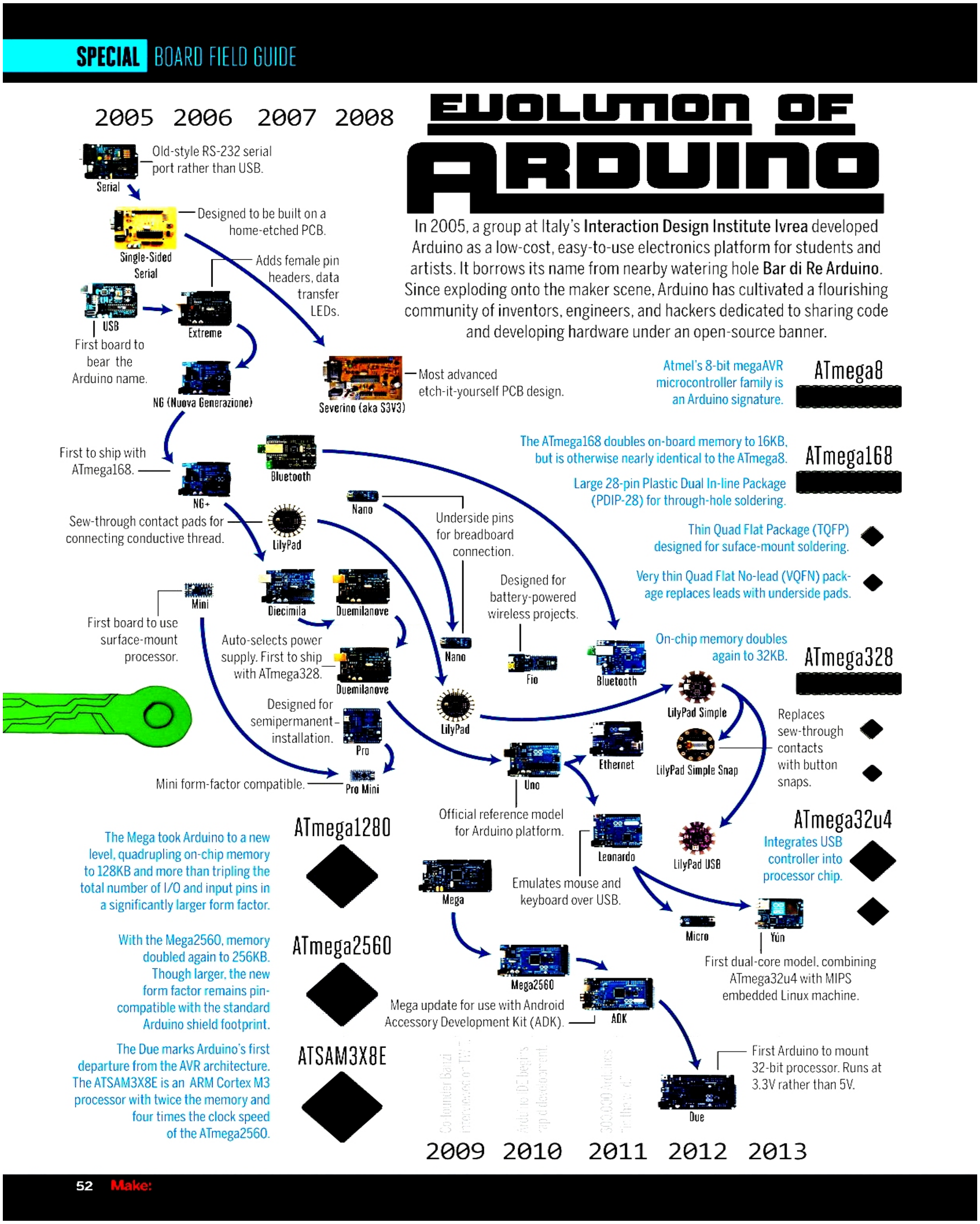

Figure 2.8: Evolution of Arduino [28]

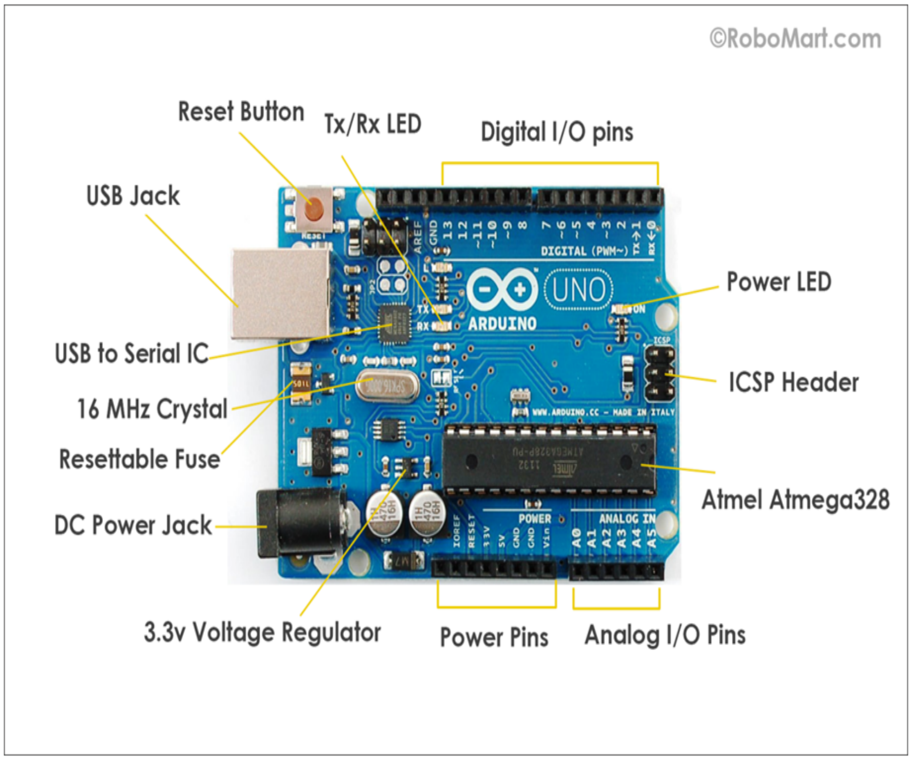

Figure 2.9: components of Arduino UNO [29]

2.3.2.1 The Microcontroller

The ATmega328 microcontroller is the MCU used in Arduino UNO R3 as a main controller. ATmega328 is an MCU from the AVR family; it is an 8-bit device, which means that its data-bus architecture and internal registers are designed to handle eight parallel data signals. ATmega328 has three types of memory:

– Flash memory: 32KB nonvolatile memory. This is used for storing application, which explains why you do not need to upload your application every time you unplug Arduino from its power source.

– SRAM memory: 2KB volatile memory. This is used for storing variables used by the application while it is running.

– EEPROM memory: 1KB nonvolatile memory. This can be used to store data that must be available even after the board is powered down and then powered up again. The Atmega328 has two packages [30], DIP-28 and TQFP 32 as shown in (Fig.2.10).

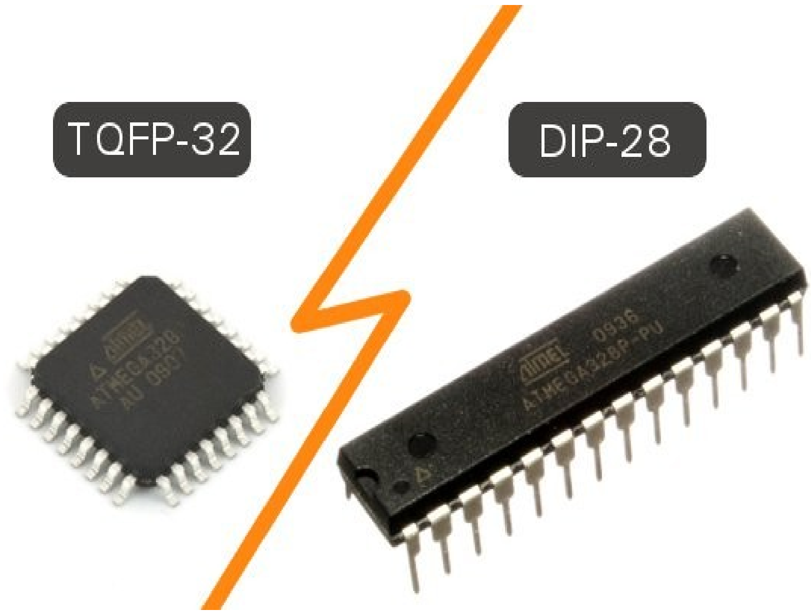

Figure 2.10: Two different packages of the ATmega328 [30].

In addition, the internal pin mapping of the Atmega328 and their connection on the Arduino board is shown in (Fig.2.11)

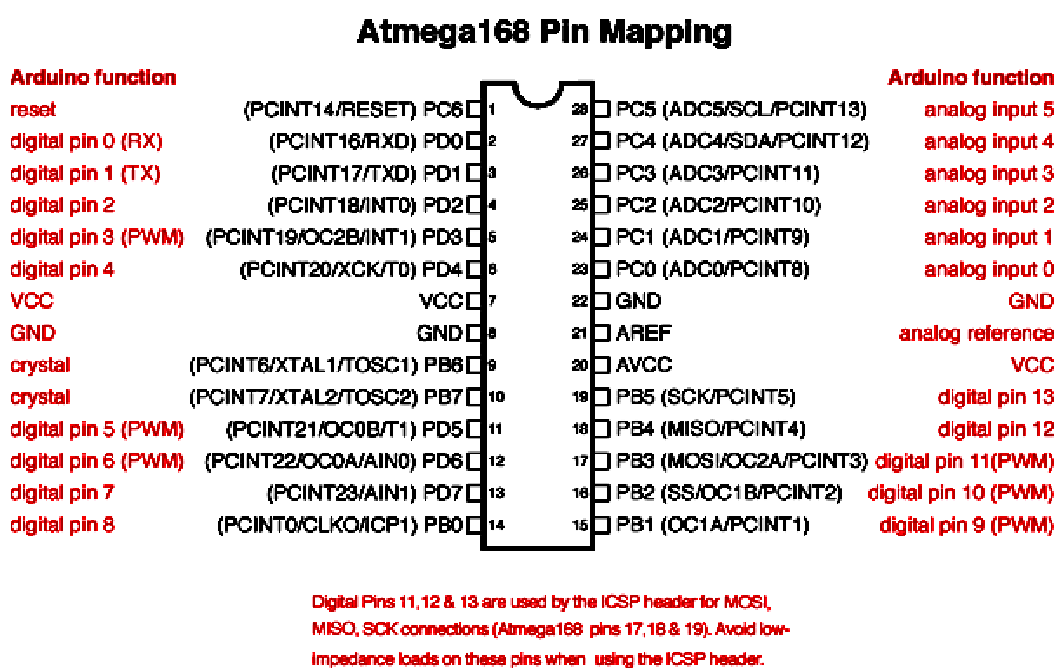

Figure 2.11: ATmega328 pin mapping [30].

