DigiVet: a knowledge-based veterinary system for rural farmers in North-Ghana

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Abstract. Rural communities in Northern Ghana are facing several environmental and social/educational restrictions and limitations that prevent them from accessing information and sharing knowledge. One of the information needs that subsistence farmers living in these areas have is that they do not have access to information on animal health or to veterinarians in case one of their animals falls ill. In order to stimulate going to a veterinarian, a voice-based veterinary information service named DigiVet has been developed. This paper describes the work done in the previous two development rounds and discusses a possible extension by introducing a purely voice-based telephonic version of DigiVet.

Keywords: DigiVet, ICT4D, Kasadaka, North-Ghana, Rural farmers, Knowledge-based system, Voice-based information service

1 Introduction

Inaccessibility of knowledge influences the lack of socio-economic development in rural areas in Ghana. Poor infrastructure and lack of education are factors that increase communication gaps between experts and rural laymen. W4RA (Web Alliance for Regreening in Africa) [11] aims to incorporate ICTs in the already existing local communicative infrastructure in order to benefit these communities in sharing knowledge and accessing information. Environmental and educational restrictions, such as poor roads and illiteracy, are some of the factors that increase the digital divide between these rural communities and citizens [5]. One of the information needs that the farmers have is on animal health.

DigiVet is a voice-based veterinary information service that aims to support subsistence farmers in making the decision whether or not they should go visit a veterinarian, while bringing them into contact with each other. This paper introduces the purely voice-based, telephonic alternative to the already existing visual variant. This version was created to increase the scope of the service.

2 Use case description

The set use cases of which the one described in this paper is a part, was conducted during a field trip to the village Zanlerigu in Northern Ghana. Interviews that were held with local, subsistence farmers, formed the input for the use cases, which could then be translated into relevant ICT services. Figuring out their information needs through conducting interviews is complex, because of the language barrier and the difficulty of the farmers in expressing the specific information gaps that prevents them from working more efficiently.

The subject of the use case described in this paper is animal health care. Some animal diseases spread within and between villages, others can only be cured with the intervention of a veterinarian. The problem that arises in these rural areas is that the expertise is often not locally available and poor infrastructures prevent information and knowledge from being accessible. Some farmers indicated that they would like to receive information on animal diseases, disease patterns, diagnosis and symptoms, to enable them to take preventive action and preclude cattle loss. Gaining information from a local veterinarian could thus be relevant and useful in these cases. The idea of the elaboration of the use case is to enable veterinarians to enter the up-to-date news and knowledge regarding common diseases verbally into a voice-based system. Figure 1 shows the process flow between the actors involved.

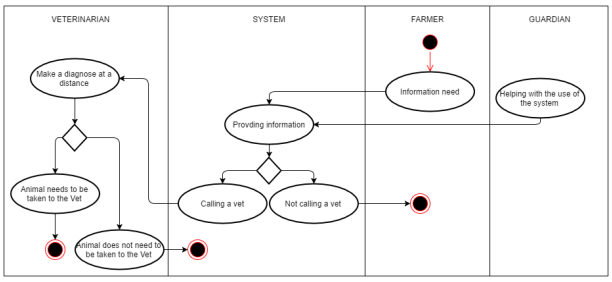

Fig. 1: The process

2.1 First prototypical cycle of DigiVet

A first voice-based prototype was build in 2015 that showed a simple interface in which farmers could click through a set of symptom related questions on a touch screen connected to the Kasadaka [8]. The Kasadaka is a rapid-prototyping platform consisting of a Raspberry Pi[3] and a GSM dongle. The main idea behind the Kasadaka is that it is composed of some basic hardware and software requirements that enable the rapid development of new voice-based information services. The first prototype of DigiVet did not yet contain animal disease information that could be used in the real world.