2.3.2.2 The Power

There are two ways to power your Arduino: using the USB connector to connect to a computer or portable power pack or you can plug into a wall adapter. USB can be used to power and program.

2.3.2.3 The Pinout

Arduino board has a different set of pin ranging from input, output, Universal Asynchronous Receiver/Transmitter and programming pins as shown in (Fig. II.12.)

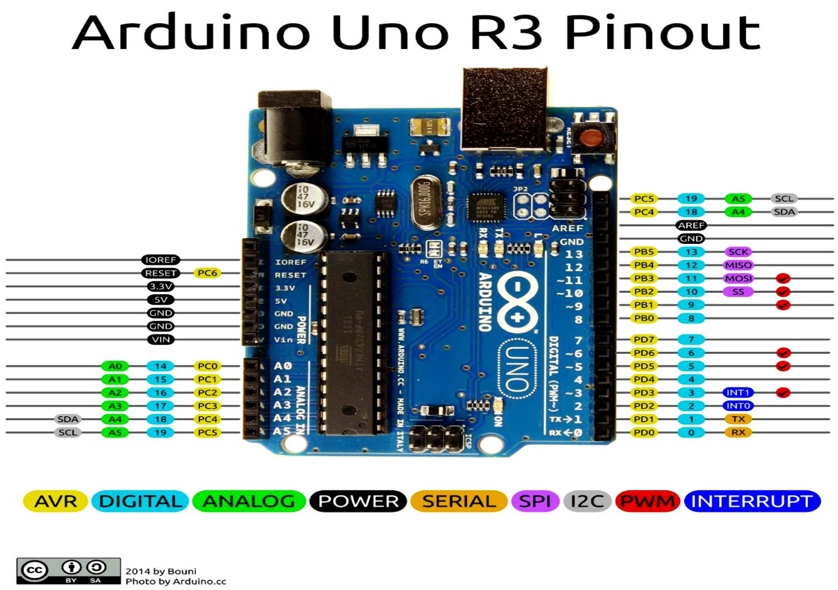

Figure 2.12: Arduino UNO R3 pinout [30]

- Digital input/output pins (I/O)
  Arduino has 14 digital I/O pins. This MCU has three ports: PORTC, PORTB, and PORTD. All pins of these ports can be used for general-purpose digital I/O or for the alternate functions indicated in the pin out below. For example, PORTC pin0 to pin 5 can be ADC inputs instead of digital I/O [31].
- Analog I/O pins
  The converter has 10 bit resolution, returning integers from 0to 1023. While the main function of the analog pins for most Arduino users is to read analog sensors, the analog pins also have all the functionality of general purpose input/output (GPIO) pins (the same as digital pins 0 - 13). Consequently, if a user needs more general

purpose input output pins, and all the analog pins are not in use, the analog pins may be used for GPIO.

- UART Peripheral
  A UART (Universal Asynchronous Receiver/Transmitter) is a serial interface. The ATmega328 has only one UART module. The pins (RX, TX) of the UART are connected to a USB-to-UART converter circuit and also connected to pin 0 and pin1 in the digital header. You must avoid using the UART if you're already using it to send/receive data over USB [30].

2.3.2.4 Other functionality

Other functionality is included in the MCU, such as that offered by the timer/counter modules.

Returning to the electronic design, the microcontroller section has the following:

- IOL and IOH (Digital) Headers:
  These headers are the digital header for pins 0 to 13 in addition to GND, AREF, SDA, and SCL. Note that RX and TX from the USB Bridge are connected with pin 0 and pin1.
- AD Header:
  The analog pins header.
- 16 MHz Ceramic Resonator (CSTCE16M0V53-R0):
  Connected with XTAL2 and XTAL1 from the MCU.
- Reset Pin:
  This is pulled up with a 10K resistor to help prevent spurious resets in noisy environments; the pin has an internal pull-up resistor.
- C4 and C6 $100nF$ Capacitors:
  These are added to filter supply noise. The impedance of a capacitor decreases with frequency :$\frac{1}{2\pi fc}$ The capacitors give high-frequency noise signals a low-impedance path to ground. $100nF$ is the most common value.
- PIN13: This is connected to the SCK pin from the MCU and is also connected to an LED. The Arduino board uses a buffer (the LMV358) to drive the LED [30].
- ICSP (In-Circuit Serial Programming) Header:
  This is used to program the ATmega328 using an external programmer. It's connec-

ted to the In-System Programming (ISP) interface (which uses the SPI pins). Usually, we don't need to use this way of programming because bootloader handles the programming of the MCU from the UART interface which is connected using a bridge to the USB. This header is used when you need to flash the MCU, for example, with a bootloader for the first time in production [30].

2.3.3 Software development

A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio. The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus [31].

A program written with the IDE shown in (Fig.2.13) for Arduino is called a sketch. Sketches are saved on the development computer as text files with the file extension "ino" Arduino Software (IDE) pre-1.0 saved sketches with the extension "pde".

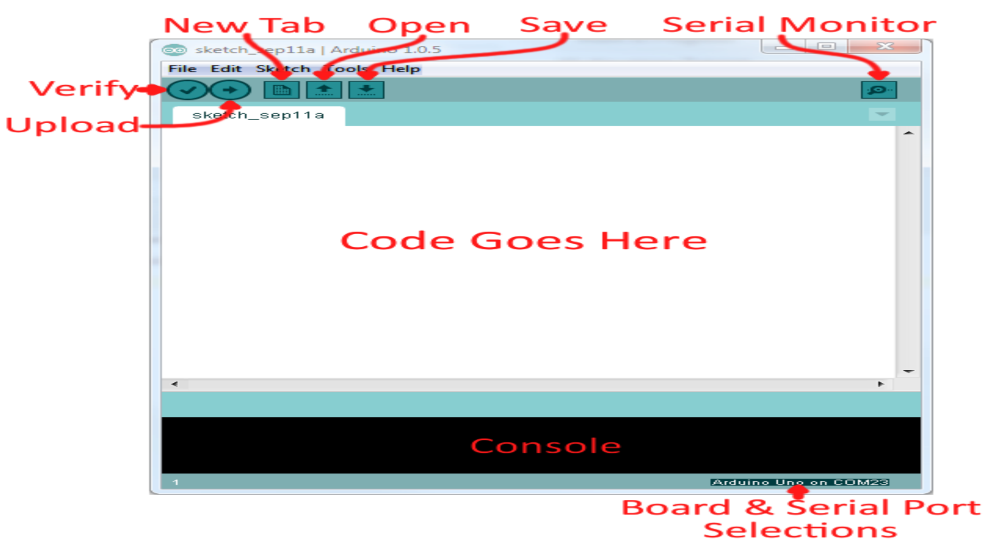

Figure 2.13: IDE for Arduino.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions ; loop function for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. A minimal Arduino C/C++ sketch, as seen by the Arduino IDE programmer, consists of only two functions:

– Setup

  This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch.

– Loop

  After setup has been called, function loop is executed repeatedly in the main program. It controls the board until the board is powered off or is reset. This program uses the functions pin Mode, digital Write, and delay, which are provided by the internal libraries included in the IDE environment. The program is usually loaded in the Arduino by the manufacturer [32] [33] [34]. (Fig.2.14) shows an example of a sketch written using Arduino IDE.

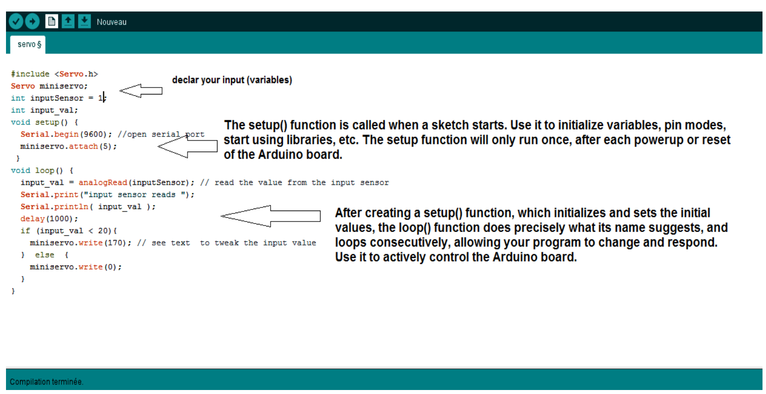

Figure 2.14: example of a written code using Arduino IDE

Generally, after your code is written in Arduino IDE, it should be uploaded to the main microcontroller of the Arduino UNO using a USB connection. First, we should go to tools, then Board to choose the type of the board. After that, the serial port should be selected. And, finally upload the sketch to the atmega328 using upload button in the bar menu. These steps are summarized in (Figs.2.15) and (Fig2.16).

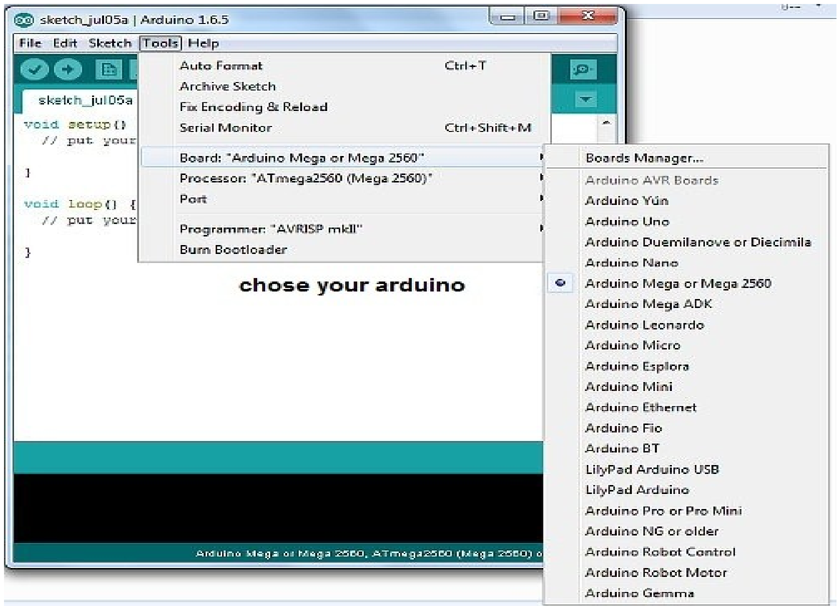

Figure 2.15: Selecting of the Arduino board

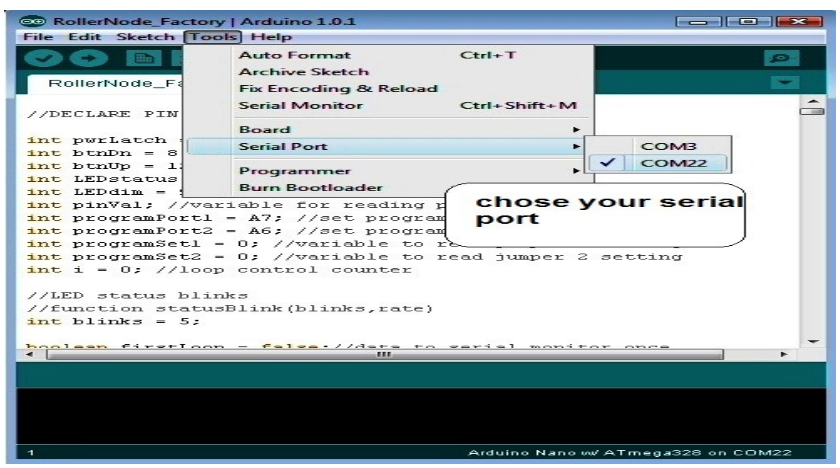

Figure 2.16: selecting of the serial port

To power the Arduino board, you can use the USB as a power source or DC jack. To reset your board, you should use a push button in the board. Another source of reset should be every time you open the serial monitor from Arduino IDE.

2.3.4 Advantages of using Arduino

- Ready to use structure:
  as Arduino comes in a complete package form which includes the 5V regulator, a burner, an oscillator, a micro-controller, serial communications interface LED and headers for the connections.
- Easy programing:
  we do not have to think about programmer connections for programming or any other interface. Just plug it into USB port of your computer and that is it.
- Examples of codes:
  Another big advantage of Arduino is its library of examples present inside the software of Arduino.
- Effortless functions:
  during coding of Arduino, we can notice some functions, which make the life so easy.
- Automatic unit conversion capability:
  we can say that during debugging and we do not have to worry about the units conversions.
- Large community:
  There are many forums present on the internet in which people are talking about the Arduino. Engineers, hobbyists and professionals are making their projects through Arduino.

2.4 Conclusion

Solar system design is not just about using the sun for electricity. It is about using this energy efficiently. In renewable energies, the PV panels is the important element, the stand-alone PV system is a source of clean and renewable electricity to aliment a DC or AC loads. In addition, thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users.

In the next chapter, we will use PV systems and Arduino to make a smart Bedouin tent, which is a modern tent and comfort and simple to use it that facilitate their life.

Chapter 3

Realisation and simulation

3.1 Introduction

In this chapter we use Arduino and the intelligent circuits to make Bedouin tent smart and simple to use, the PV system has been to power all the tent. The chosen location is situated in Laghouat, Algeria Sahara. Moreover, an economical study is presented in the end of this chapter to show the total cost of the proposed smart tent system.

3.2 Characterisation of the location (Laghouat Sahara)

Located at an altitude of $750m$, the Laghouat Province (Fig.3.1), Coordinates: $33°48\prime10''N2°52\prime30''E$ is part of the Saharian Atlas Mountains chain with some peaks above $2,000m$, "Djebel Amour: $2,200m$" Laghouat town in the Amour Range of the Saharan Atlas is an oasis on the north edge of the Sahara Desert. It is an important administrative and military center and marketplace, and is known for rug and tapestry weaving. There are natural gas deposits in the region. The town has a meteorological station [35] [36].

An oasis south of Algiers and lined with gardens. It is built on the banks of the Wadi Mzi, which flows eastwards from the Amour Mountains and is one of a large number of seasonal streams that empty into Chott Melrhir. It is a regional centre in the Algerian steppe; it is bordered to the north by the municipality of Sidi Makhlouf, to the west by Tadjemout and kheneg, to the east the municipality of El Assafia, and to the south the municipality of Mekhareg.

Figure 3.1: Location of Laghouat in Algeria [35]

Laghouat lies on the Wadi Mzi (Wadi Djedi in its lower course), built on two hills that are northward extensions of Mount Tizigarine. The modern quarter, on the southern hill, contains the administrative and military installations. The old section, on the northern hill, retains its Saharan-style architecture. Three dams on the Wadi Mzi irrigate date palms, fruit trees, vegetables, and cereals. Laghouat is known for its woven wall hangings and knotted woolen carpets [35] [36].

3.3 Prototype of the smart khaima

In the proposed tent, we controlle the lights, the temperature, level water and the counting of sheep. Based on this, we have chosen the right location of tent and the right location of the circuits. We have put the tent in higher place for avoid the streams of water resulting from rain.

The direct of tent is East-West (Usually Qibla direction) in the summer the two doors of tent is open. To ventilate more and in the winter just the east door open. For the circuit (sensors; lights . . .etc.), (Fig.3.2) shows their location:

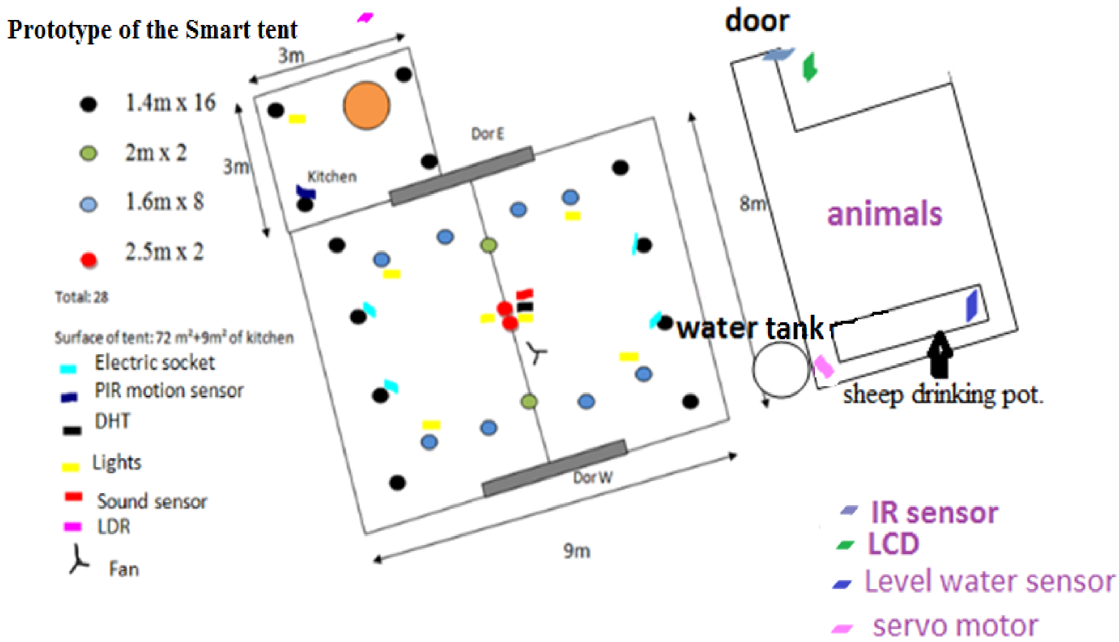

Figure 3.2: Prototype of the proposed Smart Khaima

3.4 Materials and sensors

IIn this part, we will present the used materials inside and outside the tent as well as their characteristics

3.4.1 Inside of tent

3.4.1.1 Lighting

In our tent we control the lights with Arduino and smart sensors for make it more simple and economic for energy. They are threes sensors used for control the lights: LDR (Light Dependent Resistor), sound sensor, PIR motion.

– **A) LDR** (Light Dependent Resistor) sensor

Two cadmium sulphide (cds) photoconductive cells with spectral responses similar to that of the human eye (Fig.3.3). The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, and batch counting and burglar alarm systems [37].