2.2 Second prototypical cycle of DigiVet

In the beginning of 2016, the second prototype of DigiVet was created. This included an improved knowledge base, based on the CommonKADS methodology [9]. In order to develop this new version, interviews were held with a Dutch as well as local, Ghanaian veterinarians. The latter was done by the W4RA group, by interviewing three veterinarians working in rural Northern Ghana. The Dutch veterinarian that we interviewed had stayed in Tamale, Ghana for a couple of months, working in a veterinary clinic. Based on these interviews, the objective of the system was changed from providing a diagnosis to giving an outcome of the decision whether or not a farmer has to go see a veterinarian. This was done in order to prevent that farmers would cure the animals themselves and in order to stimulate them to more proactively visit a veterinarian.

3 Description of the service

As DigiVet aims to make veterinary information more accessible to all farmers living in remote areas, the reach of the service can be increased by creating a telephonic accessible version of it. Therefore, a prototype is developed which elaborates on the already developed visual version of DigiVet by adding a second one that enables local farmers to call to the Kasadaka, and in this way accessing DigiVet.

Figure 2 shows the call-flow diagram of the system. If a farmer calls the system, he/she is primarily welcomed and is asked to indicate the type of animal that he/she would like to obtain information on. Subsequently, the farmer can answer all of the symptom related questions by pressing the corresponding Dual Tone Multiple Frequency (DTMF) number. For instance: "Press 1 if you have a dog" will guide the farmer to more specific questions regarding dog diseases. Once the system knows what kind of animal the farmer has, a general question is asked. If a farmer answers this question with yes, more specific questions will be asked, if not, the next general questions is prompted. Subsequently, if the system has enough information, it will give the output to the farmer regarding the decision whether or not to go see a veterinarian. Finally, the decision is given and an option should be provided to contact a close by veterinarian.

In order to make the system easier to use, improvements were made based on the first prototypical version. Focusing primarily on increasing the usability, the user now receives more feedback when

calling to the system. Sentences such as: "We will now list the symptoms, please indicate for each of the symptoms if it is experienced by your animal." were added to improve the flow of the call. The second extension was made by adding the option to switch between the languages English and French by adding the latter as a possible language. French is one of the main languages spoken in Mali where the application will be tested, which is why this is a logical addition.

4 Data model and system architecture

The data, available in the database as well as in the triple store, contains all the information used by the system, such as the symptom questions. These can be found on the DigiVet 3.0 Github repository [4], as well as the earlier version of DigiVet (2.0) and the prototype described in this paper. Figure 3 shows the domain schema based on the CommonKADS methodology that is used for this prototype.