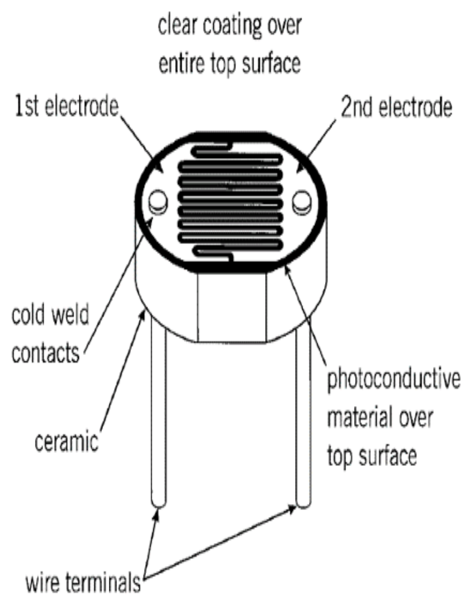

Figure 3.3: typical construction of LDR [38]

The Electrical Characteristics of LDR are presented in Table 3.1 [37]

Table 3.1: The electrical characteristic of LDR sensor

Parameters	Conditions	Min	Type	Max	Unit
Cell resistance	1000 LUX 10 LUX		400 , 9	-	Ohm , K Ohm
Dark Resistance	-		1	-	M Ohm
Dark Capacitance	-		3.5	-	pF
Rise Time	1000 LUX 10 LUX		2.8 , 18	-	ms
Fall Time	-		48 , 120	-	ms
Voltage AC/DC Peak	-	-	-	320	V max
Current	-	-		75	mA max
Power Dissipation	-	-		100	mW max
Operating Temperature	-	-60	-	+75	Deg. C

The sensitivity of LDR is shown in (Fig.3.4)

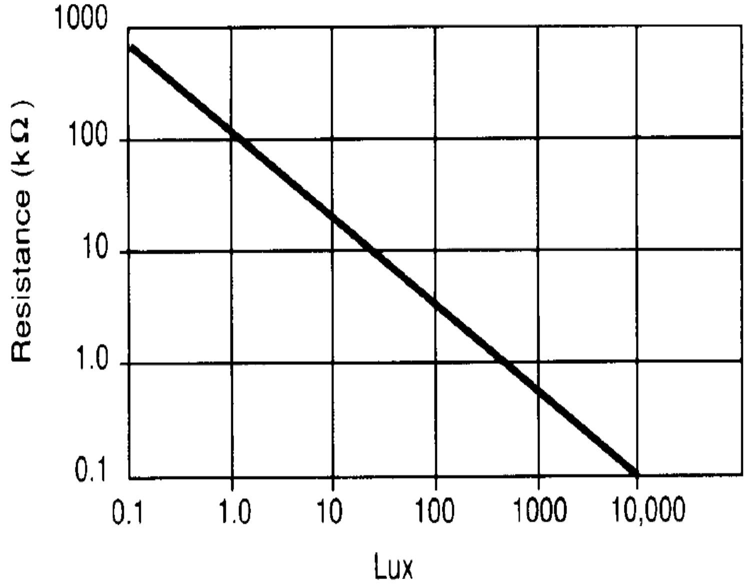

Figure 3.4: resistance as function of illumination [37]

The spectral response of LDR is shown in (Fig.3.5)

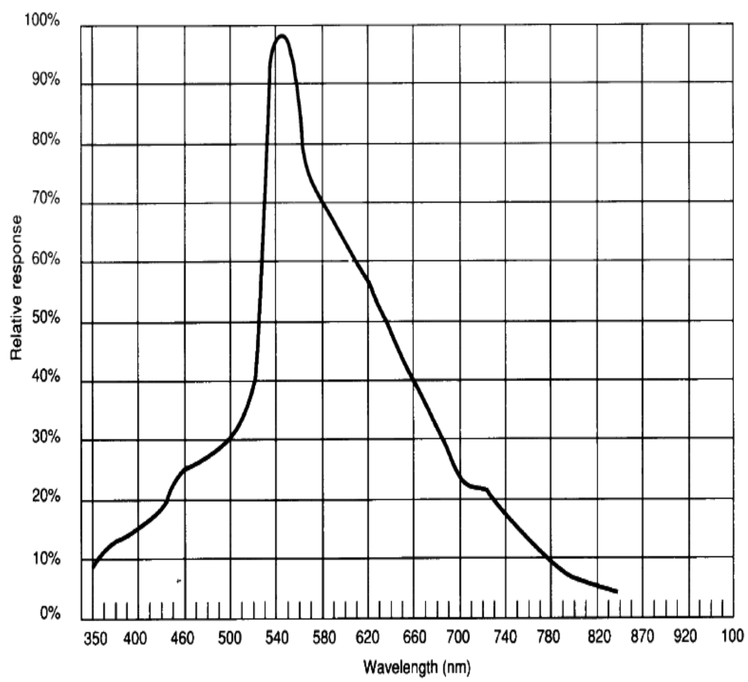

Figure 3.5: Spectral response [37]

The LDR sensor is used in the tent to control the ON/OFF of lights so in the dark the light will be ON and in when sunshine the lights will be OFF. For making this condition we realise this circuit (Fig.3.6):

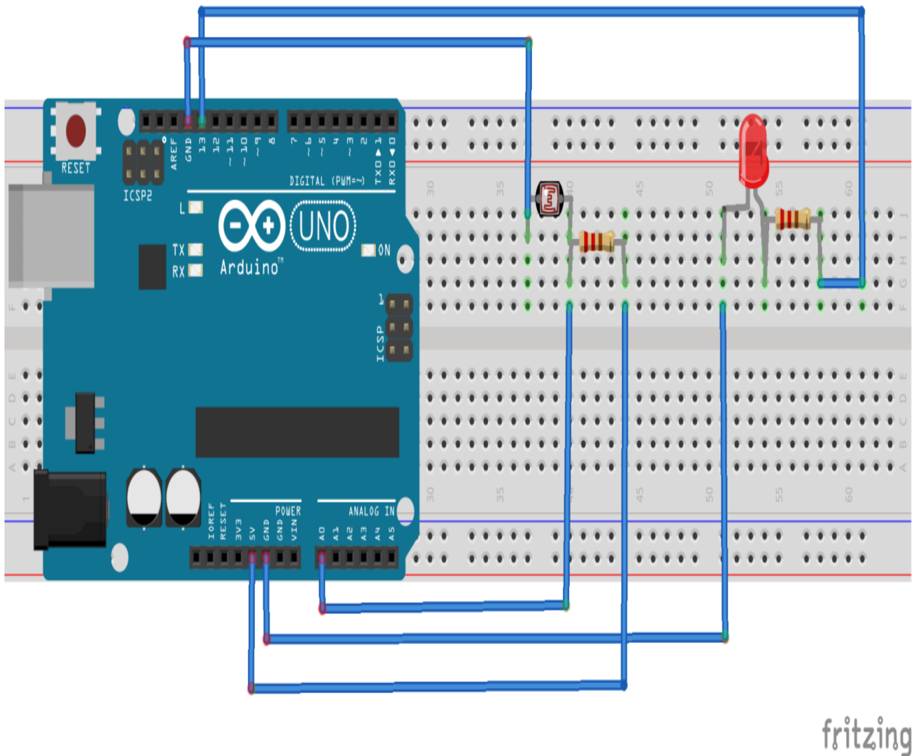

Figure 3.6: Circuit diagram of LDR ON/OFF light using Arduino Uno

The used code (sketch) inthe Arduino IDE is shown as follows :

```
//set pin numbers
//const won't change
const int ledPin = 13; //the number of the LED pin
const int ldrPin = A0; //the number of the LDR pin
void setup() {
Serial.begin(9600);
pinMode(ledPin, OUTPUT);
pinMode(13, OUTPUT);//initialize the LED pin as an output
pinMode(ldrPin, INPUT); //initialize the LDR pin as an input
}
void loop() {
int ldrStatus = analogRead(ldrPin); //read the status of the LDR value if (ldrStatus <=30)
{
digitalWrite(ledPin, HIGH); //turn LED on Serial.println("LDR is DARK, LED is ON");
}
```

```
else {
digitalWrite(ledPin, LOW); //turn LED off
Serial.println("LDR is on light, LED is OFF");
}
}
```

– **B) Sound sensor**

The sound sensor module (Fig3.7) provides an easy way to detect sound and is generally used for detecting sound intensity. This module can be used for security, switch, and monitoring applications. Its accuracy can be easily adjusted for the convenience of usage.It uses a microphone which supplies the input to an amplifier, peak detector and buffer. When the sensor detects a sound, it processes an output signal voltage which is sent to a microcontroller then performs necessary processing [39].

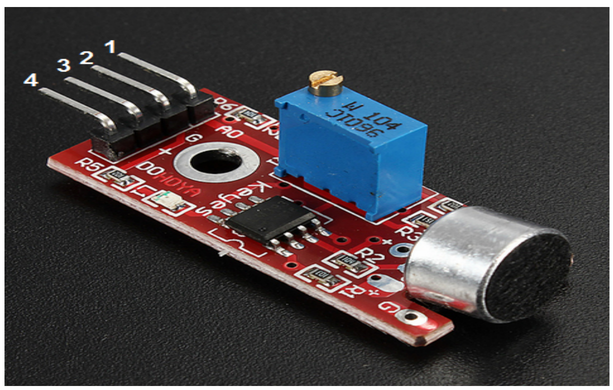

Figure 3.7: Sound sensor [39]

Specifications:

– Operating voltage $3.3V - 5V$.
– Output model: digital switch outputs (0 and1, high or low level).
– With a mounting screw hole.
– PCB size: $3,4cm * 1,6cm$.

Schematic Diagram:

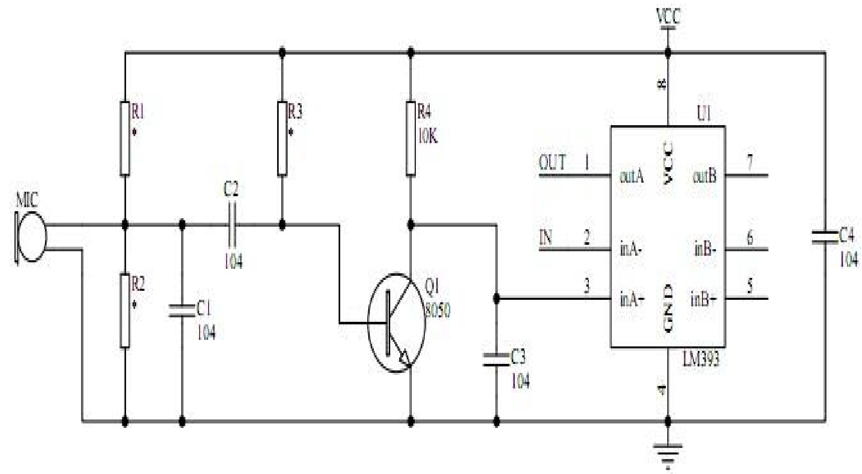

Figure 3.8: Sound sensor schematic diagram [39]

– **Pin Configuration:**

1. A_0 : Analog output
2. GND : Ground
3. V_{CC} : $3.3V - 5V DC$
4. D_0 : Digital output.

To make the ON and OFF of lights very simple, we have used this sensor to control the lights by clapping; that meaning when the Bedouin wont OFF the lights just make two clapping, and do the same thing for ON the lights.

For making this condition we realise this circuit (Fig.3.9):

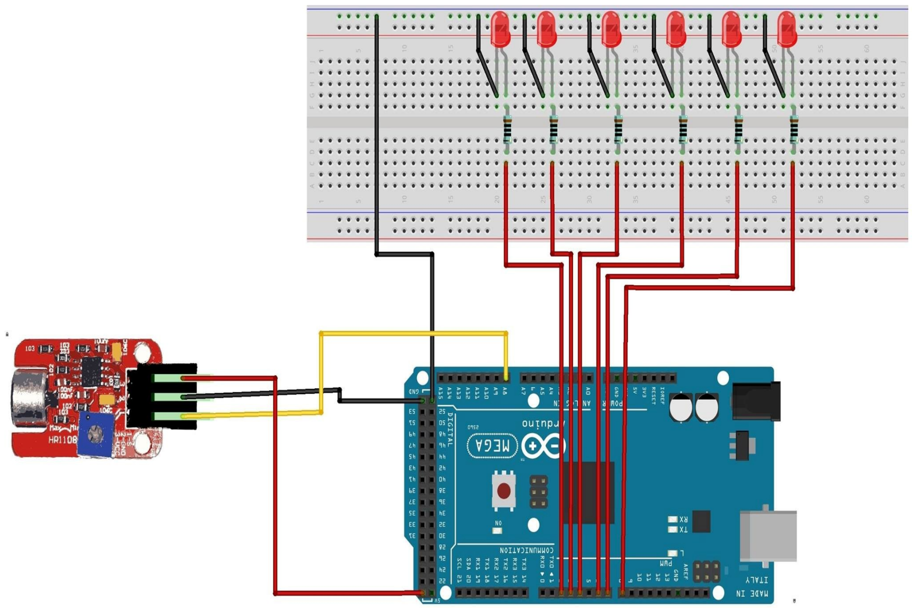

Figure 3.9: Circuit diagram of sound sensor ON/OFF light using Arduino Mega

On the Arduino, we use this code:

```
/****************************Lights******************************/
int LED1 = 12;
int LED2=11;
int LED3=10;
int LED4=9;
int LED5=8;
int LED6=7;
/*************************microphone***************************/
int microphone = A3;
int mv1=0;
int mv2=0;
boolean lon=false;
boolean lon1=false;
boolean lon3=false;
boolean lon4=false;
boolean lon5=false;
boolean lon6=false;
////////////////////////////////////////////////////////////////////////////////
void setup() {
Serial.begin(9600);
pinMode(LED1,OUTPUT);
pinMode(LED2,OUTPUT);
```

```
pinMode(LED3,OUTPUT);
pinMode(LED4,OUTPUT);
pinMode(LED5,OUTPUT);
pinMode(LED6,OUTPUT);
pinMode(microphone, INPUT); }
////////////////////////////////////////////////////////////////////////////
void loop() {
mv1=analogRead (microphone);
Serial.println(analogRead(mv1));
delay(1);
mv2=analogRead (microphone);
Serial.println(analogRead(mv2));
/****************************led1****************************/
if (mv1-mv2>2 || mv2-mv1>2)
{
lon=!lon; digitalWrite(LED1,lon) ;
}
else {
digitalWrite(LED1,LOW);
}
/***************************led 2****************************/
if (mv1-mv2>2 || mv2-mv1>2)
{
lon=!lon;
digitalWrite(LED2,lon) ;
}
else {
digitalWrite(LED2,LOW);
}
/*************************** led 3****************************/
if (mv1-mv2>2 || mv2-mv1>2)
{
lon=!lon;
digitalWrite(LED3,lon) ;
}
else {
digitalWrite(LED3,LOW);
}
/**************************** led 4****************************/
if (mv1-mv2>2 || mv2-mv1>2)
{
lon=!lon;
```

```
digitalWrite(LED64,lon) ;
}
else {
digitalWrite(LED4,LOW);
}
/**************************** led 5****************************/
if (mv1-mv2>2 || mv2-mv1>2)
{
lon=!lon;
digitalWrite(LED5,lon);
}
else {
digitalWrite(LED5,LOW);
}
/*************************** led 6****************************/
if (mv1-mv2>2 || mv2-mv1>2)
{
lon=!lon;
digitalWrite(LED6,lon) ;
}
else {
digitalWrite(LED6,LOW);
}
/////////////////////////////////////////////////////////////////////////////
}
```

– **C) Control lights with LDR and sound**

sensor We control the lights in two sides in the tens, one for man side and the other is for women using LDR and when the family wants the lights turned OFF just clapping to make it; The figure following show the diagram of the circuit:

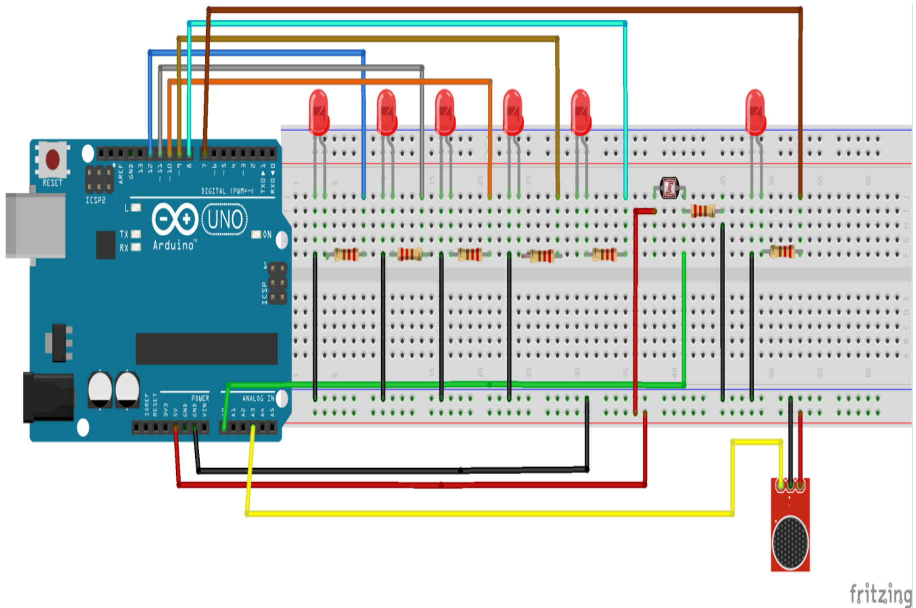

Figure 3.10: Circuit diagram of sound sensor ON/OFF light with LDR using Arduino Uno

On the Arduino, we have used this code:

```
/****************************Lights*******************************/
int LED1=12;
int LED2=11;
int LED3=10;
int LED4=9;
int LED5=8;
int LED6=7;
/************************microphone**************************/
int microphone = A3;
int mv1=0;
int mv2=0;
boolean lon=false;
boolean lon1=false;
boolean lon3=false;
boolean lon4=false;
boolean lon5=false;
boolean lon6=false;
////////////////////////////////////////////////////////////////////////////////
void setup() {
```

```
Serial.begin(9600);
pinMode(LED1,OUTPUT);
pinMode(LED2,OUTPUT);
pinMode(LED3,OUTPUT);
/************************microphone***************************/
int microphone = A3;
int mv1=0;
int mv2=0;
boolean lon=false;
boolean lon1=false;
boolean lon3=false;
boolean lon4=false;
boolean lon5=false;
boolean lon6=false; pinMode(LED4,OUTPUT);
pinMode(LED5,OUTPUT);
pinMode(LED6,OUTPUT);
pinMode(microphone, INPUT); }
/////////////////////////////////////////////////////////////////////////////////
void loop() {
int ldrStatus = analogRead(ldrPin);
mv1=analogRead (microphone);
Serial.println(analogRead(mv1));
delay(2);
mv2=analogRead (microphone);
Serial.println(analogRead(mv2));
/****************************led1*****************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED1,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED1,lon) ;
}
```

```
/*************************led 2**************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED2,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED2,lon1) ;
}
/************************* led 3*************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED3,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED3,lon3) ;
}
/************************** led 4*************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED4,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED4,lon4) ;
}
/**************************** led 5**************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED5,LOW);
}
```

```
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED5,lon5) ;
}
/**************************** led 6****************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED6,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED6,lon6) ;
}
/////////////////////////////////////////////////////////////////////////////////
}
```

All these circuits are used inside the tent. However, for the kitchen we have usedanother sensor to control the light using the PIR motion sensor.

– **D) PIR motion sensor**

PIR sensors (Fig.3.11) are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output [40].