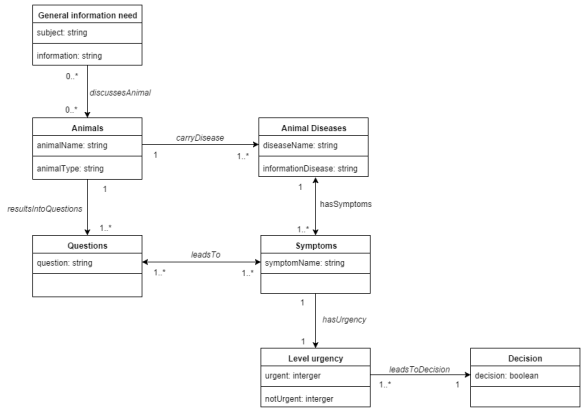

Fig. 3: Domain Schema

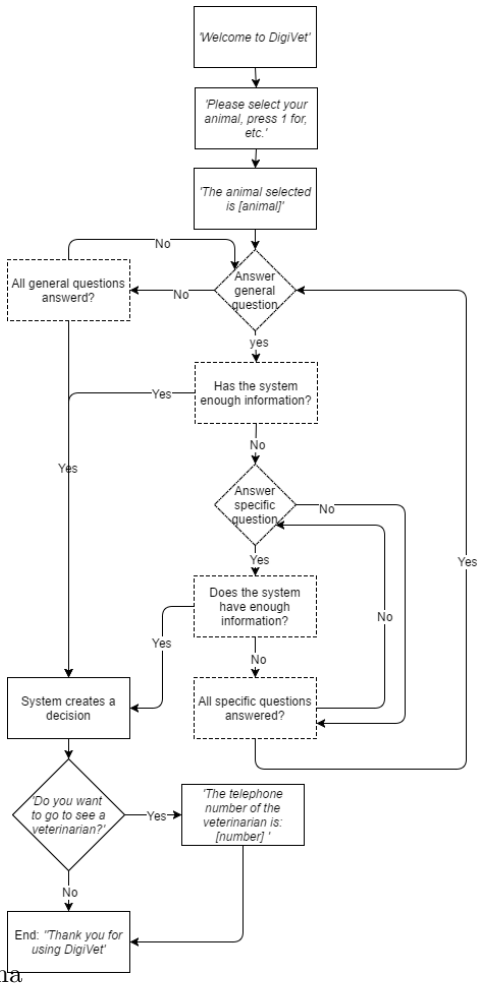

Fig. 2: Call-flow diagram

As can be seen in the domain schema, the symptoms are given a level of urgency, meaning that they are either urgent or non-urgent. The scoring of the urgency of the symptoms taken together eventually lead to the decision whether or not it is recommended to visit a veterinarian. This structure was applied in the visual version of DigiVet that uses a database. The purely voice-based version that is currently being made will eventually follow the same scoring structure. At this point, however, the questions are hard-coded, which means that the specific questions that are answered with yes or no up to the last very last question are leading to the next question in line. The final specific question in given a general question can have two different outcomes based on the input. If the user acknowledges that his/her animal suffers from that specific symptom, the system will recommend this farmer to visit a veterinarian. If this specific symptom is not recognized, the decision will be to not visit a veterinarian. In future work the scoring system will be adjusted in order for it to correspond to a real-world situation.

Figure 4 shows the systems architecture as described in section 2 and 3.

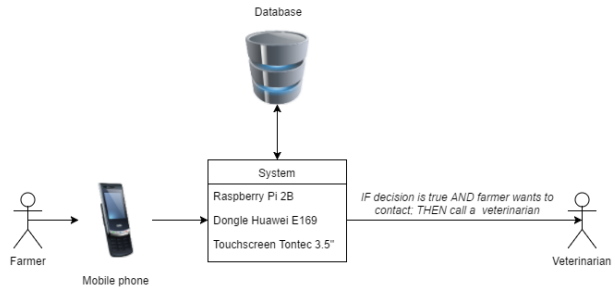

Fig. 4: System architecture

The prototype can be downloaded from the Github Repositoy. The prototype is made with the use of voiceXML files which is a document standard for voice dialogs [10]. So, with XML files the described dialog (see figure 2) is programmed. An XML file has been made that enables the option for farmers to call a veterinarian directly if the farmers want to call a veterinarian based on the decision of the system. Further tests should prove whether this method is sufficient. For the system, audio files needed to be generated. Audacity [1], a software tool for editing and recording sounds, is used to record spoken text from a text to speech websites [7] [6].

5 Installation guide

This section will describe the set of steps that have to be made in order to install the voice-based version of DigiVet successfully on your Linux(Debian)-based device.

Prerequisites

- A Linux(Debian)-based system, such as a Raspberry Pi (2nd or 3rd generation), or a computer running Debian.
- The Kasadaka image (see next paragraph).
- If preferred, a GSM dongle, such as the Huawei E169.

Install Kasadaka image

Download the Kasadaka image from the following Wiki: `https://github.com/abaart/KasaDaka/wiki/Virtual-KasaDaka`. Once the download has completed, you may import it in the Debian version that you are using as described in the Wiki.

Loging into the system can be done by entering the user name and password, which are both: kasadaka.

Place DigiVet on the Kasadaka

Use the following commands to replace the existing folders and files by the ones needed for DigiVet.

```
kasadaka@kasadaka:~$ cd KasaDaka/html
kasadaka@kasadaka:~/KasaDaka/html$ rm -rf audio
kasadaka@kasadaka:~/KasaDaka/html$ git clone http://github.com/Rromulus/DigiVet_audio.git
```

You should now be able to see the DigiVet subdirectories that are cloned from github [2] to the *html* directory. In the audio directory, the English (`/html/audio/en/audiofiles_english/`) and the French (`/html/audio/fr/audiofiles_french/`) audiofiles are stored there, as well as the English XML files (`/html/DigiVet/EN/`) and the French versions (`/html/DigiVet/FR/`).

Adjustment Asterisk extensions file

The last adjustment we should make before testing the application is to replace the extensions.conf file that is used to invoke the XML files.

```
kasadaka@kasadaka:~$ cd KasaDaka/etc/asterisk
kasadaka@kasadaka:~/KasaDaka/etc/asterisk$ sudo nano extensions.conf
[sudo] password for kasadaka: kasadaka
```

After entering the kasadaka sudo password, a screen will pop up that allows you to make changes to the extensions.conf file. Replace the 10th and 14th line in the file such that they match the following two lines respectively:

```
;10th line replacement
exten => _.,n,Vxml(http://127.0.0.1/DigiVet/EN/welcome.xml)

;14th line replacement
exten => kasadaka,n,Vxml,(http://127.0.0.1/DigiVet/En/welcome.xml)
```

Save and exit the file by using *Ctrl + X*, then *Ctrl + Y*, followed by *ENTER*. Since the Asterisk file has been adjusted, we should now reboot the system. This can either be done manually or by typing the *sudo reboot* command in the Terminal.

Calling DigiVet

Once the system has rebooted itself, log in and use the Applications Menu to navigate to the softphone called Linphone. This is located under Internet >Linphone. The softphone will open with the appropriate SIP already entered, namely: <sip:kasadaka@127.0.0.1>. Dial this number and the system should internally call DigiVet.

Of course a dongle can also be used to call DigiVet. Insert the dongle containing a simlock-free SIM-card and dial the phone number belonging to the SIM-card to access DigiVet.

6 Demonstration scenario

Due to the fact that the questions are hard-coded, instead of a connection with a database (see future points in section 7), we have made a couple of scenario's for demonstrating the goal and usability of the prototype.

When the user calls the system, the system welcomes the user and the user has to select its kind of animal. For the prototype, only the cow (number 1) works. Next, the user has to answer a couple of questions. The prototype is build in such a way, that it consists of a couple of general and a set of specific questions which, at the end, lead to the decision whether or not the farmer has to go to see a veterinarian. Based on this decision, the farmer can decide whether or not to contact the veterinarian immediately.

We have the following questions that we want to ask:

1. Would you go see a veterinarian if the system would indicate that this is recommended?
2. How do costs and travel distance influence your decision to go see a veterinarian?
3. Would you prefer to use the Kasadaka (visual DigiVet 2.0) or just calling the system with your mobile phone?

7 Discussion

The voice-based version of DigiVet that was created has been extended, giving it a more complex structure as well as the ability for users to switch between the languages French and English. The audio files used to do the text to speech translations can easily be replaced by audio files recorded in the local languages, if necessary. For now, the support of the two languages is sufficient, given the area in which we would like to test the prototype (Mali and possibly Ghana).

The visual interface that was previously build (section 2.2) was quite detailed and complex in terms of the scoring structured used. The voice-based version of DigiVet is much simpler, and the reliability and robustness of this service could benefit from the extended structure of the visual DigiVet. However, for both these versions holds that the validity can only be guaranteed by extensively testing them in the field. Veterinarians in Tamale, Ghana, have already indicated that they are willing to test the service. In collaboration with these veterinarians, we could work on a functioning version of DigiVet, both visually and purely voice-based.

Future work for us is to extend the DigiVet application with the use of Linked Data. To be able to extend the simple prototype that was made, a connection to a database is necessary. In the second version of DigiVet, the application is connected to a MySQL database which enables for the systems to automatically retrieve information (questions) from the database. This database was later converted into a Linked Data triple store.

The next step is thus to extend the call service of the Digivet is to connect the application to the triple store. This will hopefully be achieved in the near future.

References

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