Figure 3.11: PIR motion sensor [40]

The PIR sensor (Fig.3.12) itself has two slots in it; each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor).

When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room, walls, or outdoors. When a warm body like a human or animal passes by, it first intercepts one-half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what detected [40].

Is to begin explaining how a basic sensor works, we will use this rather nice diagram:

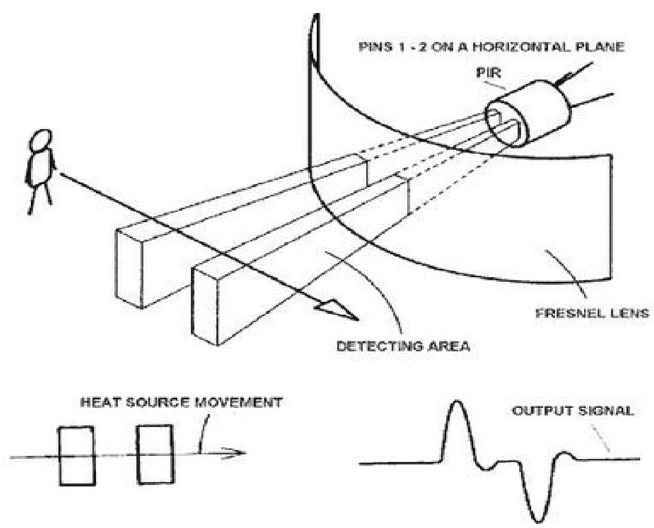

Figure 3.12: Diagram explaining how a PIR motion works [40]

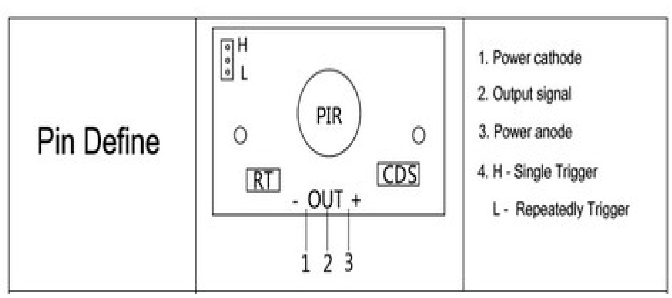

Figure 3.13: Pins define the PIR

Feature:

Input Voltage	: $DC4.5 - 20V$
Static current	: $50uA$
Block time:	$2.5S$(default)
Delay time	: $5S$ (default)
Sentry Angle	:$< 110degree$
Sentry Distance	:$3m$(default) - $max7m$
Lens Size	: Diameter :$23mm$(Default)
Dimensions	: $32mm * 24mm$
Trigger	: H-Yes, L-No

This sensor has been used in the kitchen to sense when a person enter inside, the lights turned on and when he exit, the lights turned off automatically We use this circuit for make it:

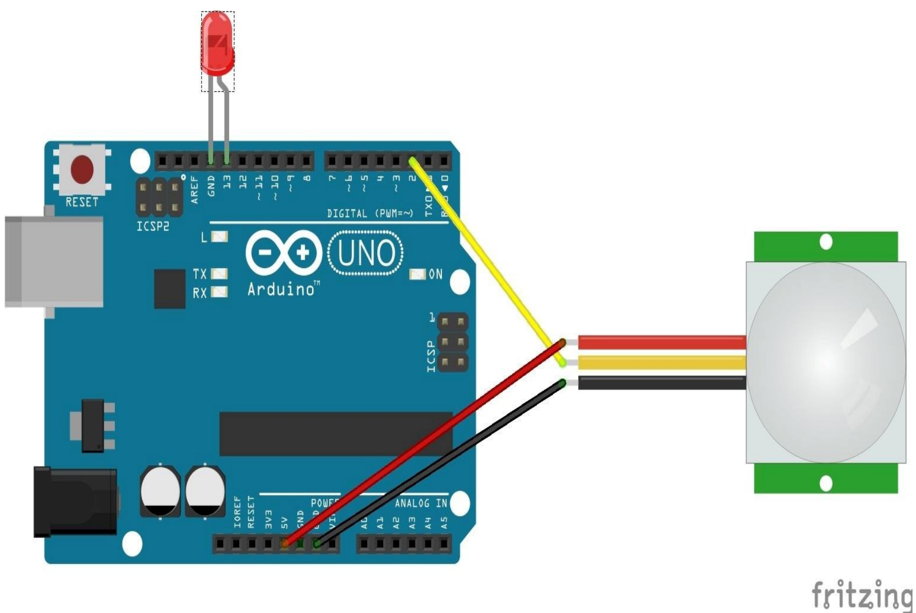

Figure 3.14: Circuit diagram of control LED with PIR motion sensor

On the Arduino, we have used this code:

```
int sensor = 2;
int led = 13;
int val = 0;
void setup(){
Serial.begin(9600);
pinMode(sensor, INPUT);
```

```
pinMode(led, OUTPUT);
} void loop(){
val=digitalRead(sensor);
if(val == HIGH){
digitalWrite(led, HIGH);
delay(3000);
}
else {
digitalWrite(led, LOW); //the led visualizes the sensors output pin state
}
}
```

So the final circuit of lighting with all the smart sensors and Arduino:

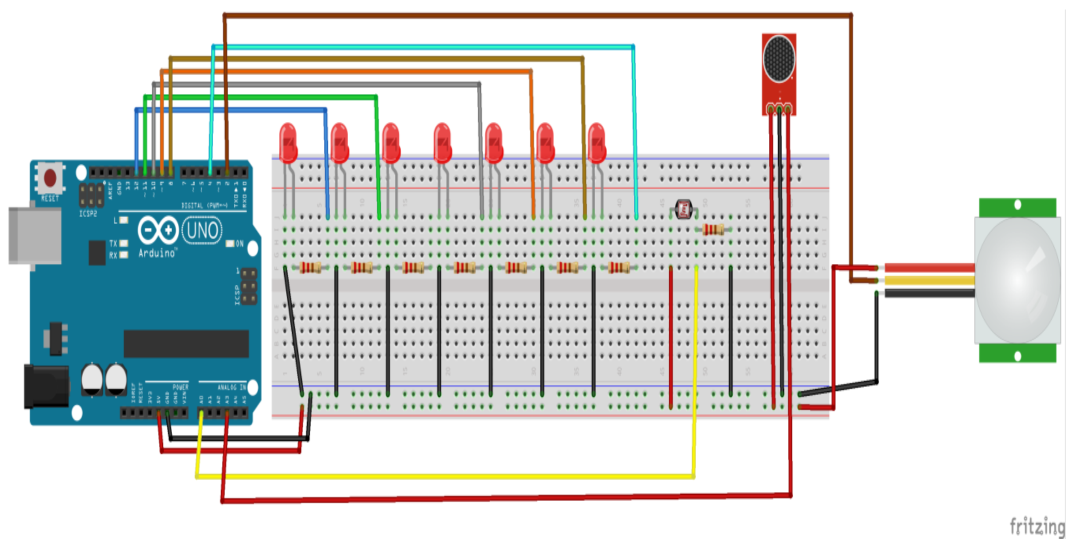

Figure 3.15: Circuit diagram of control LEDs with smart sensors and Arduino

On the Arduino, we have used this code:

```
/******************************Lights******************************/
int LED1=12;
int LED2=11;
int LED3=10;
int LED4=9;
int LED5=8;
int LED6=7;
int led=4;
```

```
/***********************LDR*************************/
const int ldrPin = A0;
/************************microphone**************************/
int microphone = A3;
int mv1=0;
int mv2=0;
boolean lon=false;
boolean lon1=false;
boolean lon3=false;
boolean lon4=false;
boolean lon5=false;
boolean lon6=false;
/**********************PIR motion***************************/
int sensor = 2;
int val = 0;
////////////////////////////////////////////////////////////////
void setup() {
Serial.begin(9600);
pinMode(LED1,OUTPUT);
pinMode(LED2,OUTPUT);
pinMode(LED3,OUTPUT);
pinMode(LED4,OUTPUT);
pinMode(LED5,OUTPUT);
pinMode(LED6,OUTPUT);
pinMode(led,OUTPUT);
pinMode(sensor,INPUT);
pinMode(ldrPin,INPUT);
pinMode(microphone, INPUT);
}
////////////////////////////////////////////////////////////////
void loop() {
val=digitalRead(sensor);
int ldrStatus = analogRead(ldrPin);
mv1=analogRead (microphone);
Serial.println(analogRead(mv1));
```

```
delay(1);
mv2=analogRead (microphone);
Serial.println(analogRead(mv2));
/****************************led1*****************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED1,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED1,lon) ;
}
/**************************led 2***************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED2,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED2,lon1) ;
}
/************************** led 3**************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED3,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED3,lon3) ;
}
/*************************** led 4**************************/
{
```

```
if ( ldrStatus >=30 )
digitalWrite(LED4,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED4,lon4) ;
}
/**************************** led 5****************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED5,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED5,lon5) ;
}
/**************************** led 6****************************/
{
if ( ldrStatus >=30 )
digitalWrite(LED6,LOW);
}
if (mv1-mv2>2 || mv2-mv1>2 && ldrStatus <=30 )
{
lon=!lon;
digitalWrite(LED6,lon6) ;
}
/////////////////////////PIR//////////////////////////
if (val>0 && ldrStatus <=30) {
digitalWrite(led, HIGH);
}
if ( ldrStatus >30){
digitalWrite(led, LOW);
}
```

```
//////////////////////////////////////////////////////////////////////
}
```

3.4.1.2 The temperature

We will monitor the temperature inside the tent and adjust it if it is not favourable The sensor use it is the DHT11 sensor.

– **A) DHT11** sensor

DHT11 (Fig.3.16) is a digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and NTC temperature measurement devices, and connected with a high-performance 8-bit microcontroller [41].

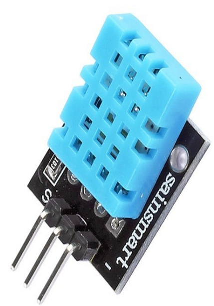

Figure 3.16: DHT 11 sensor

This circuit is a standalone automatic fan speed controller that controls the speed of an electric fan according to the requirement. Is very compact and uses a few components only. The project will help save energy/electricity. Schematic of the Automatic Fan Speed Controller:

Model	DHT11
Power supply	3-5.5V DC
Output signal	digital signal via single-bus
Sensingelement	humidity 20-90%R$, temperature 0-50 Celsius
Sensingelement	humidity 20-90%RH , temperature 0-50 Celsius
Accuracy	humidity +-4%RH (Max +-5%RH) , temperature +-2.0Celsius
Resolution or sensitivity	humidity 1%RH; temperature 0.1Celsius
Repeatability	humidity +-1%RH; temperature +-1Celsius
Humidity hysteresis	+-1%RH
Long-term Stability	+-0.5%RH/year
Sensing period	Average: 2s
Interchange ability	fully interchangeable
Dimensions	size 12*15.5*5.5mm

Table 3.2: Technical Specification of DHT 11 [41]

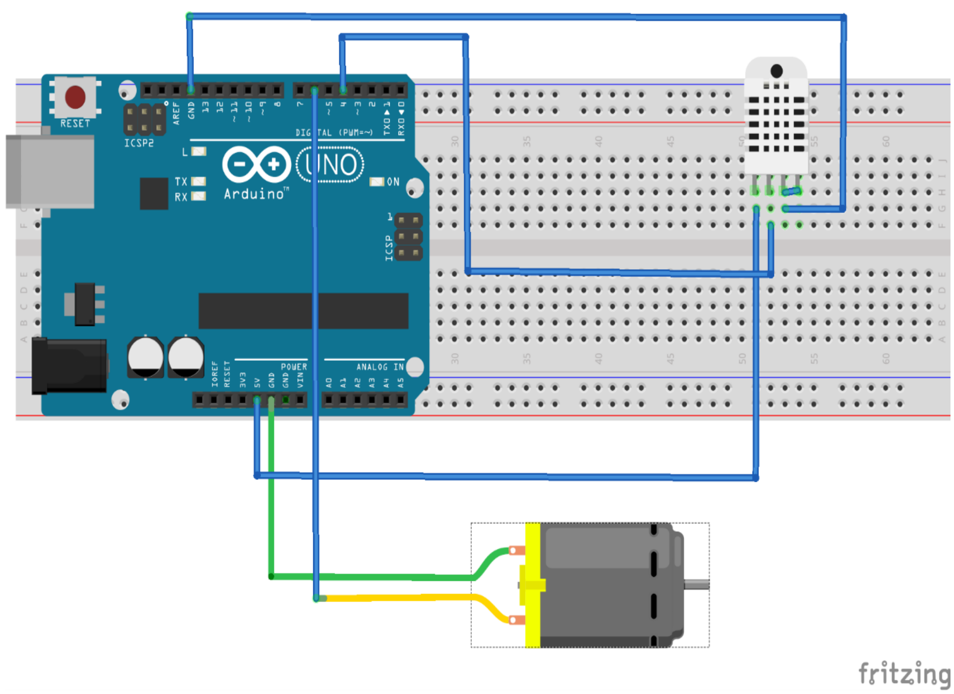

Figure 3.17: of the Automatic Fan Speed Controller

The used Arduino Sketch is:

```
#include <dht11.h>
dht11 DHT;
#define DHT11_PIN 7
```

```
void setup(){
Serial.begin(9600);
Serial.println("DHT TEST PROGRAM ");
Serial.print("LIBRARY VERSION: ");
Serial.println(DHT11LIB_VERSION);
Serial.println();
Serial.println("Type,\tstatus,\tHumidity (%),\tTemperature (C)");
}
void loop(){
int chk;
Serial.print("DHT11, \t");
chk = DHT.read(DHT11_PIN); // READ DATA
switch (chk){
case DHTLIB_OK:
Serial.print("OK,\t");
break;
case DHTLIB_ERROR_CHECKSUM:
Serial.print("Checksum error,\t");
break;
case DHTLIB_ERROR_TIMEOUT:
Serial.print("Time out error,\t");
break;
default:
Serial.print("Unknown error,\t");
break;
}
if (DHT.temperature <26){
digitalWrite(6, LOW);
}
else{
digitalWrite(6, HIGH);
}
Serial.print(DHT.humidity,1);
Serial.print(",\t");
Serial.println(DHT.temperature,1);
```

delay(1000);
}

3.4.2 Outside Of The Tent

In outside of the tent we will help the Bedouin to count the sheeps because is very difficult task to do and because it is important; and we control the level of water in the sheep drinking pot.

– **A) Counting sheeps :**
The circuit is based on the interfacing of some components such as sensors. With Arduino microcontroller. This counter can count sheep's in both directions. This circuit can be used to count the number of sheep's entering a Sheep Corral in the entrance gate. The used sensor is IR sensor and counting is displayed on a 16x2 LCD through the controller.

IR sensor

Infrared Obstacle Avoidance Proximity Sensors (Fig.3.18) Module has built-in IR transmitter and IR receiver that sends out IR energy and looks for reflected IR energy to detect presence of any obstacle in front of the sensor module. The module has on board potentiometer that lets user adjust detection range. The sensor has very good and stable response even in ambient light or in complete darkness [42].

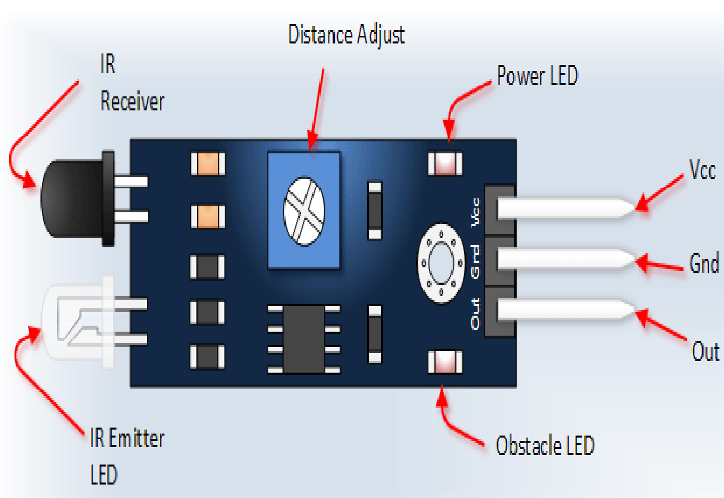

Figure 3.18: Infrared sensor [43]

Features:

- LM393 Comparator based detection circuit is very stable and accurate
- On board potentiometer sets obstacle detection range
- On board Power LED indicator
- On board Obstacle Detection LED indicator
- 3.0MM mounting hole for easy mounting the sensor
- Male header for easy connection;
- Good Accuracy: By use of Infrared LED transmitter, the module performs well in Ambient light.

Technical Specifications:

Model Number	:FC-51
Detection angle	:35°
Operating Voltage	:3.0V–6.0V
Detection range	:2cm–30cm (Adjustable using potentiometer)
PCB size	:3.1$cm(L)x1.4cm(W)$
Overall Dimension	:4.5$cm(L)x1.4cm(W), 0.7cm(H)$
Active output level	:Outputs Low logic level when obstacle is detected
In-active output level	:Outputs High logic level when obstacle is not detected
Current Consumption:	:at 3.3V : 23mAat5.0V: 43mA

Pin out

- VCC: $3.3V - 5V$ power input pin
- GND: $0V$ power pin
- OUT: Digital Output Pin

LCD	Arduino	LCD	Arduino
1 GND	GND	9 DB2	Not connected
2 VDD	5V	10 DB3	Not connected
3 Contrast	Resistor to GND	11 DB4	PIN 22
4 RS	PIN 14	12 DB5	PIN 23
5 R/S	GND	13 DB6	PIN 24
6 Enable	PIN 15	14 DB7	PIN 25
7 DB0	Not connected	15 Back LED+	Resistor to 5V
8 DB1	Not connected	16 Back LED-	GND

Table 3.3: LCD 16x2 pins connections

The schematic of this circuit:

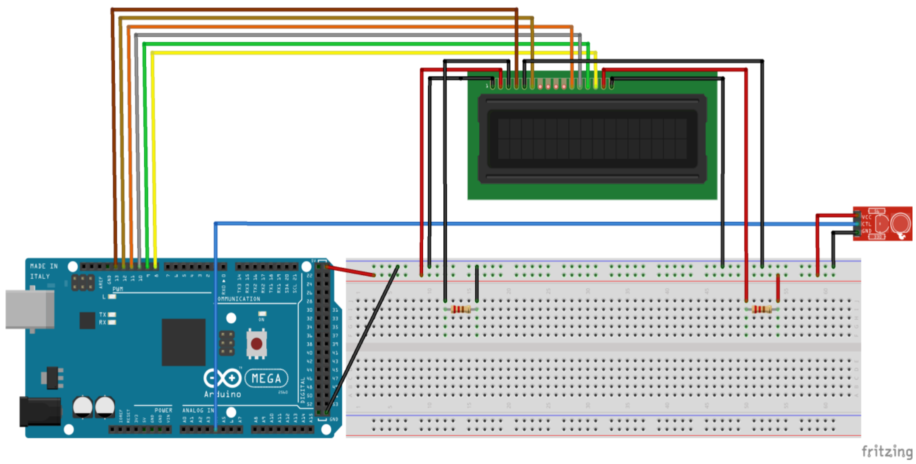

Figure 3.19: Circuit diagram of counting circuit

Arduino Sketch :

First, we have included the library for LCD and defined pins as expressed previously. And defined also input and output pins for the sensors, the used code for Arduino is expressed as follows:

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(14, 15, 22, 23, 24, 25);
#define sensor A4
int count=0;
void setup() {
pinMode(sensor, INPUT);
lcd.begin(16,2);
lcd.print("Sheeps Counter");
lcd.setCursor(0,1);
delay(1000);
lcd.clear();
lcd.print("nbr of sheeps:");
lcd.setCursor(0,1);
lcd.print(count);
```

```
}
void loop()
{
{
if (digitalRead(sensor))
{
count++;
while(digitalRead(sensor));
}
lcd.clear();
lcd.print("nbr of sheeps:");
lcd.setCursor(0,1);
lcd.print(count); delay(10);
}
}
```

B) Level water sensor

We use this circuit for saving the water in drinking pot for sheep's and save the water tank; it's simple circuit based on a level water sensor and servo motor use for open the valve when the water in pot low. Water level sensor (Fig.3.20) is an easy-to-use, cost-effective high level/drop recognition sensor, which is obtained by having a series of parallel wires exposed traces measured droplets/water volume in order to determine the water level. Easy to complete water to analog signal conversion and output analog values can be directly read Arduino development board to achieve the level alarm effect [44].

Figure 3.20: level water sensor

Specifications:

Product Name	: water level sensor
Operating current	: less than20mA
Sensor Type	: Analog
Detection Area	:40mmx16mm
Production process	: FR4 double-sided HASL
Operating temperature	:10℃-30℃
Humidity	: 10 non-condensing
Product Dimensions	: 62mmx20mmx8mm
Operating voltage	: DC$3-5V$

Servo motor [45]**:**

TowerPro SG90 - Micro Servo

Basic Information

Modulation:	Analog
Torque:	**4.8V:** 25.0 oz-in (1.80 kg-cm)
Speed:	**4.8V:** 0.10 sec/60°
Weight:	0.32 oz (9.0 g)
Dimensions:	Length: 0.91 in (23.1 mm) Width: 0.48 in (12.2 mm) Height: 1.14 in (29.0 mm)
Motor Type:	3-pole
Gear Type:	Plastic
Rotation/Support:	Bushing

Additional Specifications

Rotational Range:	180°
Pulse Width:	500-2400 µs

The schematic of this circuit is shown in Fig. (3.21):

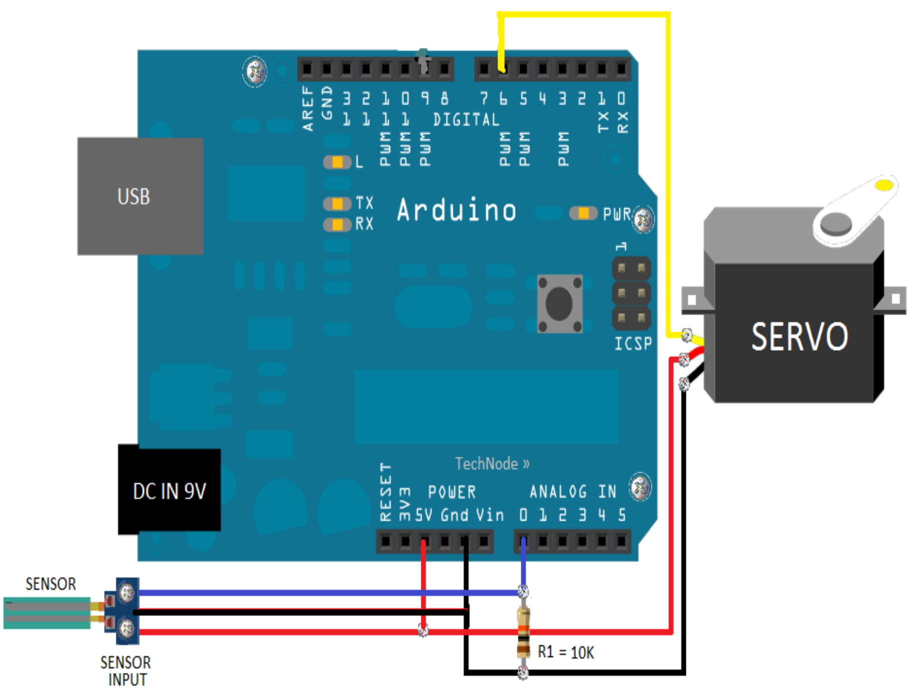

Figure 3.21: controlling servomotor with level water sensor and Arduino Uno

The used Arduino Sketch is:

```
#include <Servo.h>
Servo miniservo;
int inputSensor = 1;
int input_val;
void setup() {
Serial.begin(9600); //open serial port
miniservo.attach(5);
}
void loop() {
input_val = analogRead(inputSensor); // read the value from the input sensor
Serial.print("input sensor reads ");
Serial.println( input_val );
delay(1000);
if (input_val < 20){
miniservo.write(170); // see text to tweak the input value
} else {
miniservo.write(0);
}
}
```

3.5 Creation of the prototype




Figure 3.22: setup of component on the tent

3.6 Sizing of stand alone pv system

In this part, sizing of the stand alone PV systems that consists of finding the best compromise between panels and batteries for optimal power supply of the tent is studied. The used methodology is based on the following steps.

– Step 1:Calculate the energy consumed by the device in kWh per day.

$$\frac{nbrofdevice \times nbrofhours \times Thedevice'swattage}{1000} = kwh/day \tag{3.1}$$

The results are expressed in Table 3.4

Device	**Device wattage (w)**	**Working hours /Day**	**Energy (kwh/day)**
Fan C10G40 **(1)**	55	8	0.44
Mini Fridge **(1)**	22	24	0.528
Lamps **(7)**	11	6	0.462
TV: Condor LED 32" **(1)**	50	8	0.4
Satellite receiver **(1)**	25	8	0.2
Servomotor T0601 **(1)**	247	2	0.494
Otherdevices **(1)**	30	2	0.06
Total (13)	440	58	**2.584**

Table 3.4: Calculate the energy consumed by the device in kWh per Day

From (Table 3.4) we can see that the required power to run all the devices in the day is: 2.584 kWh/Day.

– Step 2: Calculate the number of panels

$$NP = \frac{\left(energyfeedingconverter/_{hoursofinsulation}\right) \times 1000}{wattageofpanel} \tag{3.2}$$

Where:

– The efficiency of DC/DC converter is 0.88;

– Energy imposed feeding converter is:(2.584)/0.88=2.9363;

– Max hours of insulation in Laghouat is :8 hours;

The estimated number of panels is about **two panels**.

– Step 3: Calculate the number of batteries

$$NB = \frac{\frac{(energyconsumedbydevicesperday \times 1000)}{DOD \times fficiencyofbatteries \times 150v} \times 1.5}{150} \tag{3.3}$$

Where:

– The efficiency of batteries is: 0.85;

– the depth of discharge of batteries (DOD) is:0.75;

– Battery voltage and current 12v, 150 A.

– The battery take day and half (1.5) for charging.

The estimated number of batteries is about **3.5 batteries**.

3.7 Economical study

The following table shows the list and the cost of parts used in this project:

Number	Parts	Quantity	Unit price ($)	Total
1	Arduino UNO	2	4.,77	9.54
2	Arduino Mega	1	10,93	10,39
3	LDR	1	0,04	0,04
4	PIR motion sensor	1	1,50	1,50
5	Sound sensor	1	0,82	0,82
6	IR sensor	1	0,30	0,30
7	LCD 16x2 a	1	2,34	2,34
8	DHT11	1	2,87	2,87
9	Level water sensor	1	2,39	2,39
10	Servo motor	1	2,29	2,29
11	Fan	1	0,70	0,70
12	Resistors 220Ω	10	0,01	0.10
13	Led	7	0,03	0.21
14	Breadboard	3	1,59	4.77
15	Jump wires	-	-	3.38
			Total	**43,64 $**

In Algeria, the stand alone PV system is supported for Bedouin that means getting it for **free**.

3.8 Conclusion

In this chapter, an attempt to create a smart Bedouin tent is reached. The realized tent makesthe life inside it easy and modern and adapted with the development technology, the main things that can help their life are discussed, lighting, comfort and even outside facilities are viewed. Finally, the obtained results make a revolution and considered as a first step in the desert camping technologies that can help lot of people in desert areas.

General conclusion

The Sahara has always represented a permanent challenge for man given the difficulties of life that mark him. The most apparent of these is probably the climate, the distance and isolation for cities. The Bedouins, Each of them uses means to adapt and overcome the difficulties of life in the Sahara. Yet nomads lead a different life. Thus, and despite the harsh climate, livestock remains the main activity of these nomads.

Bedouins are faced with challenges in their lifestyle, as their traditional Bedouin tent was woven from goats' hair.

When it rains the weave contracts and doesn't let the water in. In the heat of the summer the outside of the tent feels very hot to the touch while the inside remains blissfully cool. In the winter when it is cold outside with a small fire inside the reverse is true, and the tent stays warm and cozy.

Nowadays the tents are used so often and are moved day by day that we changed the material and style to be more proper for our guests. But they still offer the Bedouin comfort and atmosphere. In this dissertation, and as a challenge, we have interested to create a hall concept of smart tent to make their life as comfortable as possible.

We have based on using the Arduino card that is a powerful microprocessor based card that makes the interaction between inputs and outputs simple. Sensors are used to ensure the best experience for these Bedouin in their tents. Lighting, temperature control, water management and even sheeps counting is taken into consideration using simple and cheap sensors. In addition, ensuring the optimal power with the minimal cost is also studied. Using a stand-alonePV systems that is given free from the Algerian government encourage the use of such green energy systems. Finally, and as a conclusion, we can confirm clearly the proposed prototype using low cost sensors and materials that helps really the nomads in their life's.

Future works can add more sensors and more developed systems as replacing Arduino with AT mega pic only, using the huge range of the available sensors that makes the experiences more and more reliable and effective for the Bedouin life style.

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